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Artificial Intelligence in Type II Diabetes Mellitus: Screening, Treatment, and Complication

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Abstract

Type II diabetes mellitus is one of the chronic metabolic diseases that are associated with insulin resistance. Type II diabetes mellitus incidence continues to increase each year and may cause various health complications, even death. Addressing early detection and appropriate treatment is important in decreasing the incidence of type II diabetes mellitus and improving the quality of life in diabetic patients. The potential of artificial intelligence in healthcare is expected to assist in screening, therapy management, and even detection of type II diabetes mellitus complications. Despite limited literature, this study aims to understand the benefit of AI in assisting health workers in screening and managing type II diabetes mellitus. Searches are conducted with search engines, such as PubMed, Science Direct, and Google Scholar, with the keywords "Artificial Intelligence" and "Diabetes Mellitus Type 2", as well as their synonyms. The search results in twenty English and Indonesian studies were published in the last ten years. These various studies found that many Artificial intelligence models developed to assist in screening, therapy management, and detect complications in patients with type II diabetes mellitus.

Introduction

Type II diabetes mellitus is a chronic metabolic disease causing insulin sensitivity disruption in body tissues and hyperglycemia. Type II diabetes mellitus is multifactorial, caused by genetic factors and lifestyle. The sedentary lifestyle that is commonly practiced by people today, along with excessive diet, plays a significant role in the occurrence of type II diabetes mellitus. According to the American Diabetes Association (ADA), the criteria for type II diabetes mellitus consist of several, namely when someone has symptoms of diabetes with blood sugar levels of more than 200 mg/dL; fasting blood sugar levels exceeding 125 mg/dL; HbA1c above 6.5%; and blood sugar on the oral glucose tolerance test (OGTT) of more than 200 mg/dL (Loscalzo *et al.,* 2022; American Diabetes Association, 2022).

The prevalence of type II diabetes mellitus in the world has continued to increase in the last two decades, estimated at around 30 million cases in 1985 and increasing to 415 million cases in 2017. Based on the World Health Organization (WHO), around 422 million people worldwide have diabetes, and the majority live in countries with low and middle economic status. The incidence of type II diabetes mellitus in Indonesians is also reported to continue to increase every year. According to Riskesdas data, in 2013, the number of people with type II diabetes mellitus was 1.5%. In 2018, it was 2%. In 2023, there was a significant increase of 12.2%, which means

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that in 100 people, 12.2 people have type II diabetes mellitus (Loscalzo *et al.,* 2022; Badan Penelitian dan Pengembangan Kesehatan. Riset Kesehatan Dasar 2013). Type II diabetes mellitus can cause impacts on various aspects of life that will result in a decrease in a person's quality of life. WHO reports that around 1.5 million people die from diabetes each year. Type II diabetes mellitus can cause various health complications in macrovascular and microvascular. Examples of macrovascular complications are cardiovascular disease, stroke, and also disorders of the peripheral blood vessels. Meanwhile, complications can occur in microvascular such as neuropathy, nephropathy, and retinopathy (Loscalzo *et al.,* 2022; American Diabetes Association, 2023).

Type II diabetes mellitus often experiences delays in diagnosis so that the patient's condition has reached a complication phase that can be life-threatening. Therefore, it is important to be able to predict by screening and establishing an early diagnosis in people at risk of developing type II diabetes mellitus. In addition to screening and early diagnosis, comprehensive therapy for patients with type II diabetes mellitus is also important. Currently, various challenges are found in providing therapy for patients with type II diabetes mellitus, which can come from patient factors, health worker factors, and also limitations of existing pharmacological treatment. The difficulty of complying with the given therapy regimen, modifying lifestyle, tolerance to the drugs given, access to health services that are hampered, and others are some of the factors that make therapy for patients with type II diabetes mellitus not easy (Loscalzo *et al.,* 2022; Dinavari *et al.,* 2023).

Artificial intelligence, or AI, is experiencing development and progress, especially in the 21st decade. AI has a complex meaning. It can be briefly defined as a technology that aims to create an intelligence algorithm that can imitate human intelligence. AI is being used in various fields to help human work, one of which is the health sector. AI is also considered to be able to assist in screening, therapy management, and detecting complications in patients with type II diabetes mellitus. Even so, few literature that discusses and deepens this matter. Therefore, the purpose of writing this literature is to comprehensively understand the role of AI in helping health workers conduct primary screening and therapy and prevent complications in patients with type II diabetes mellitus (Wu *et al.,* 2023).

Method

The search was conducted using the keywords "Artificial Intelligence" and "Diabetes Mellitus Type II", and their synonyms. The search engines used were PubMed, Science Direct, and Google Scholar. The studies used were English and Indonesian published in the last 10 years. In the literature search, 20 studies could be used in this review article.

Results and Discussions

Late diagnosis of diabetes can lead to complications and lower life expectancy, so early screening and diagnosis are vital. However, early diagnosis of diabetes is more difficult because it is generally asymptomatic, so many people go undiagnosed (Guan *et al*., 2023). AI can help screen for diabetes in individuals who have high-risk factors for diabetes. Research by Joshi *et al*. (2021), using logistic regression and classification tree models to identify important factors of type II diabetes mellitus. Finally, five main risk factors were found to be related. Namely the number of pregnancies in women, glucose, family history, BMI, and age. After a validation test, the research model had a prediction accuracy of 78% (Joshi & Dhakal, 2021). A recent study by Kaufman *et al*. (2023) can even use speech patterns to detect type II diabetes with AI. With voice frequency analysis, voice changes inaudible to the human ear will pass through AI analysis. Often, a voice recorder on a telephone is the software needed to perform the analysis. It will examine speech melody, rhythm, pauses, and pitch. Particular symptoms have distinctive phonetic characteristics, such as the pronunciation of the vowel A for five seconds. The human voice can display up to 200,000 different characteristics. An AI algorithm can sift through these characteristics to identify specific vocal patterns that match certain symptoms. The AI will sift through voice recordings that last between six and ten seconds, looking for differences in pitch

and intensity of the vocals. Combined with basic health data, such as age, gender, height, and weight, the program can gauge whether the speaker has type II diabetes (kaufman *et al.,* 2023).

A study by Li *et al*. (2021) used tongue color and texture as predictors of diabetes, with an accuracy of up to 99%. This study explains that the tongue can be a potential marker to help diagnose prediabetes and diabetes (Li *et al*., 2021). A previous study by Shu *et al*. (2017) used the effect of facial texture in predicting diabetes mellitus based on specific facial areas with texture extractors. In this study, an accuracy of up to 99% was obtained with a support vector machine (Shu *et al.,*2017). A study by Pyrros *et al*. (2023) used AI to screen for diabetes using x-ray images. By using 'deep learning' methods on images and electronic health record data, researchers were able to develop a model to detect the increased risk of diabetes in a retrospective analysis. Every year, millions of Americans receive chest X-rays, and these images become part of the patient's medical record and can later be analyzed for diabetes or other conditions. The AI model was run on more than 270,000 x-ray images from 160,000 patients, with 'deep learning' methods determining which image features were most likely to predict a later diagnosis of diabetes. Chest X-rays are not a common way to detect diabetes, so the researchers used AI techniques to determine how and why the model made its decisions. It found that the location of fat tissue was vital in determining risk, with visceral fat in the upper body and abdomen associated with type II diabetes, insulin resistance, hypertension, and other conditions. When the AI model was applied to a separate group of nearly 10,000 patients, it predicted risk better than a simple model based only on clinical data. In some cases, chest X-rays warned of a high risk of diabetes as early as three years before the patient was finally diagnosed (Pyrros *et al*., 2023).

The incidence of type II diabetes mellitus as a non-communicable disease continues to increase from year to year. This chronic disease is influenced by various factors, including genetic factors and lifestyle. With the development of technology, more and more patients are utilizing AI, such as Chat Generative Pre-Trained Transformer (ChatGPT), a text-generating AI (TGAI), to find more information about their condition. A study by Hernandez CA, Vazquez Gonzalez AE, Polioanovskaia A, *et al*. (2023) showed that questions directed at TGAI provided fairly accurate answers. In the study, a group of experienced doctors asked various questions about type II diabetes mellitus to ChatGPT three times. All ChatGPT answers were summarized and categorized by the standard of care (latest guideline)', 'not appropriate', namely answers that contain elements of correct information but are incomplete or outdated, and 'unreliable' based on the assessment of two experienced doctors. A total of 70 questions, such as 'Can type II diabetes cause increased urination frequency?' were answered by ChatGPT, with an accuracy rate of 98.5%. Of the 70 questions, the question categorized as 'inappropriate' was 'Can stress affect blood glucose levels?'. The results follow a previous study by Haver *et al*. with an accuracy rate of 88%. The accuracy rate achieved by the TGAI application is higher than a regular search engine. However, TGAI requires further processing to improve accuracy.[15]

In addition, a study by Chen *et al*. (2022) was conducted in China due to limited access to health facilities so patients experience obstacles in receiving diabetes education. The study examined the effect of mobile phone applications on the knowledge of type II diabetes mellitus patients who will start treatment with premixed insulin. A mobile phone-based application called the Lilly Connected Care Program (LCCP) which functions as an educational program about diabetes was used by 9,426 patients with uncontrolled HbA1c for 12 weeks. The application contains a 'Daily Quiz' menu and 60 videos and articles about diabetes. After 12 weeks, HbA1c levels decreased from 9.8 ± 1.5% (84 ± 16.4 mmol/mol) to 7.4 ± 1.2% (57 ± 13.1 mmol/mol), and 36% of patients achieved HbA1c levels <7%. In addition, the number of patients experiencing hypoglycemia decreased from 10.1% to 4.4% (Chen *et al*., 2023).

Nutritional intake also plays a vital role in blood sugar management in adult patients with type II diabetes mellitus. A study in Korea by Lee *et al*. (2023) divided 295 overweight

and obese patients into three groups. The first group only received routine therapy/care, the second group only used a digital platform, and the third group used the platform. It was accompanied by advice from medical personnel and combined with continuous glucose monitoring (CGM) periodically. Participants in groups B and C were given a glucometer, a sphygmomanometer, a scale equipped with bioelectrical impedance analysis, and a watch-shaped pedometer that could be connected to the platform via Bluetooth. An AI program called FoodLens was used to photograph the food consumed by patients. It can assess calories and other nutritional data from various foods in the photo and then integrate with the platform. Group C participants were also equipped with a CGM device that was used for 1 week every 3 months and received feedback via SMS from medical personnel. The study showed that after 24 weeks, the decrease in HbA1c levels was higher in group B (−0.32 ± 0.58%) and group C (−0.49 ± 0.57%) than in group A (−0.06 ± 0.61%). After 48 weeks, groups B (−0.28 ± 0.56%) and C (−0.44 ± 0.62%) continued to experience a higher decrease than group A (0.07 ± 0.78%). In addition, at week 48, group C experienced a significant weight loss compared to group A (Lee *et al*., 2023). Research by Zeevi *et al*. (2015) found that there was a high level of blood sugar variability in the same diet. The study created a machine learning algorithm that integrated diet, blood sugar parameters, anthropometry, physical activity, and gut microbiota. The algorithm was used in 100 participants (31% with HbA1c >= 5.7% and 3% with HbA1c >= 3%) and effectively decreased post-prandial blood sugar (Zeevi *et al.,* 2015).

Several applications have been designed to facilitate the monitoring of diabetes mellitus, a chronic disease that has become the center of attention in health technology. Health technology provides a series of features, including monitoring diabetes conditions, creating a communication medium between patients and medical staff, enabling remote monitoring, recording and maintaining medical history, and increasing patient knowledge of the disease. An intelligent mobile diabetes management system (SAED) is designed to improve self-management, focusing on diabetes mellitus. The SAED system consists of three components, namely the user component (mobile patient/healthcare provider), the intelligent diabetes management component, and the diabetes educational module component (Diabetes educational module).

The user component functions to record blood sugar measurement results using a particular tool connected to the user's smartphone via Bluetooth. The data will be sent to the SAED cloud server accessed by the clinician concerned so that monitoring and communication can be done remotely. The diabetes management intelligence component functions as a system that helps to determine clinical decisions for clinicians by providing data from patients related to their current medical history. The diabetes education module aims to improve the knowledge of patients with diabetes to facilitate better self-management. A case-control study conducted by Alotaibi *et al*. (2016) showed that the intervention group with the SAED system experienced a significant decrease in HbA1c levels (7.85 ± 0.70) within 6 months compared to the control group, which experienced an increase in the average value (8.68 ± 1.54). Overall, the SAED system offers a solution to improve the quality of life of people with diabetes mellitus effectively and at low cost (Alotaibi *et al.,* 2016).

The currently popular method of monitoring blood sugar levels is the continuous glucose monitoring (CGM) biosensor. Jin *et al*. (2023), have made the latest innovation by combining AI and CGM biosensors to obtain individual-focused health services. CGM biosensors enable real-time monitoring of a person's blood sugar levels, reduce the pain obtained from capillary blood sugar examinations, and capture a holistic, individualized glycemic control model that facilitates lifestyle changes and personalized therapy. CGM systems generally consist of glucose recognition elements, physical or chemical transducer elements, wireless transmitter elements, and receivers. Glucose detection technology in CGM systems can be carried out electrochemically, optically, and using tools.

Artificial Intelligence can be used in closed-loop control algorithms or artificial

pancreas systems, glucose prediction algorithms based on CGM biosensors, and CGM biosensor calibration algorithms. In artificial pancreas systems, AI can be incorporated into insulin pumps worn or smartphones that will function to calculate insulin doses accurately based on real-time measurements and differences in values with previous measurements. In addition, AI will also create an algorithm that can provide information or advice according to the knowledge of experts (practitioners or diabetes experts) to regulate insulin administration. Another function of the AI algorithm is to provide glucose level predictions that can be used to achieve glycemic balance. The calibration algorithm functions to prevent calculation errors that can result in hypoglycemia or hyperglycemia. The combination of AI with CGM biosensors offers convenience in controlling glucose levels in the body for people with diabetes mellitus. AI can be used in closed-loop control algorithms or artificial pancreas systems, glucose prediction algorithms based on CGM biosensors, and CGM biosensor calibration algorithms. In the artificial pancreas system, AI can be incorporated into a wearable insulin pump or smartphone that will calculate the insulin dose accurately based on real-time measurements and differences in values with previous measurements. In addition, AI will also create an algorithm that can provide information or advice according to the knowledge of experts (practitioners or diabetes experts) to regulate insulin administration. Another function of the AI algorithm is to predict glucose levels to achieve glycemic balance. The calibration algorithm functions to prevent calculation errors that can result in hypoglycemia or hyperglycemia. The combination of AI with CGM biosensors offers convenience in controlling glucose levels in the body for people with diabetes mellitus (Jin *et al.,* 2023). The quality of life of people with type II diabetes mellitus depends on the ability to predict, diagnose, and provide appropriate management of complications (both acute and chronic). Here are some potential advances in AI for early detection of complications in type II diabetes mellitus.

Flash glucose monitors (FGMs) and continuous glucose monitors (CGMs) are AI technologies used to detect and control hypoglycemia and hyperglycemia in patients with type II diabetes mellitus. Artificial intelligence has been commercially available and has shown potential in managing blood glucose effectively, not only in type 1 diabetes mellitus but also in type II diabetes mellitus requiring insulin. Evaluation of glycemic fluctuations with CGMs such as FreeStyle Libre (Abbott Diabetes Care, Alameda, CA, USA) has been shown to improve glycometabolic control and short-term oscillations in patients requiring multiple insulin administrations. Continuous glucose monitoring (CGM) is more effective than FGM in preventing hypoglycemia. When combined with an insulin pump, CGM systems offer the potential for closed-loop insulin systems, also known as artificial pancreas systems. For example, Diabeloop technology (Diabeloop SAS, Grenoble, France) promises to manage type II diabetes mellitus by reducing overall healthcare costs and delivering insulin to individuals who need it (Behera, 2021). An autonomous artificial intelligence (AI) known as IDx-DR (Digital Diagnostics, Coralville, IA, United States) is designed to diagnose diabetic retinopathy and macular edema in real time at the point of care. The initial development of IDx-DR occurred at the University of Iowa as the Iowa Detection Program (IDP).

IDx-DR is the first autonomous artificial intelligence system to receive commercial authorization from the U.S. Food and Drug Administration (FDA). The study that formed the basis for IDx-DR approval was conducted in a primary care setting using operators with no prior experience in retinal imaging. Data collected by certified retinal photographers (OCT) and four wide-field stereoscopic fundus images were compared to patient outcomes. The images were evaluated by an autonomous reading center that developed the Early Treatment for Diabetic Retinopathy Study (ETDRS), the patient outcome reference standard applied to all DR management trials. The system is designed to identify clinically significant or center-related diabetic macular edema (DME), or an ETMDS grade of 35 or higher. IDx-DR has been certified in Europe as a class IIa medical device (Grzybowski & Brona, 2021).

In Caucasian, North African, and Sub-Saharan populations, the IDP has demonstrated positive results. The IDP algorithm and human raters analyzed images associated with 3640 participants in the Nakuru Eye Study conducted in Kenya. Human raters and the IDP agreed that the images were of inadequate quality 334 times. Twenty cases were identified by human raters as having poor image quality, whereas the IDP analysis determined that the images were evaluable and free of diabetic eye disease (DED). The IDP achieved a specificity of 70.0% and a sensitivity of 86.7% when patients were not evaluable, which was similar to the performance of human raters. Importantly, human raters did not identify any of the false-negative results as indicating sight-threatening DED (Grzybowski *et al.*, 2020).

In addition, IDX-DR was recently validated in a practical setting within the Dutch diabetes care system. Eighty-four percent of 1410 patients were deemed to be of adequate quality by three independent human raters, compared with 66.3% for the IDX-DR system; however, there were concerns regarding the functionality of the re-imaging alert built into the system. Images were evaluated by study experts using a combination of the ICDR and EURODIAB scoring systems. The sensitivity/specificity of IDX-DR was 91%/84% by EURODIAB and 68%/86% by ICDR. The significant performance gap between EURODIAB and ICDR can be attributed to the ICDR scale criteria that classify one bleed as having at least one major complication. Reconsidering it, the authors observed that the sensitivity and specificity of IDX-DR would be 96% and 86%, respectively. The population studied showed a low prevalence of DR, a characteristic associated with effective diabetes management and regular screening (Van der Heijden, 2018).

Developed in Portugal, the RetmarkerDR software has been used locally for diabetic retinopathy (DR) screening for several years. In 2011, it was integrated into a human-rater-based DR screening program already running in a Portuguese center. In this case, Retmarker is used for initial classification into "disease" or "no disease," thus designating the "disease" subgroup for evaluation by human raters. RetmarkerDR implements a machine learning (ML) algorithm based on features. The primary uniqueness of RetmarkerDR lies in its ability to compare current images with those previously evaluated. It allows us to determine whether disease progression has occurred. In addition, the software can identify the rate of manifestation of new and pre-existing microaneurysms; it is referred to as the "microaneurysm change rate." It appears to be a prospective marker for progression to diabetic maculopathy and worsening DR, as intravitreal ranibizumab therapy for diabetes mellitus is associated with a decreased rate of microaneurysm change. Intravitreal implants containing dexamethasone have also been associated with a lower rate of microaneurysm change in patients with diabetes. However, this is a subject that requires substantial additional research (Grzybowski *et al*., 2020).

In a comprehensive review of the prospective application of AI-based DR screening tools in national DR screening in the UK, RetmarkerDR was used for analysis.24 From over twenty thousand patients screened at a single center in London, Tufail *et al*. analyzed two images per eye, one focused on the macula and the other on the disc. A comprehensive evaluation of the economic efficiency and screening efficacy of three ARIAS - RetmarkerDR, EyeArt, and iGradingM - was performed for this study. The obtained sensitivities for proliferative retinopathy (97.9%), referable retinopathy (85.0%), and any retinopathy (73.0%) were in contrast to the results of audited human assessors. There were 47% false positives (Grzybowski *et al.*, 2020).

Currently, AI is used to create a risk factor algorithm that combines physical examination parameters and demographic information to calculate the likelihood of a patient developing a diabetic foot ulcer with an accuracy of 79.8%.26 The primary purpose of using AI is to identify the likelihood of a patient developing a diabetic foot ulcer. The applied technologies are thermography and multispectral imaging. The use of AI in the prevention of diabetic foot ulcers is currently under development. Currently, no adequate data can be used to diagnose prevention in patients at high risk of diabetic foot ulcers. Most data currently under

development is from Manchester Metropolitan University, with a total of 11 thousand images, but the number of images is still insufficient to diagnose prevention (Huang *et al*., 2022).

Current diagnostic examinations for diabetic peripheral neuropathy (nerve conduction velocity examination, quantitative sensory examination, skin biopsy) are less efficient because they are time-consuming and have low specificity. AI can be diagnosed with three types. They are qualitative and quantitative physiology and anatomical examinations. Qualitative examinations can be in EuroQol-5 Dimension (EQ5D) health-related quality-of-life examinations. Artificial Intelligence plays a role in quantitative physiological examinations to stratify the level of severity at different places at the same time. Anatomically, AI with magnetic resonance imaging and ultrasound images of peripheral nerves can create biomarkers of diabetic peripheral neuropathy pain based on functional connectivity and blood flow in the central nervous system. However, Corneal confocal microscopy is more effective than AI examinations because it has faster sensitivity and results and is more non-invasive (Huang *et al*., 2022).

Conclusions

Artificial Intelligence (AI) has significantly influenced the management of type II diabetes mellitus with success in screening, diagnosis, therapy management, and complication detection. With various AI models, such as logistic regression, color analysis, and blood sugar monitoring technology, high accuracy in detecting risk factors and symptoms of the disease has been achieved. In diabetes management, AI plays a role in health education, nutrition monitoring, and the closed-loop control system developed for insulin dosing. Mobile applications and digital education programs help improve patient understanding and control HbA1c levels. The contribution of AI in detecting complications opens up the potential for early prevention and intervention. Although challenges such as validation and safety need to be overcome, the great potential of AI in improving quality of life and reducing the risk of complications shows a positive direction toward AI integration in chronic disease management.

References

Alotaibi, M.M., Istepanian, R., & Philip, N., 2016. A Mobile Diabetes Management and Educational System for Type-2 Diabetics in Saudi Arabia (SAED). *mHealth*, 2, pp.33.

American Diabetes Association., 2022. *Standards of care in Diabetes-2023 abridged for Primary Care Providers*.

American Diabetes Association., 2023. Standards of Care in Diabetes to Guide Prevention, Diagnosis, and Treatment for People Living with Diabetes.

Badan Penelitian dan Pengembangan Kesehatan., 2013. *Riset Kesehatan Dasar 2013*.

Behera, A., 2021. Use of Artificial Intelligence for Management and Identification of Complications in Diabetes. *Clinical Diabetology*, 2021.

Chen, S., Lu, J., Peng, D., Liu, F., Lu, W., Zhu, W., Zhou, J., & Jia, W., 2023. Effect of a Mobile Health Technology-Based Diabetes Education Program on Glucose Control in Patients with Type 2 Diabetes Initiating Premixed Insulin: A Prospective, Multicenter, Observational Study. *Diabetes Care*, 46(1), pp.e6–e7.

Dinavari, M.F., Sanaie, S., Rasouli, K., Faramarzi, E., & Molani-Gol, R., 2023. Glycemic Control and Associated Factors Among Type 2 Diabetes Mellitus Patients: A Cross-Sectional Study of Azar Cohort Population. *BMC Endocrine Disorders*, 23(1), pp.273.

Grzybowski, A., Brona, P., Lim, G., Ruamviboonsuk, P., Tan, G.S.W., Abramoff, M., & Ting, D.S.W., 2020. Artificial Intelligence for Diabetic Retinopathy Screening: A Review. *Eye (London, England)*, 34(3), pp.451–460.

Grzybowski, A., & Brona, P., 2021. Analysis and Comparison of Two Artificial Intelligence Diabetic Retinopathy Screening Algorithms in a Pilot Study: IDx-DR and Retinalyze. *Journal of Clinical Medicine*, 10(11), pp.2352. Van der Heijden, A.A., Abramoff, M.D., Verbraak, F., van Hecke, M.V., Liem, A., & Nijpels, G., 2018. Validation of Automated Screening for Referable Diabetic Retinopathy with the IDx-DR Device in the Hoorn Diabetes Care System. *Acta Ophthalmologica*, 96(1), pp.63–68.

Guan, Z., Li, H., Liu, R., Cai, C., Liu, Y., Li, J., Wang, X., Huang, S., Wu, L., Liu, D., Yu, S., Wang, Z., Shu, J., Hou, X., Yang, X., Jia, W., & Sheng, B., 2023. Artificial Intelligence

in Diabetes Management: Advancements, Opportunities, and Challenges. Cell Reports. *Medicine*, 4(10), pp.101213.

Hernandez, C.A., Vazquez Gonzalez, A.E., Polianovskaia, A., Amoro Sanchez, R., Muyolema Arce, V., Mustafa, A., Vypritskaya, E., Perez Gutierrez, O., Bashir, M., & Eighaei Sedeh, A., 2023. The Future of Patient Education: AI-Driven Guide for Type 2 Diabetes. *Cureus*, 15(11), pp.e48919.

Huang, J., Yeung, A.M., Armstrong, D.G., Battarbee, A.N., Cuadros, J., Espinoza, J.C., & Klonoff, D.C., 2022. Artificial Intelligence for Predicting and Diagnosing Complications of Diabetes. *Journal of Diabetes Science and Technology*, 17(1), pp.224–238.

Jin, X., Cai, A., Xu, T., & Zhang, X., 2023. Artificial Intelligence Biosensors for Continuous Glucose Monitoring. *Interdisciplinary Materials*, 2(2), pp.290–307.

Joshi, R.D., & Dhakal, C.K., 2021. Predicting Type 2 Diabetes Using Logistic Regression and Machine Learning Approaches. *International Journal of Environmental Research and Public Health*, 18(14), pp.7346.

Kaufman, J.M., Thommandram, A., & Fossat, Y., 2023. Acoustic Analysis and Prediction of Type 2 Diabetes Mellitus Using Smartphone-Recorded Voice Segments. *Mayo Clinic Proceedings: Digital Health*, 1(4), pp.534–544.

Lee, Y.B., Kim, G., Jun, J.E., Park, H., Lee, W.J., Hwang, Y.C., & Kim, J.H., 2023. An Integrated Digital Health Care Platform for Diabetes Management With AI-Based Dietary Management: 48-Week Results from a Randomized Controlled Trial. *Diabetes Care*, 46(5), pp.959–966.

Li, J., Yuan, P., Hu, X., Huang, J., Cui, L., Cui, J., Ma, X., Jiang, T., Yao, X., Li, J., Shi, Y., Bi, Z., Wang, Y., Fu, H., Wang, J., Lin, Y., Pai, C., Guo, X., Zhou, C., Tu, L., & Xu, J., 2021. A Tongue Features Fusion Approach to Predicting Prediabetes and Diabetes with Machine Learning. *Journal of Biomedical Informatics*, 115, pp.103693.

Loscalzo, J., Fauci, A., Kasper, D., Hauser, S., Longo, D., & Jameson, J., 2022. *Harrison's Principles of Internal Medicine*, 21e. McGraw-Hill Education.

Mousa, K.M., Mousa, F.A., Mohamed, H.S., & Elsawy, M.M., 2023. Prediction of Foot Ulcers Using Artificial Intelligence for Diabetic Patients at Cairo University Hospital, Egypt. *SAGE Open Nursing*, 9, pp.23779608231185873.

Pyrros, A., Borstelmann, S.M., Mantravadi, R., Zaiman, Z., Thomas, K., Price, B., Greenstein, E., Siddiqui, N., Willis, M., Shulhan, I., Hines-Shah, J., Horowitz, J.M., Nikolaidis, P., Lungren, M.P., Rodríguez-Fernández, J.M., Gichoya, J.W., Koyejo, S., Flanders, A.E., Khandwala, N., Gupta, A., Garrett, J.W., Cohen, J.P., Layden, B.T., Pickhard, P.J., & Galanter, W., 2023. Opportunistic Detection of Type 2 Diabetes Using Deep Learning from Frontal Chest Radiographs. *Nature Communications*, 14(1), pp.4039.

Shu, T., Zhang, B., & Yan Tang, Y., 2017. An Extensive Analysis of Various Texture Feature Extractors to Detect Diabetes Mellitus Using Facial Specific Regions. Computers in Biology and Medicine, 83, pp.69–83.

Tufail, A., Kapetanakis, V.V., Salas-Vega, S., Egan, C., Rudisill, C., Owen, C.G., Lee, A., Louw, V., Anderson, J., Liew, G., Bolter, L., Bailey, C., Sadda, S., Taylor, P., & Rudnicka, A.R., 2016. An Observational Study to Assess if Automated Diabetic Retinopathy Image Assessment Software Can Replace One or More Steps of Manual Imaging Grading and to Determine Their Cost-Effectiveness. *Health Technology Assessment (Winchester, England)*, 20(92), pp.1–72.

Wu, Y., Min, H., Li, M., Shi, Y., Ma, A., Han, Y., Gan, Y., Guo, X., & Sun, X., 2023. Effect of Artificial Intelligence-Based Health Education Accurately Linking System (AI-Heals) for Type 2 Diabetes Self-Management: Protocol for a Mixed-Methods Study. *BMC Public Health*, 23(1).

Zeevi, D., Korem, T., Zmora, N., Israeli, D., Rothschild, D., Weinberger, A., Ben-Yacov, O., Lador, D., Avnit-Sagi, T., Lotan-Pompan, M., Suez, J., Mahdi, J.A., Matot, E., Malka, G., Kosower, N., Rein, M., Zilberman-Schapira, G., Dohnalová, L., Pevsner-Fischer, M., Bikovsky, R., Halpern, Z., Elinav, E., & Segal, E., 2015. Personalized Nutrition by Prediction of Glycemic Responses. *Cell*, 163(5), pp.1079–1094.

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Unsuccessful Drug-Resistant TB Treatment Outcomes among Patients with Short-Term Regimen in Central Java, Indonesia

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Abstract

Tuberculosis which shows resistance to various types of drugs poses a significant burden in efforts to prevent and control tuberculosis globally. Since 2020, guidelines from the WHO have recommended a shorter treatment with an all-oral regimen for Drug-Resistant Tuberculosis (DR-TB), with the inclusion of bedaquiline instead of an injectable agent. However, the treatment success rate for DR-TB in Indonesia is still low. This study aimed to determine factors contributing to unsuccessful DR-TB treatment using STR in Central Java. This was a nested case-control study of 412 DR-TB patients enrolled with a Short-Term Regimen, registered in 2021 to 2023 who had treatment results in a subset of the Tuberculosis Information System cohort data. Independent variables analyzed included age, gender, patient employment status, history of previous TB treatment, DM status, HIV status, resistance pattern, initial sputum examination results, drug side effects, treatment initiation interval, body mass index, and BPJS ownership status. Statistical analysis was done using SPSS version 22 software, with logistic regression analysis to identify the determinants. The determinant of unsuccessful treatment outcome in Central Java Province which is 51.04% was the positive results of initial sputum examination of treatment (aOR=10.501; 95%CI=5.056-21.807), drug side effects (aOR=1.853; 95%CI=1,000-3.436), obesity (aOR=3.115; 95%CI=1.188-8.166) and BPJS non-possession status (aOR=2.213; 95%CI=0.932-5.255). More strategies are needed to improve the success of treatment with STR.

Introduction

Drug-resistant tuberculosis (DR-TB) is defined as tuberculosis infection caused by bacteria that is resistant to treatment with at least two first-line antitubercular medications, namely rifampicin, or isoniazid and rifampicin. DR-TB can be transmitted through primary infection or treatment failure, the combination of drugs, co-infection, previous use of antitubercular medications, inadequate drug absorption, underlying disease, and non-adherence to antitubercular medications (World Health Organization, 2021). A research report at Rotinsulu Lung Hospital in Bandung, Indonesia found that a history of TB treatment significantly increased the risk of MDR-TB with an odds ratio of 56.84 (Nugrahaeni and Zaqiya, 2019). A study in Surakarta General Hospital, Central Java, Indonesia (2016-2017) reported that patients' knowledge about TB

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and its treatment influences adherence and treatment success rates (Sutanto, Sutanto and Harti, 2021).

Based on the WHO global report in 2019, there were around 465,000 cases of DR-TB globally, with a proportion of 3.3% new TB patients and 18% patients with previous TB treatment. In 2017, there were 558,000 cases of DR-TB, and around 8.5% of DR-TB cases became Extensively Drug Resistance TB (XDR-TB) (World Health Organization, 2019). In Southeast Asia, the incidence of TB has reached 4,340,000 cases, of which 171,000 are DR-TB cases (WHO, 2020). The estimated DR-TB in Indonesia is 2.4% of all new TB patients and 13% of previously treated TB patients with a total estimated incidence of DR-TB cases of 24,000 or 8.8/100,000 population. In 2019, around 11,500 DR-TB patients were discovered and reported, and around 48% of patients started second-line TB treatment, with a treatment success rate of 45% (WHO, 2020). Based on the level of distribution, in this case, Central Java Province ranks second (80,264 cases) with the highest number of TB infection cases in Indonesia after West Java Province (189,886 cases). Among them, 985 cases of DR-TB were notified and treated (Kemenkes, 2021).

WHO recommends identifying factors influencing treatment duration and outcomes as a research priority, particularly in high-burden countries (World Health Organization, 2019). WHO recommends 3 DR-TB treatment options: BPaL/BPaLM, Short Term Regimen (STR), and Long-Term Regimen/Individual Regimen. Short Term Regimen (STR) is a short all-oral regimen for 9 months consisting of: 6 Bedaquiline (Bdq) with 4-6 Levofloxacin (Lfx)/Moxifloxacin (Mfx)-Clofazimin (Cfz)-Pyrazinamide (Z)-Ethambutol (E)-Isoniazid (H) high dose-Etionamide (Eto)/5 Levofloxacin/Moxifloxacin-Clofazimin-Pyrazinamide-Ethambutol (World Health Organization, 2022; Conradie *et al.*, 2020, 2022; Sangsayunh *et al.*, 2024). A comparative prospective cohort study in DR-TB patients with alloy Long Term and Short Term in Pakistan showed that short-term treatment (73.8%) was as effective as long-term treatment (75.6%), with the added benefit of fewer side effects (Munir *et al.*, 2024).

The shorter TB regimen is based on observational studies in several countries that have implemented it previously, including Bangladesh, Benin, Burkina Faso, Burundi, Cameroon, Central Africa, Congo, Niger, Swaziland and Uzbekistan. The results show that the success rate of short-term treatment is higher than that of long-term treatment (Das and Ganguly, 2020; Trubnikov *et al.*, 2021; Wahid *et al.*, 2021; Soeroto *et al.*, 2022). Many studies show that the success rate of treatment with short-term regimens varies, between 44.3% – 83.7% (Das and Ganguly, 2020; Trubnikov *et al.*, 2021; Wahid *et al.*, 2021; Soeroto *et al.*, 2022). Considering the varying success rates, this study aims to identify the determining factors for the failure of treatment for drug-resistant tuberculosis in patients with shorter regimens in Central Java.

Method

This research uses data integrated into the Tuberculosis Information System (SITB) through the TB-03 form at the Central Java provincial level. This system records TB patient data and treatment monitoring carried out by DR-TB officers at health facilities. Research data was taken from the TB patients registered in 2021 to 2023. Respondents registered in the 2021-2023 SITB cohort totaled 509 DR-TB patients, but only 412 had DR-TB treatment results. The dependent variable is the success status of short-term DR-TB regimen treatment which is categorized as successful (cured and complete treatment) and unsuccessful (patients who died, failed treatment, and lost-to-follow-up) (Olayanju *et al.*, 2018; Oelofse *et al.*, 2021).

Independent variables that are potentially related to failure of short-term DR-TB regimen treatment are age which is categorized as 0-65 years, and age ≥ 65 years, gender, patient employment status which is categorized as working and not working, history of Previous TB treatment was categorized as a new case patient, and re-treatment, DM status was categorized into patients who had DM, and did not have DM, HIV status was categorized into non-reactive, reactive, and unknown. Resistance patterns were categorized into Mono-resistant, Rifampicin-resistant, Poli-resistant, MDR, Pre-XDR, and XDR. Resistance patterns are categorized into Mono-resistant,

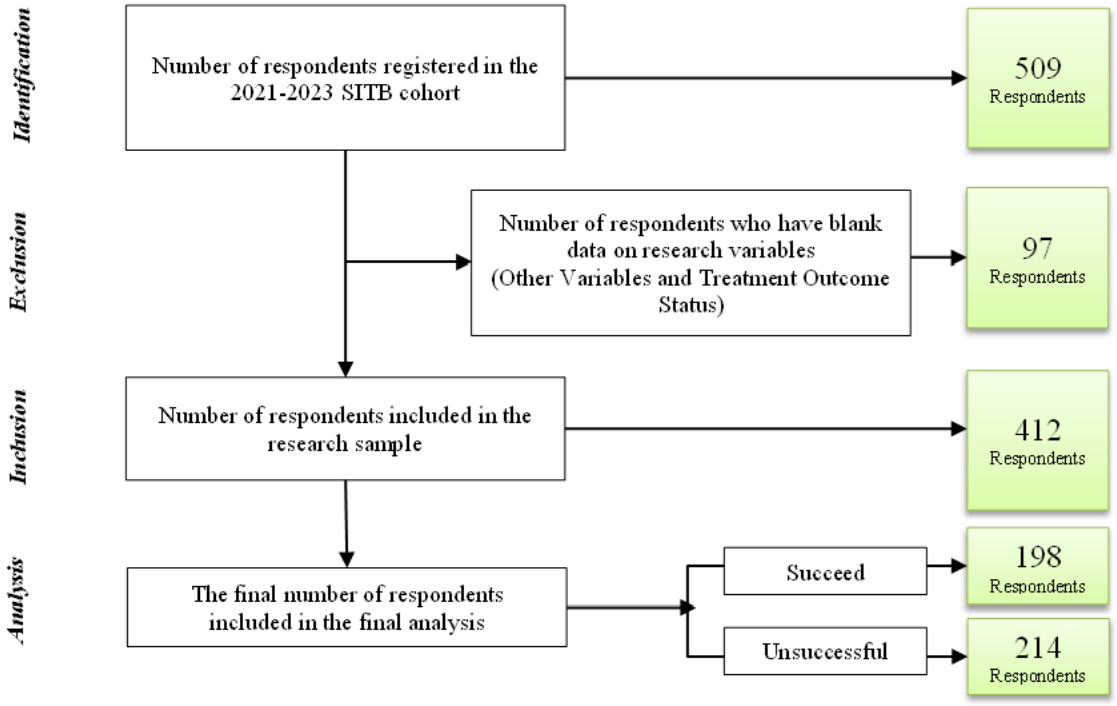

Figure 1. Sample Selection Chart

Rifampicin-resistant, Poli-resistant, MDR, Pre-XDR, and XDR. High Dose Isoniazid Resistance, Isoniazid-resistant, Levofloxacin-resistant, High Dose Moxifloxacin-resistant, and Moxifloxacin-resistant which are all categorized into sensitive, resistant, indeterminate, and unknown, examination results s Initial results are categorized into results negative, positive, and unknown, drug side effect status was categorized into none and there are drug side effects, treatment initiation interval was categorized into ≤ 7 days, and > 7 days, Body Mass Index (BMI) was categorized into Normal BMI (BMI 18, 5-25.0 kg/), Thin (BMI <18.5 kg/), and Obese (BMI >25 kg/), BPJS ownership status is categorized as having and not having BPJS.

Data are presented in frequencies and percentages based on variable categories. Bivariate analysis was used to identify risk factors associated with the failure of short-term DR-TB treatment regimens. All variables without collinearity were included in the logistic regression model using a stepwise method to determine associated variables (p 0.05). The odds ratio (OR) with 95% confidence interval (CI) was calculated as a measure of association. All analyses were performed by SPSS 22.0 (IBM Corporation, NY, USA). This research has received ethical approval from the Health Research Ethics Commission, Faculty of Health Sciences University of Jenderal Soedirman. Research ethical permission number 1481/EC/KEPK/VI/2024. No further ethical permission is required for the analysis of secondary data.

Result And Discussion

The distribution of 412 respondents was spread across 42 Programmatic Management of Drug-Resistant TB (PMDT) health facilities consisting of 3 community health centers and 39 hospitals, with the Ministry of Health owning 6 health facilities, non-profit organizations, 4 health facilities, 27 Regency/City Government health facilities, 2 Provincial Government health facilities, 1 company health facility, and 2 TNI health facilities. In the Prevalence of treatment for DR-TB patients in Central Java Province

Table 1. Characteristics of Respondents

Variable	Frequency	Percent
Treatment Results		
Succeed	198	48.06
Healed	192	46.60
Complete Treatment	6	1.46
Unsuccessful	214	51.94
Treatment Failure	26	12.15
Failed Due to Change in Diagnosis	91	42.52
Died	38	17.76
Lost-to-follow-up	150	27.57
Age		
0-65 Years	377	91.50
≥ 65 Years	35	8.50
Gender		
Man	230	55.83
Woman	182	44.17
Patient Employment Status		
Work	330	80.10
Doesn't work	82	19.90
History of Previous TB Treatment		
New Case	219	53.16
Retreatment	193	46.84
DM Status		
No DM	336	81.55
DM	76	18.45
HIV Status		
Non Reactive	272	66.02
Reactive	5	1.21
Not known	135	32.77
Resistance Patterns		
Monoresistens	0	0
RR	220	53.40
Poliresisten	4	0.97
MDR	178	43.20
Pre-XDR	8	1.94
XDR	2	0.49
High Dose Isoniazid Resistance		
Sensitive	125	30.34
Resist	174	42.23
Not Known	113	27.43
Isoniazid Resistance		
Sensitive	49	11.89
Resist	104	25.24
Not Known	259	62.86

Variable	Frequency	Percent
Levofloxacin Resistance		
Sensitive	291	70.63
Resist	10	2.43
Indeterminate	18	4.37
Not Known	93	22.57
High Dose Moxifloxacin Resistance		
Sensitive	291	70.63
Resist	10	2.43
Indeterminate	18	4.37
Not Known	93	22.57
Moxifloxacin Resistance		
Sensitive	294	71.36
Resist	8	1.94
Indeterminate	17	4.13
Not Known	93	22.57
Initial Sputum Examination Results		
Negative	219	53.16
Positive	97	23.54
Not known	96	23.30
Drug Side Effects		
No Drug Side Effects	74	17.96
There are drug side effects	338	82.04
Treatment Initiation Interval		
≤ 7 days	78	18.93
> 7 days	334	81.07
Body Mass Index (BMI)		
Normal	169	41.02
Thin	210	50.97
Obesity	33	8.01
BPJS status		
BPJS	41	9.95
Non BPJS	371	90.05

with combinations of Short-Term Regimens only 48.96% were declared successful, while 51.94% were unsuccessful. The prevalence of success was higher than research conducted in India, only 48%. (Kumar *et al.*, 2024).

Based on Table 1, the results of treatment of DR-TB patients in Central Java Province with combination Short-Term Regimen only 48.96% were declared successful, consisting of 192 recovered patients (46.60%), complete treatment was 6 patients (1.46%), while 51.94% were unsuccessful with the category consisting of 26 patients who failed treatment (12.15%), failed due to change in diagnosis in 91 patients (42.52%), died in 38 patients (17.76%), lost-to-follow-up 150 patients (27.57%). The characteristics of the majority of patients (91.50%) were aged between 0 and 65 years, 55.83% of patients were male and 44.17% were female. 80.10% of patients were working, 53.16% were new case patients, the majority of patients (81.55%) did not have DM,

Table 2. Determinants of Treatment Failure Short-Term Regimen in Drug-Resistant Tuberculosis Patients in Central Java Province

Variable	Succeed		Not successful		OR	CI 95		p-value
	n	%	n	%		Lower	Upper	
Age								0.040
0-65 Years	187	50.27	190	51.08	1 (Ref)	–	–	
≥ 65 Years	11	31.43	24	68.57	2.147	1.023	4.508	
Gender								0.090
Man	102	44.35	128	55.65	1 (Ref)	–	–	
Woman	96	52.75	86	47.25	0.714	0.483	1.055	
Patient Employment Status								0.114
Work	165	50.00	165	50.00	1 (Ref)	–	–	
Doesn't work	33	40.24	49	59.76	1.485	0.908	2.427	
History of previous TB treatment								0.587
New Case	108	49.32	111	50.68	1 (Ref)	–	–	
Retreatment	90	46.63	103	53.37	1.114	0.756	1.641	
Status DM								0.015
No DM	171	50.89	165	49.11	1 (Ref)	–	–	
DM	27	35.53	49	64.47	1.881	1.122	3.151	
Status HIV								0.532
Non Reactive	135	49.63	137	50.37	1 (Ref)	–	–	
Reactive	3	60.00	2	40.00	0.657	0.108	3.994	
Not known	60	44.44	75	55.56	1.232	0.814	1.864	
Resistance Patterns								0.000
RR	133	60.45	87	39.55	1 (Ref)	–	–	
Poliresisten	1	25.00	3	75.00	4.586	0.469	44.804	
MDR	60	33.71	118	66.29	3.007	1.992	4.539	
Pre-XDR	3	37.50	5	62.50	2.548	0.594	10.934	
XDR	1	50.00	1	50.00	1.529	0.094	24.764	
High Dose Isoniazid Resistance								0.000
Sensitive	69	55.20	56	44.80		–	–	
Resist	58	33.33	116	66.67	2.464	1.536	3.954	
Not Known	71	62.83	42	37.17	0.729	0.434	1.225	
Isoniazid Resistance								0.000
Sensitive	22	44.90	27	55.10	1 (Ref)	–	–	
Resist	25	24.04	79	75.96	2.575	1.253	5.293	
Not Known	151	58.30	108	41.70	0.583	0.315	1.078	
Levofloxacin Resistance								0.008
Sensitive	126	43.30	165	56.70	1 (Ref)	–	–	
Resist	4	40.00	6	60.00	1.145	0.317	4.146	
Indeterminate	9	50.00	9	50.00	0.764	0.295	1.980	
Not Known	59	63.44	34	36.56	0.440	0.272	0.712	

Variable	Succeed		Not successful		OR	CI 95		p-value
	n	%	n	%		Lower	Upper	
High Dose Moxifloxacin Resistance								0.008
Sensitive	126	43.30	165	56.70	1 (Ref)	–	–	
Resist	4	40.00	6	60.00	1.145	0.317	4.146	
Indeterminate	9	50.00	9	50.00	0.764	0.295	1.980	
Not Known	59	63.44	34	36.56	0.440	0.272	0.712	
Moxifloxacin Resistance								0.007
Sensitive	126	42.86	168	57.14	1 (Ref)	–	–	
Resist	4	50.00	4	50.00	0.750	0.184	3.057	
Indeterminate	9	52.94	8	47.06	0.667	0.250	1.776	
Not Known	59	63.44	34	36.56	0.432	0.267	0.699	
Initial Sputum Examination Results								0.000
Negative	132	60.27	87	39.73	1 (Ref)	–	–	
Positive	49	50.52	48	49.48	1.486	0.918	2.405	
Not Known	17	17.71	79	82.29	7.051	3.909	12.717	
Drug Side Effects								0.000
No Drug Side Effects	17	22.97	57	77.03	1 (Ref)	–	–	
There are drug side effects	181	53.55	157	46.45	0.259	0.145	0.463	
Treatment Initiation Interval								0.032
≤ 7 days	46	58.97	32	41.03	1 (Ref)	–	–	
> 7 days	152	45.51	182	54.49	1.721	1.044	2.838	
Body Mass Index (BMI)								0.014
Normal	77	45.56	92	54.44	1 (Ref)	–	–	
Which ones	112	53.33	98	46.67	0.732	0.488	1.100	
Obesity	9	27.27	24	72.73	2.232	0.979	5.086	
BPJS status								0.157
BPJS	24	58.54	17	41.46	1 (Ref)	–	–	
Not BPJS	174	46.90	197	53.10	1.598	0.831	3.074	

66.02% were declared non-reactive to HIV, the resistance pattern of 53.40% of patients were Rifampicin-resistant, 53.16% of patients had negative initial sputum examination results, 82.04% experienced drug side effects during treatment, the treatment initiation interval was more than 7 days 81.07%, patients with a thin BMI were 50.97% and 90.05% did not have BPJS.

Table 2 shows the results of crosstabulation determinants of failure of short-term DR-TB regimen treatment are patients aged 65 years and over (OR=2.147; p-value <0.005), patients with DM (OR=1.881; p-value <0.005), patients with MDR resistance patterns (OR=3.007; p-value <0.005), has a higher risk of failure to treat DR-TB with a short-term regimen. Patients with resistance to high doses of isoniazid, isoniazid, levofloxacin, or moxifloxacin (p-value <0.005) have a higher risk of not being successful in treatment compared to patients who are sensitive to these drugs. Patients who started treatment more than 7 days after diagnosis had a higher risk of treatment failure (OR=1.721, P-value <0.005), as well as patients with obesity (OR=2.232, P-value <0.005), which was higher for less successful in treatment compared with patients with normal BMI. In line with research in India which stated that the main reasons for stopping treatment in DR-TB patients were busy schedules (29%), comorbidities (19.8%), feeling there was early improvement/no improvement (10.5%), and the presence of drug side effects (18.4%)

Table 3. Logistic Regression Determinants of Unsuccessful Drug-Resistant TB Treatment Outcomes Among Patients with Short-Term Regimen in Central Java

Variable	B	S.E.	Wald	df	Sig.	Exp(B)	95 C.I.for EXP(B)	
							Lower	Upper
Isoniazid Resistance			18.64	2	0.000			
Resist	-1.268	0.447	8.04	1	0.005	0.281	0.117	0.676
Not Known	-1.252	0.343	13.36	1	0.000	0.286	0.146	0.559
Initial Sputum Examination Results			41.38	2	0.000			
Positive	2.351	0.373	39.77	1	0.000	10.501	5.056	21.807
Not Known	2.401	0.43	31.13	1	0.000	11.036	4.748	25.65
Drug Side Effects	-1.619	0.371	19.04	1	0.000	0.198	0.096	0.41
There are drug side effects	0.617	0.315	3.838	1	0.050	1.853	1.000	3.436
Body Mass Index (BMI)			8	2	0.018			
Thin	0.593	0.497	1.423	1	0.233	1.81	0.683	4.797
Obesity	1.136	0.492	5.341	1	0.021	3.115	1.188	8.166
Non BPJS	0.794	0.441	3.242	1	0.072	2.213	0.932	5.255
Constant	-1.333	0.568	5.505	1	0.019	0.264		

Notes. Model 5: Hosmer and Lemeshow test: $\chi 2$ = 9,847; P = 0.000, Nagelkerke R^2 = 41;

(Kumar *et al.*, 2024), although the results of this study showed that there was no significant relationship between drug side effects and treatment success, 73.36% of patients with drug side effects experienced treatment failure, a prospective study conducted on a cohort of Pre-XDR and XDR DR-TB patients in India resulted in a combination Short Term Regimen with bedaquiline achieved good treatment success, though bedaquiline and other antitubercular medications have the potential to prolong the QTc interval, the benefits outweigh the risks. Additionally, this regimen proved to be highly effective with rapid sputum culture conversion rates and good treatment outcomes. Giving a Short-Term Regimen requires cardiovascular and biochemical evaluation before treatment as a precautionary measure and appropriate patient selection for the use of bedaquiline safe and successful results (Barvaliya *et al.*, 2020).

Multivariate analysis showed positive initial sputum examination results (aOR=10,501; 95%CI=5,056-21,807), there were drug side effects (aOR=1,853; 95%CI=1,000-3,436), BMI (aOR=3,115; 95%CI= 1.188-8.166) and BPJS non-possession status (aOR=2.213; 95%CI=0.932-5.255) increase the chance of treatment failure. The results of this study highlight several main factors, namely positive initial sputum examination results, drug side effects, obesity and not having BPJS. The results of the same study in West Java showed that male gender was an independent factor that increased the chances of successful treatment, while a history of previous TB treatment, sputum conversion time >2 months, and malnutrition, especially underweight, reduced the chances of success for DR-patients. TB is treated with shorter regimens. (Soeroto *et al.*, 2022). Other studies have also identified several predictors of poor DR-TB treatment outcomes, including older age, being male, a history of resistance to ofloxacin and other second-line drugs, delayed conversion of sputum culture, positive BTA at diagnosis, and the presence of comorbidities (HIV, type 2 DM, malnutrition) (Tiwari, Kumar and Kapoor, 2012; Javaid *et al.*, 2018; Leveri *et al.*, 2019; Tola *et al.*, 2021), in addition to the results of crosstabulation. This study shows a significant relationship between age and treatment success, where patients aged 65 years and over have a significantly higher risk of not being successful in treatment compared to younger patients (OR=2.147; p-value <0.005). This is consistent with literature showing that factors related to the aging process, such as decreased immune function and comorbidities,

may worsen the prognosis of DR-TB (Zhao *et al.*, 2012; Demile *et al.*, 2018; Agustina, Maulida and Yovsyah, 2019; Tao *et al.*, 2021).

The presence of Diabetes Mellitus (DM) also plays an important role in the success of DR-TB treatment. Patients with DM have a higher risk of not being successful in treatment (OR=1.881; p-value <0.005). This is following previous findings showing that DM can influence the response to TB treatment through immune system disorders and pharmacological interactions between TB drugs and DM treatment. DM can interfere with the production of protective cytokines, such as type 1 and type 17 cytokines, which are important for the immune response to TB (Abbas *et al.*, 2022; Kumar and Babu, 2023). The pattern of TB drug resistance is also a critical factor influencing the success of treatment. Patients with MDR resistance patterns had a higher risk of treatment failure (OR=3.007; p-value <0.005). This shows the importance of rapid identification and treatment of drug resistance patterns to optimize DR-TB treatment outcomes.

Resistance to various types of TB drugs, such as high-dose isoniazid, isoniazid, levofloxacin, and moxifloxacin, was also shown to be a significant risk factor for treatment failure (p-value <0.005). Resistance to various types of TB drugs, such as high-dose isoniazid, isoniazid, levofloxacin, and moxifloxacin, is a significant risk factor for treatment failure (Migliori *et al.*, 2013). Drug resistance, particularly to rifampicin, isoniazid, and fluoroquinolones, has been identified as a major contributor to treatment failure and the emergence of multidrug-resistant (Pre-XDR) tuberculosis[30]. Appropriate drug sensitivity testing and adjustment of treatment regimens based on drug resistance are needed in treating DR-TB.

Delay in starting treatment also has a serious impact on DR-TB treatment outcomes. Patients who started treatment more than 7 days after diagnosis had a higher risk of treatment failure (OR=1.721; p-value <0.005) (Asres, Jerene, and Deressa, 2018; Tedla *et al.*, 2020). Early detection and immediate intervention in the management of DR-TB to avoid disease progression. This study also highlights that obese patients have a higher risk of treatment failure compared to patients with normal BMI (OR=2.232; p-value <0.005). This increased risk is due to several factors, including changes in the pharmacokinetics and pharmacodynamics of TB drugs in obese patients, which may lead to reduced drug exposure and efficacy. Additionally, obese patients may have a higher burden of comorbidities, such as diabetes, which may further complicate TB treatment and increase the risk of treatment failure (Longo *et al.*, 2013; Theofiles *et al.*, 2015; Conway *et al.*, 2016; Pinner *et al.*, 2021; Schell *et al.*, 2022).

Efforts that need to be made by health agencies to prevent the failure of DR-TB treatment with short-term regimens include several important strategies. These strategies encompass better management of DR-TB cases by prioritizing early detection through routine sputum examinations, surveillance, and intensive treatment of drug side effects to minimize negative impacts that could interfere with the success of treatment. Additionally, expanding access to BPJS or other health insurance programs for TB patients is crucial so that they can receive adequate treatment without being hampered by financial problems.

Conclusion

The results showed that the initial sputum examination was positive (aOR=10,501; 95%CI=5,056-21,807), drug side effects (aOR=1,853; 95%CI=1,000-3,436), BMI (aOR=3,115; 95%CI=1,188 -8.166) and BPJS non-possession status (aOR=2.213; 95%CI=0.932-5.255) are predictors of failure to achieve short-term DR-TB treatment. This study provides helpful insights into the determinants of unsuccessful DR-TB treatment outcomes and has implications for enhancing treatment success in tuberculosis control programs. Strategies to prevent failure of DR-TB treatment with short-term regimens in this population must include good management of DR-TB cases. It is important to control risk factors for treatment failure to reduce the burden of DR-TB, both internally and externally to prevent it. This research only covers one area of Central Java Province, so it cannot represent other areas that have different characteristics. Further research needs to be conducted to

overcome these limitations. Further research needs to be carried out regarding the success of the DR-TB treatment regimen in the form of BPaL/M (Bedaquiline, Pretomanid, Linezolid, and/or Moxifloxacin) which will begin to be implemented comprehensively in Central Java Province in 2024 as a comparison with the results of this study. Clinical-based research on DR-TB treatment and the risk factors associated with it should also be conducted for comparison with the results of these community-based studies.

References

Abbas, U., Masood, K.I., Khan, A., Irfan, M., Saifullah, N., Jamil, B., & Hasan, Z., 2022. Tuberculosis and Diabetes Mellitus: Relating Immune Impact of Co-Morbidity With Challenges in Disease Management in High Burden Countries. *Journal of Clinical Tuberculosis and Other Mycobacterial Diseases*, 29, pp.100343.

Agustina, R., Maulida, R., & Yovsyah, Y., 2019. Faktor-Faktor yang Berhubungan Dengan Hasil Pengobatan Regimen Pendek (Short Treatment Regiment) pada Pasien Tuberkulosis Resistensi Obat di Indonesia Tahun 2017. *Jurnal Epidemiologi Kesehatan Indonesia*, 2(2), pp.65–71.

Asres, A., Jerene, D., & Deressa, W., 2018. Delays to Treatment Initiation is Associated with Tuberculosis Treatment Outcomes Among Patients on Directly Observed Treatment Short Course in Southwest Ethiopia: A Follow-Up Study. *BMC Pulmonary Medicine*, 18(1), pp.64.

Barvaliya, S.V., Desai, M.K., Panchal, J.r., & Solanki, R.N., 2020. Early Treatment Outcome of Bedaquiline Plus Optimised Background Regimen in Drug Resistant Tuberculosis Patients. *Indian Journal of Tuberculosis*, 67(2), pp.222–230.

Conradie, F., Diacon, A.H., Ngubane, N., Howell, P., Everitt, D., Crook, A.M., Mendel, C.M., Egizi, E., Moreira, J., Timm, J., McHugh, T.D., Wills, G.H., Bateson, A., Hunt, R., Niekerk, C.V., Li, M., Olugbosi, M., & Spigelman, M., 2020. Treatment of Highly Drug-Resistant Pulmonary Tuberculosis. *New England Journal of Medicine*, 382(10), pp.893–902.

Conradie, F., Bagdasaryan, T.R., Borisov, S., Howell, P., Mikiashvili, L., Ngubane, N., Samoilova, A., Skornykova, S., Tudor, E., Variava, E., Yablonskiy, P., Everitt, D., Wills, G.H., Sun, E., Olugbosi, M., Egizi, E., Li, M., Holsta, A., Timm, J., Bateson, A., Crook, A.M., Fabiane, S.M., Hunt, R., McHugh, T.D., Tweed, C.d., Foraida, S., Mendel, C.M., & Spigelman, M., 2022. Bedaquiline–Pretomanid–Linezolid Regimens for Drug-Resistant Tuberculosis. *New England Journal of Medicine*, 387(9), pp.810–823.

Conway, E., Sellick, J., Kurtzhalts, K., & Mergenhagen, K., 2016. Obesity Contributes to Failure of Outpatient Treatment of Skin and Soft Tissue Infections. *Open Forum Infectious Diseases*, 3(1), pp.1152.

Das, P.K., & Ganguly, S.B., 2020. Effectiveness of the Shorter MDR Regimen in The Management of Tuberculosis: Shortfall in The Outcome of Disease A Multidimensional Approach and Evaluation For A Better Alternative. *Biomedical and Biotechnology Research Journal (BBRJ)*, 4(2), pp.143–147.

Demile, B., Zenebu, A., Shewaye, H., Xia, S., & Guadie, A., 2018. Risk Factors Associated With Multidrug-Resistant Tuberculosis (MDR-TB) in A Tertiary Armed Force Referral And Teaching Hospital, Ethiopia. *BMC Infectious Diseases*, 18(1), pp.249.

Javaid, A., Ullah, I., Masud, H., Basit, A., Ahmad, W., Butt, Z.A., & Qasim, M., 2018. Predictors of Poor Treatment Outcomes in Multidrug-Resistant Tuberculosis Patients: A Retrospective Cohort Study. *Clinical Microbiology and Infection*, 24(6), pp.612–617.

Kemenkes, R.I., 2021. *Profil Kesehatan Indonesia 2020.* Kementrian Kesehatan Republik Indonesia.

Kumar, L., Kumar, S., Vohra, V., Mohan, K., & Khayyam, K.U., 2024. Risk Factors of Treatment Interruptions Among Drug-Sensitive and Drug-Resistant Pulmonary Tuberculosis Patients - A Study from South Delhi, New Delhi, India. *Indian Journal of Tuberculosis*, 2024.

Kumar, N.P., & Babu, S., 2023. Impact of Diabetes Mellitus on Immunity to Latent Tuberculosis Infection. *Frontiers in Clinical Diabetes and Healthcare*, 4(1), pp.1–7.

Leveri, T.H., Lekule, I., Mollel, E., Lyamuya, F., & Kilonzo, K., 2019. Predictors of Treatment Outcomes Among Multidrug Resistant Tuberculosis Patients in Tanzania. *Tuberculosis Research and Treatment*, 2019.

Longo, C., Bartlett, G., Macgibbon, B., Mayo, N., Rosenberg, E., Nadeau, L., & Daskalopoulou, S.S., 2013. The Effect of Obesity on Antibiotic Treatment Failure: A Historical Cohort Study. *Pharmacoepidemiology and Drug Safety*, 22(9), pp.970–976.

Migliori, G.B., Sotgiu, G., Gandhi, N.R., Falzon, D., DeRiemer, K., Centis, R., Delgado, M.G.H., Palmero, D., Pérez-Guzmán, C., Vargas, M.H., D'Ambrosio, L., Spanevello, A., Bauer, M., Chan, E.D., Schaaf, H.S., Keshavjee, S., Holtz, T.H., & Menzies, D., 2013. Drug Resistance Beyond Extensively Drug-Resistant Tuberculosis: Individual Patient Data Meta-Analysis. *European Respiratory Journal*, 42(1), pp.169–179.

Munir, M.K., Saeed, M.S., Haider, S.Z., & Shamim, S., 2024. Comparison of Short Term and Long Term Multidrug Resistant Tuberculosis Treatment Outcomes in Tertiary Care Settings. *Journal of King Saud University - Science*, 36(4), pp.103133.

Nugrahaeni, D.K., & Zaqiya, S., 2019. The Relationship Between Previous Tuberculosis Treatment and HIV Status With Multidrug-Resistant Tuberculosis. *Jurnal Kesehatan Masyarakat*, 14(3), pp.347–352.

Oelofse, S., Esmail, A., Diacon, A.H., Conradie, F., Olayanju, O., Ngubane, N., Howell, P., Everitt, D., Crook, A.M., Mendel, C.M., Wills, G.H., Olugbosi, M., Parigi, A.D., Sun, E., Calatroni, A., Spigelman, M., & Dheda, K., 2021. Pretomanid with Bedaquiline and Linezolid for Drug-Resistant TB: A Comparison of Prospective Cohorts. *The International Journal of Tuberculosis And Lung Disease*, 25(6), pp.453–460.

Olayanju, O., Limberis, J., Esmail, A., Oelofse, S., Gina, P., Pietersen, E., Fadul, M., Warren, R., & Dheda, K., 2018. Long-Term Bedaquiline-Related Treatment Outcomes in Patients With Extensively Drug-Resistant Tuberculosis from South Africa. *The European Respiratory Journal*, 51(5).

Pinner, N.A., Tapley, N.G., Barber, K.E., Stover, K.R., Wagner, J.L., 2021. Effect of Obesity on Clinical Failure of Patients Treated With β-Lactams. *Open Forum Infectious Diseases*, 8(8).

Sangsayunh, P., Sanchat, T., Chuchottaworn, C., Cheewakul, K., & Rattanawai, S., 2024. The Use of BPaL Containing Regimen in the MDR/PreXDR TB Treatments in Thailand. *Journal of Clinical Tuberculosis and Other Mycobacterial Diseases*, 34, pp.100408.

Schell, T., Lee, A., Lindholm, C.R., Li, Z., Sampene, E., & Saha, S., 2022. Treatment Failure and Clinical Response Differences in Fixed-Dosing versus Weight-Adjusted Anti-TNF Therapy in Obese Patients With Ulcerative Colitis. *Official journal of the American College of Gastroenterology | ACG*, 117(10S).

Soeroto, A.Y., Nurhayati, R.D., Purwiga, A., Lestari, B.W., Pratiwi, C., Santoso, P., Kulsum, I.D., Suryadinata, H., Ferdian, F., 2022. Factors Associated With Treatment Outcome Of MDR/RR-TB Patients Treated with Shorter Injectable Based Regimen in West Java Indonesia. *PloS one*, 17(1), pp.e0263304.

Sutanto, Y.S., Sutanto, M.S., & Harti, A.S., 2021. Anti-Tuberculosis Drugs against the Resistance Level of Mycobacterium tuberculosis Isolates. *Jurnal Kesehatan Masyarakat*, 17(1), pp.14–23.

Tao, N., Li, Y., Song, W., Liu, J., Zhang, Q., Xu, T., Li, S., An, Q., Liu, S., & Li, H., 2021. Risk Factors for Drug-Resistant Tuberculosis, The Association Between Comorbidity Status And Drug-Resistant Patterns: A Retrospective Study of Previously Treated Pulmonary Tuberculosis in Shandong, China, During 2004–2019. *BMJ Open*, 11(6), pp.e044349.

Tedla, K., Medhin, G., Berhe, G., Mulugeta, A., & Berhe, N., 2020. Delay in Treatment Initiation and Its Association With Clinical Severity and Infectiousness Among New Adult Pulmonary Tuberculosis Patients in Tigray, Northern Ethiopia. *BMC Infectious Diseases*, 20(1), pp.456.

Theofiles, M., Maxson, J., Herges, L., Marcelin, A., Angstman, K.B., 2015. Cellulitis in Obesity:Adverse Outcomes Affected by Increases in Body Mass Index. *Journal of Primary Care & Community Health*, 6(4), pp.233–238.

Tiwari, S., Kumar, A., & Kapoor, S.K., 2012. Relationship between Sputum Smear Grading And Smear Conversion Rate and Treatment Outcome in The Patients of Pulmonary Tuberculosis Undergoing Dots–A Prospective Cohort Study. *Indian J Tuberc*, 59(3), pp.135–140.

Tola, H., Holakouie-Naieni, K., Mansournia, M.A., Yaseri, M., Gamtesa, D.F., Tesfaye, E., Mahamed, Z., Sisay, M.M., 2021. National Treatment Outcome and Predictors of Death and Treatment Failure in Multidrug-Resistant Tuberculosis in Ethiopia: a 10-Year Retrospective Cohort Study. *BMJ Open*, 11(8), pp.e040862.

Trubnikov, A., Hovhannesyan, A., Akopyan, K., Ciobanu, A., Sadirova, D., Kalandarova, L., Parpieva, N., & Gadoev, J., 2021. Effectiveness and Safety of a Shorter Treatment Regimen in a Setting with a High Burden of Multidrug-Resistant Tuberculosis. *International Journal of Environmental Research and Public Health*,

18(8).

Wahid, A., Ahmad, N., Ghafoor, A., Latif, A., Saleem, FD., Khan, S., Atif, M., & Iqbal, Q., 2021. Effectiveness of Shorter Treatment Regimen in Multidrug-Resistant Tuberculosis Patients in Pakistan: A Multicenter Retrospective Record Review. *The American Journal of Tropical Medicine and Hygiene*, 104(5), pp.1784–1791.

World Health Organization., 2020. *Global Tuberculosis Report 2020*.

World Health Organization., 2019. *WHO Consolidated Guidelines on Drug-Resistant Tuberculosis Treatment*.

World Health Organization., 2022. *WHO Consolidated Guidelines on Tuberculosis. Module 4: Treatment-Drug-Resistant Tuberculosis Treatment*.

World Health Organization., 2021 *Global Tuberculosis Report 2021*. Geneva: World Health Organization.

Zhao, P., Li, X.J., Zhang, S.F., Wang, X.S., & Liu, C.Y., 2012. Social Behaviour Risk Factors for Drug Resistant Tuberculosis in Mainland China: A Meta-Analysis. *Journal of International Medical Research*, 40(2), pp.436–445.

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Blood Pressure and Oxygen Saturation Post Deep Breathing Exercise and Head Up in Stroke Patients

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Abstract

According to Basic Health Research (Riskesdas) data from the last 12 years, the prevalence of strokes in Indonesia is still relatively high. Hypertension prevention aims to keep blood pressure under control. Non-pharmacological management is also required to supplement pharmacological therapy. Deep breathing exercises and head-up 30 degrees are two interventions that can be implemented. This study aimed to measure the influence of deep breathing exercises and head up 30 degrees on stroke patients' oxygen saturation and blood pressure. This research used a quasi-experiment with a pretest-posttest control group design involving the recruitment of 60 respondents using a consecutive sampling technique. Head-up 30-degree positions and continuous deep breathing were measured using a digital sphygmomanometer, protractor, and oximeter. Data were analyzed using Wilcoxon and Mann-Whitney. The results showed that there was a significant difference in systolic blood pressure which was p=0.000 (p <0.005), and oxygen saturation showed p=0.001 (p <0.005). But there was no significant difference in diastolic blood pressure which was p=0.836 (p> 0.005). Deep breathing exercises and head-ups 30 degrees help control blood pressure in stroke patients.

Introduction

Strokes are a non-communicable disease that is increasing in both developed and developing countries (Setyopranoto *et al*., 2019). Stroke prevalence in Indonesia remains relatively high, according to statistics from the Indonesian Basic Health Research for the last 12 years (Saefurrohim *et al*., 2022). Strokes accounted for 10.9 percent of all illnesses identified by doctors in Indonesia in 2018. Yogyakarta Special Region has the highest number of sufferers, accounting for 14.7% of those over the age of 15 (Arifin *et al*., 2022). A stroke is a disorder characterized by signs or symptoms that correspond to a damaged focal area of the brain (Murphy & Werring, 2020). Patients suffering from the effects of strokes on a long-term basis may have impaired oxygen transfer (cerebral blood flow), resulting in diminished tissue perfusion and ischemia. Stroke patients have circulatory disturbances such as low blood pressure and oxygen saturation. Proper monitoring and treatment are required to ensure that oxygen delivery in the body does not impair heart function (Bao *et al*., 2024; Salaudeen *et al*., 2024).

Hypertension is one of the predisposing factors. The findings reveal that elderly people with hypertension have a 19-fold increased risk of stroke (Fahrina *et al*., 2021; Murphy & Werring, 2020). The goal of hypertension prevention is to keep blood pressure under control. There are pharmacological and non-pharmacological treatments. The patient's blood pressure is influenced by pharmacological management, which means drugs are used. Non-pharmacological management is also required to supplement pharmacological therapy (Carvalho *et al*., 2020; Kuriakose & Xiao, 2020). Deep breathing exercises and

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head-up 30 degrees are two interventions that can be implemented.

In stroke patients, using the head-up position 30 degrees can improve hemodynamic conditions. It facilitates increased cerebral blood flow and maximizes cerebral tissue oxygenation. One study has found that using the head-up 30-degree position increased oxygen saturation values. According to research, a higher head position can promote increased cerebral blood flow and maximize cerebral tissue oxygenation (Carvalho *et al*., 2020; Summers *et al*., 2015). As self-management interventions for health conditions such as hypertension, deep breathing techniques can cause benefits in terms of baroreceptor stimulation and autonomic and emotional modulation (Gholamrezaei *et al*., 2021).

Deep breathing stimulates the release of endorphin neurotransmitters in the autonomic nervous system. It reduces the work of the sympathetic nerves while increasing the work of the parasympathetic nerves. Thus, the heart rate is slow and this causes vasodilation in blood vessels. This technique is a type of nursing care where the patients are taught how to take deep breaths, slow breaths (hold inspiration for as long as possible), and exhale slowly. Deep breathing is used to increase alveolar ventilation, maintain gas exchange, prevent lung atelectasis, reduce stress (both physical and emotional), and ultimately lower blood pressure (Russo *et al*., 2017).

A meta-analysis of a systematic review finds that respiratory muscle training effectively improves respiratory function in stroke patients. The study's criteria complied with nineteen randomized controlled trials (RCTs). Respiratory muscle training improves first-second forced expiratory volume (FEV1), forces vital capacity (FVC), peak expiratory flow (PEF), maximal expiratory pressure (MEP), maximal inspiratory pressure (MIP), and walking ability (6-minute walk test), but not the Barthel index, Berg balance scale, or dyspnea. Respiratory muscle training interventions are effective in improving post-stroke patients' pulmonary function and functional mobility (Pozuelo-Carrascosa *et al*., 2020).

The preliminary study was conducted at a hospital in Yogyakarta. According to medical records, there were 74 stroke patients (both hemorrhagic and non-hemorrhagic) in June and July 2019. According to the findings of an interview with the head of the ward, stroke patients did not receive non-pharmacological interventions to treat cases of high blood pressure and low oxygen saturation. With this background, the researchers wanted to investigate the effect of deep breathing exercises and using stroke patients' head-up 30 degrees position as a non-pharmacological intervention. This study aimed to examine how deep breathing exercises and a 30-degree head-up position affected oxygen saturation and blood pressure in stroke patients.

Method

The study used a pretest-posttest quasi-experimental research design with a control group and was conducted in hospitals in Yogyakarta, Indonesia. A consecutive sampling method was utilized to recruit the sample of stroke patients who met the criterion for inclusion, which was that they had a stable hemodynamic status. Meanwhile, the exclusion criteria included patients with cervical trauma, mental illness, communication problems, and respiratory diseases. Sixty participants met the inclusion and exclusion criteria and were selected. They were then separated into two groups of thirty: the intervention group and the control group.

In this study, blood pressure was measured using a digital sphygmomanometer, a protractor to measure angles, and an oximeter to measure oxygen saturation. Pre-tests and post-tests were conducted on both groups on the first, second, and third days, respectively. All respondents in both groups had their blood pressure and oxygen saturation measured. The intervention was started by using a head-up 30-degree position, followed by a deep breathing exercise 30 times. This intervention was carried out three times a day for three days. Meanwhile, the control group received the standard intervention, in other words: no intervention.

The mean difference before and after the intervention was analyzed using a paired t-test, and the mean differences between the intervention and control groups were compared

using Wilcoxon and Mann-Whitney. Before the study, every participant who participated to participate was informed about the study's aims, advantages, and procedures. They were also asked to complete an informed consent form. During the study, respondents' confidentiality and anonymity were protected, as were fair training, benefits, and avoiding harmful acts. The ethics and research committee of the Faculty of Medicine at Achmad Yani University in Yogyakarta, Indonesia, approved this study with the following approval number: Skep/04/KEPK/II/2020.

Result And Discussion

The results of this study suggest that more than half of the respondents in both the intervention and control groups are male and over 60 years old. This, and the proportion of respondents who had a hemorrhagic stroke, is shown in =Table 1.

Analysis of the effect of deep breathing exercise and head up 30 degrees position on the blood pressure of stroke patients in the intervention and control groups is shown in Table 2 and Table 3. Table 2 shows that there is a decrease in systolic and diastolic blood pressure values in the intervention group compared to the control group as evidenced by the p-value. <0.05. There is a greater decrease in median systole and diastole after the intervention compared to the control group. There is a significant difference in systolic p=0.000 (p<0.05) and diastolic p=000 (p<0.05) in the intervention and control groups (Table 2).

Analysis of systolic and diastolic differences after deep breathing exercise intervention and head-up 30 degrees are presented in Table 3. The data used indicate the difference between systolic and diastolic in the intervention and control groups for the three days of observation. The results of the analysis

Table 1. Characteristics of Respondents (n=60)

Characteristic	Intervention	Control	Total
	f (%)	f (%)	f (%)
Age			
18 – 45 years old	5 (16.67)	6 (20.00)	11 (18.33)
46 – 60 years old	12 (40.00)	10 (33.33)	22 (36.67)
> 60 years old	13 (43.33)	14 (46.67)	27 (45.00)
Gender			
Male	16 (53.33)	20 (66.67)	36 (60.00)
Female	14 (46.67)	10 (33.33)	24 (40.00)
Classification Stroke			
Hemorrhagic stroke	21 (70.0)	22 (73.33)	43 (71.67)
Non haemorrhagic stroke	9 (30.0)	8 (26.67)	17 (28.33)

Source: Primary Data

Table 2. Differences in Blood Pressure of Stroke Patients (n= 60)

Blood pressure	Intervention Group		Control Group	
	Median (Min-Max)	p	Median (Min-Max)	p
Systole				
Pre-test	178.00 (129.00-216.00)	0.000*	175.00 (129.00-215.00)	0.000*
Post-test	160.00 (133.00-172.00)		152.00 (133.00-183.00)	
Diastole				
Pre-test	93.50 (85.00-152.00)	0.000*	100.00 (61.00-150.00)	0.000*
Post-test	85.00 (76.00-99.00)		84.50 (59.00-100.00)	

**Wilcoxone, $p < 0.05$* significance value

Table 3. Effect of Deep Breathing Exercise and Head-up 30 Degrees on Blood Pressure of Stroke Patients (n= 60)

Blood Pressure	Intervention Group	Control Group	
	Median (Min-Max)	Median (Min-Max)	p
Systole			
Pretest – Post test	19.5 (60.00-80.00)	16.00 (62.00-21.00)	0.000
Diastole			
Pretest – Post test	7.50 (62.00-9.00)	7.00 (71.00-10.00)	0.836

**Mann-Whitney, $p < 0.05$ significance value*

Table 4. Differences in Oxygen Saturation of Stroke Patients (n= 60)

Oxygen Saturation	Intervention Group		Control Group	
	Median (Min-Max)	p	Median (Min-Max)	p
Pre-test	98.00 (94.00-100.00)	0.000*	98.00 (92.00-100.00)	0.162*
Post-test	99.00 (97.00-100.00)		98.00 (96.00-100.00)	

**Wilcoxon*

Table 5. Effect of Deep Breathing Exercise and Head Up 30 Degrees on Oxygen Saturation of Stroke Patients (n= 60)

Oxygen Saturation	Intervention Group	Control Group	
	Median (Min-Max)	Median (Min-Max)	p
Pretest – Posttest	1.00 (1.00-9.00)	0.00 (2.00-4.00)	0.001

**Mann-Whitney, $p < 0.05$ significance value*

of the difference test on systolic blood pressure show a value of p=0.000 (p <0.005). This shows that deep breathing exercises and head-up 30-degree interventions affect systolic blood pressure values compared to standard hospital interventions. The decrease in diastolic blood pressure in the intervention group is higher than in the control group. However, there is no significant difference in diastolic between the intervention and control groups with the results of the analysis of the difference test on diastolic blood pressure showing a value of p=0.836 (p> 0.005). This shows that deep breathing exercises and a head-up 30-degree position do not affect the value of diastolic blood pressure compared to standard hospital interventions.

Analysis of the effect of deep breathing exercise and head-up 30 degrees position on the oxygen saturation of stroke patients in the intervention and control groups is shown in Table 4 and Table 5. There was a greater decrease in the median oxygen saturation after the intervention compared to the control group. Table 4 shows that there was an increase in oxygen saturation in the intervention group. There was also a significant difference in oxygen saturation in the intervention group with a value of p = 0.000 (p <0.05) (Table 4). Meanwhile, the control group did not show a significant difference with a value of p = 0.162 (p> 0.05).

The analysis of differences in oxygen saturation values after deep breathing exercise intervention and head-up 30 degrees position is presented in Table 5. The data used are the difference in oxygen saturation in the intervention and control groups for three days of observation. The results of the analysis of the difference test on oxygen saturation showed a value of p = 0.001 (p <0.005). This shows that there is an effect of deep breathing exercises and head-up 30-degree position interventions on oxygen saturation values compared to standard hospital interventions.

The results of this study indicate that stroke patients are more often male sex than female. This is in line with other research indicating that the majority of stroke patients

are male and have ischemic stroke (Shetty *et al*., 2020). This research aligns with another study that shows that 65% of stroke sufferers are male (Yuwanda *et al*., 2020). This is because women have more estrogen than men before menopause (Mahayani & Putra, 2019). Research conducted on 1,060 respondents shows that as many as 658 respondents were male with an average age of 57.47 years, while 560 (52.8%) of the respondents suffered from hemorrhagic strokes (Tangkudung *et al*., 2019). The aging process will cause atherosclerosis, so blood flow and tissue nutrients are obstructed. When atherosclerosis appears, it will interfere with tissue perfusion, thereby increasing peripheral vascular pressure (Libby *et al*., 2019)

The results show that the intervention was effective for three days. This is evidenced by the p-value <0.05 on the pretest day 1 and posttest day 3. Research on interventions with progressive muscle relaxation therapy and breath relaxation in patients with hypertension has shown significant results. The statistical test results obtained a p-value of 0.000 (≤0.05), so it can be concluded that there is a significant difference between the average between systolic and diastolic blood pressure before and after using deep breath relaxation techniques (Ikhwan *et al*., 2019). Another study on the use of breathing exercises has resulted in a significant difference in systole and systole values (Orcioli-Silva *et al*., 2024).

The head-up 30-degree position setting has a significant effect on the level of consciousness and Mean Arterial Pressure (MAP) which moves from an average of 80.42 to 93.46. A stable MAP will maintain adequate perfusion. The head-up 30-degree position is a position that matches the anatomy of the human body and so can affect hemodynamics. The MAP value is determined by systolic and diastolic blood pressure. MAP must be maintained above 60 mmHg to ensure perfusion of the brain, coronary arteries, and kidneys during the head-up position. The study finds a p-value of 0.031 (0.05) on mean arterial pressure, indicating that the head-up 30-degree position has a statistically significant effect on mean arterial pressure. The head-up 30 degrees position has a substantial impact on intracranial pressure changes (Pertami *et al*., 2017). When treating patients with heart and neuromuscular disease, it is essential to remember that body position impacts pulmonary physiology and function (Khanbabaee *et al*., 2023).

The results show that the intervention is more effective when it is carried out for three days. This is evidenced by the p-value <0.05 on the pretest day 1 and posttest day 3. Research on stroke patients shows that breathing exercises are effective in improving lung function, balance, and gait in patients with chronic stroke with a p-value ≤0.05. The results of using breathing exercises in stroke patients with restrictive ventilator disorders show that the endurance of their trunk muscles is increased, and the FVC is increased due to an increase in deep breathing capacity, and consequently, this increases the volume of breath. In addition, FEV1 is also increased because breathing exercises increase the strength and coordination of the body muscles and improve respiratory function. Breathing exercises lead to an increase in the exhalation muscle and FVC due to an increase in exhalation capacity thereby increasing exhalation volume. In addition, these exercises can improve the strength and coordination of the body's muscles in improving respiratory function (Lee *et al*., 2018)

Research in the form of a systematic review with a meta-analysis shows training to strengthen breathing in stroke patients improves lung function (Zhang *et al*., 2024). Other studies have also revealed that the strength of the diaphragm and external intercostal muscles increases after breathing exercises (Riri Maria, 2022). The results of RCT studies show that exercises strengthen breathing and improve stroke patient abilities such as motility, muscle strength, and endurance of the respiratory muscles, which are weakened by hemiplegia. The stability of the bar when walking also increases, consequently improving weight distribution and balancing ability, thereby increasing walking ability. The results of this study confirm that breathing exercises are effective for improving lung function, balance, and gait in chronic stroke patients (Jung & Bang, 2017).

Another study on the effect of breathing exercises on stroke patients explains that breathing exercises were effective in improving

physical function (p <0.05). Breathing exercises improve the function of the respiratory muscles. This is because it restores reduced lung volume which has a positive effect on physical function (Lee *et al*., 2018). Another study on the use of training in patients with hypertension shows that it increased peak oxygen uptake. This demonstrates the effect of training on oxygen saturation (p-value < 0.001)(Muller *et al*., 2024). There is research on determining the differences in respiration rate (RR) and oxygen saturation (SaO2) in the head-up positions, semi-fowler and fowler with pre-experimental design. The results reveal that the average value of SaO2 increased from the head to the semi-fowler and fowler positions. The results show that the SaO2 levels differ between these positions (p-value 0.002). The difference in SaO2 value between the head-up and Fowler positions can be seen (p-value 0.033) (Khasanah & Yudono, 2019)

According to some research, there is an increase in the mean value of cerebral blood flow after intervention. The result showed a mean increase in cerebral blood flow (CBF) velocity of 8.5 cm/s in the ischaemic middle cerebral artery (Carvalho *et al*., 2020). In theory, the prone position combined with a head-up position indicates that the return of blood from the inferior part to the right atrium is quite good because the blood vessels' resistance and the right atrium's pressure are not too high. Hence, the volume of blood entering (venous return) to the right atrium is quite good, and the right ventricular filling pressure (preload) increases, which can lead to an increase in stroke volume and cardiac output. Patients in the head-up 30° position will experience increased blood flow in the brain and maximize cerebral tissue oxygenation (Lam *et al*., 2020).

A study has been conducted on stroke patients to determine the efficacy of head elevation models ranging from 30° to 45° in increasing oxygen saturation. A quasi-experiment with a non-randomized pretest-posttest control group design approach has been used in this study. The samples consisted of 22 people who were treated for four weeks with head elevations ranging from 30 to 45 degrees. The statistical test result achieved a p-value of 0.000 less than alpha (p<0.05), concluding that elevation influences increasing oxygen saturation. The 30-degree head elevation models were more influenced to raise oxygen saturation in ischemic stroke patients. (A. W. Pakaya & Nurliah, 2020).

This study also follows previous research which shows that a higher head position, like 15 degrees or 30 degrees, can increase oxygen saturation. However, there is no significant difference in the oxygen saturation value in stroked patients before and after head elevations of 15 or 30 degrees (Kiswanto & Chayati, 2022). Other studies suggest that head elevation measures can facilitate increased blood flow to the cerebral and maximize cerebral tissue oxygenation. However, the height of the head position cannot be identified with certainty. The study shows that there was an effect of head elevation therapy on oxygen saturation (p-value <0.05). It indicates that the treatment group shows an increase in oxygen saturation values with a difference of 2.48. (Pertami *et al*., 2020). Research shows that deep breathing exercises that are carried out three times a week for four weeks with a duration of 15 minutes per exercise can increase the average oxygen saturation from 96.9% to 98.2% with a p-value of 0.018 (<0.05) (Destanta *et al*., 2019).

Deep breathing exercises are exercises that focus on optimizing the expansion of the auxiliary muscles, especially the diaphragm, during the inspiratory phase resulting in an increase in the alveolar ventilation volume due to increased inspiratory volume and capacity, causing stretching of the alveolar wall (N. Pakaya & Nento, 2023). This stretching will promote the production of alveolar type II surfactant resulting in a decrease in alveolar tension and an impact on increasing the lung's capabilities. Effective inspiration due to deep breathing is also supported by the addition of intra-alveolar volume which opens chronic pores in the alveolar wall and causes collateral ventilation effect. Optimization of the inspiratory lung volume and capacity leads to an increase in the efficiency of gas exchange at the alveolar-capillary level. In principle, the rate of transfer and exchange of gases is also influenced by the surface area effect. The increase in alveolar surface area due to stretching that occurs will increase gas transfer, in particular the exchange of O^2 and CO^2, with the pulmonary capillaries,

thus having an effect on the oxygen saturation value in the circulation (Birdee *et al.*, 2023).

Oxygen saturation increases from an average of 93.76% to 96.24% with a p-value of 0.000 between the elevation of the pillow or bed to 30 degrees and afterward in hemorrhagic and non-hemorrhagic stroke patients. The head elevation aims to influence venous return to the maximum so that blood flow to the brain is smooth, to increase the cerebral tissue metabolism, and maximize brain tissue oxygenation, so that the brain can work according to its function (Pertami *et al.*, 2020). Breathing exercises had positive outcomes in pulmonary function and maximal respiratory pressures in stroke subjects. Breathing exercises can maximize the air breathed out during expiration, optimize lung expansion, reduce space loss, and increase the diffusion process. This allows for an increase in the vital capacity of the lungs (Shetty *et al.*, 2020). Deep breathing exercises can train and strengthen the breathing muscles, the airways that were initially narrow will be dilated to maximize ventilation. Good ventilation will increase pulmonary oxygen and increase oxygen diffusion between the alveoli and pulmonary capillaries and a reduction in space loss which ultimately increases oxygen saturation. The oxygen saturation of patients who undergo deep breathing exercise increases from its initial value with a p-value <0.001, and 15 minutes after resting with a p-value of 0.004, but there is no significant difference when compared with the control group.

Conclusion

The results of this research show that there was a significant difference in systolic blood pressure which was p=0.000 (p <0.005), and oxygen saturation showed p=0.001 (p <0.005). But there was no significant difference in diastolic blood pressure which was p=0.836 (p> 0.005). Deep breathing exercises and head-ups 30 degrees help control blood pressure in stroke patients.

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References

Arifin, H., Chou, K.-R., Ibrahim, K., Fitri, S.U.R., Pradipta, R.O., Rias, Y.A., Sitorus, N., Wiratama, B.S., Setiawan, A., Setyowati, S., Kuswanto, H., Mediarti, D., Rosnani, R., Sulistini, R., & Pahria, T., 2022. Analysis of Modifiable, Non-Modifiable, and Physiological Risk Factors of Non-Communicable Diseases in Indonesia: Evidence from the 2018 Indonesian Basic Health Research. *Journal of Multidisciplinary Healthcare*, 15, pp.2203–2221.

Bao, Y., Qi, H., Wang, D., Ding, M., Li, W., Chen, L., Lei, Z., Yang, R., & Zeng, N., 2024. Ischemic Stroke Pathophysiology: A Bibliometric and Visualization Analysis from 1990 to 2022. *Heliyon*, 10(7), pp.e28597.

Birdee, G., Nelson, K., Wallston, K., Nian, H., Diedrich, A., Paranjape, S., Abraham, R., & Gamboa, A., 2023. Slow Breathing for Reducing Stress: The Effect of Extending Exhale. *Complementary Therapies in Medicine*, *73*, pp.102937.

Carvalho, L.B., Kramer, S., Borschmann, K., Chambers, B., Thijs, V., & Bernhardt, J., 2020. Cerebral Haemodynamics with Head Position Changes Post-Ischemic Stroke: A Systematic Review and Meta-Analysis. *Journal of Cerebral Blood Flow & Metabolism*, 40(10), pp.1917–1933.

Destanta, D.S., Setiawati, E., Isma, R., & Putri, A., 2019. Pengaruh Latihan Deep Breathing Terhadap Saturasi Oksigen Pada Perokok Aktif. *Diponegoro Medical Journal (Jurnal Kedokteran Diponegoro)*, 8(1), pp.142–147.

Fahrina, D., Mahmuddin, M., Nasution, I.K., & Anwar, Y., 2021. Liver Function, Leucocyte, and Blood Pressure Levels with Acute Stroke Functional Outcomes. *Jurnal Kesehatan Masyarakat*, 16(3), pp.417–427.

Gholamrezaei, A., Van Diest, I., Aziz, Q., Vlaeyen, J.W.S., & Van Oudenhove, L., 2021. Psychophysiological Responses to Various Slow, Deep Breathing Techniques. *Psychophysiology*, 58(2), pp.1–16.

Ikhwan, M., Utomo, A.S., & Nataliswati, T., 2019. The Comparison Between Progressive Muscle Relaxation and Slow Deep Breathing Exercise on Bood Pressure In Hypersensitive Patients. *Ejournal-Kertacendekia*, 1(2013), pp.75–86.

Jung, K.M., & Bang, D.H., 2017. Effect of Inspiratory Muscle Training on Respiratory Capacity and Walking Ability with Subacute Stroke Patients: A Randomized Controlled Pilot Trial. *Journal of Physical Therapy Science*,

29(2), pp.336–339.

Khanbabaee, G., Zadeh, P.K., Nasehi, M.M., Tabatabaii, S.A., Porghasem, M., Alaei, F., & Sadr, S., 2023. Pulmonary Involvement in Neuromuscular Diseases: A Review. *Iranian Journal of Child Neurology*, 17(2), pp.9–17.

Khasanah, S., & Yudono, D.T., 2019. The Differences Between Oxygen Saturation and Respiratory Rate Of Congestive Heart Failure Patients on The Alteration of Position. *Jurnal Kesehatan Al-Irsyad*, *XII*(1), pp.68–78.

Kiswanto, L., & Chayati, N., 2022. Effect of Head Elevation 30° on GCS Value, and Oxygen Saturation in Stroke Patients. *JOSING: Journal of Nursing and Health*, 3(1), pp.54–66.

Kuriakose, D., & Xiao, Z., 2020. Pathophysiology and Treatment of Stroke: Present Status and Future Perspectives. *International Journal of Molecular Sciences*, 21(20), pp.7609.

Lam, M.Y., Haunton, V.J., Nath, M., Panerai, R.B., & Robinson, T.G., 2020. The Effect of Head Positioning on Cerebral Hemodynamics: Experiences in Mild Ischemic Stroke. *Journal of the Neurological Sciences*, 419, pp.117201.

Lee, D.-K., Jeong, H.-J., & Lee, J.-S., 2018. Effect of Respiratory Exercise on Pulmonary Function, Balance, and Gait in Patients With Chronic Stroke. *Journal of Physical Therapy Science*, 30(8), pp.984–987.

Libby, P., Buring, J.E., Badimon, L., Hansson, G.K., Deanfield, J., Bittencourt, M.S., Tokgözoğlu, L., & Lewis, E.F., 2019. Atherosclerosis. *Nature Reviews Disease Primers*, 5(1), pp.56.

Mahayani, N.K.D., & Putra, I.K., 2019. Karakteristik Penderita Stroke Hemoragik di RSUP Sanglah Denpasar. *Medicina*, 50(1), pp.210–213.

Muller, C., Hauser, C., Carrard, J., Gugleta, K., Hinrichs, T., Schmidt-Trucksäss, A., Hanssen, H., & Streese, L., 2024. Effects of High-Intensity Interval Training on Retinal Vessel Diameters and Oxygen Saturation in Patients With Hypertension: A Cross-Sectional and Randomized Controlled Trial. *Microvascular Research*, 151, pp.104616.

Murphy, S. JX., & Werring, D.J., 2020. Stroke: Causes and Clinical Features. *Medicine*, 48(9), pp,561–566.

Orcioli-Silva, D., Beretta, V.S., Santos, P.C.R., Rasteiro, F.M., Marostegan, A.B., Vitório, R., Gobatto, C.A., & Manchado-Gobatto, F.B., 2024. Cerebral and Muscle Tissue Oxygenation During Exercise in Healthy Adults: A Systematic Review. *Journal of Sport and Health Science*, 2024.

Pakaya, A.W., & Nurliah., 2020. Efektivitas Model Elevasi Kepala Antara 30^{o} dan 45^{o} Terhadap Peningkatan Saturasi Oksigen pada Pasien Stroke Iskemik di RSUD dr.MM. Dunda Kabupaten Gorontalo. *Jurnal Ilmu Kesehatan: Zaitun*, 8(2), pp.1–23.

Pakaya, N., & Nento, A.E.P., 2023. The Effectiveness of Diaphragmatic Breathing Exercise Slow Deep Breathing Musical Therapy and Foot Massage Therapy on Reducing High Blood Pressure in Hypertensive Patiens. Literature Review. *Proceedings of the International Conference on Nursing and Health Sciences*, 4(1), pp.119–126.

Pertami, S.B., Munawaroh, S., & Dwi Rosmala, N.W., 2020. Pengaruh Elevasi Kepala 30 Derajat Terhadap Saturasi Oksigen Dan Kualitas Tidur Pasien Stroke. *Health Information: Jurnal Penelitian*, 11(2), pp.133–144.

Pertami, S.B., Sulastyawati, S., & Anami, P., 2017. Effect of 30° Head-Up Position on Intracranial Pressure Change in Patients With Head Injury in Surgical Ward of General Hospital of Dr. R. Soedarsono Pasuruan. *Public Health of Indonesia*, 3(3), pp.89–95.

Pozuelo-Carrascosa, D.P., Carmona-Torres, J.M., Laredo-Aguilera, J.A., Latorre-Román, P.Á., Párraga-Montilla, J.A., & Cobo-Cuenca, A.I., 2020. Effectiveness of Respiratory Muscle Training for Pulmonary Function and Walking Ability in Patients With Stroke: A Systematic Review with Meta-Analysis. *International Journal of Environmental Research and Public Health*, 17(15), pp.1–22.

Riri Maria, R., 2022. The Position of Leaning Forward to Reduce Breathing of COPD Patients: Literature Review. *JIKO (Jurnal Ilmiah Keperawatan Orthopedi)*, 5(2), pp.62–68.

Russo, M.A., Santarelli, D.M., & O'Rourke, D., 2017. The Physiological Effects of Slow breathing in the Healthy Human. *Breathe*, 13(4), pp.298–309.

Saefurrohim, M.Z., Azam, M., Rahayu, S.R., & Cahyati, W.H., 2022. Incidence of Stroke and Associated Risk Factors in Bogor, Indonesia: A Nested Case-Control Study. *Jurnal Kesehatan Masyarakat*, 17(4), pp.621–629.

Salaudeen, M.A., Bello, N., Danraka, R.N., & Ammani, M.L., 2024. Understanding the Pathophysiology of Ischemic Stroke: The Basis of Current Therapies and Opportunity for New Ones. *Biomolecules*, 14(3), pp.305.

Setyopranoto, I., Bayuangga, H.F., Panggabean, A.S., Alifaningdyah, S., Lazuardi, L., Dewi, F.S.T., & Malueka, R.G., 2019. Prevalence of Stroke

and Associated Risk Factors in Sleman District of Yogyakarta Special Region, Indonesia. *Stroke Research and Treatment*, 2019, pp.1–8.

Shetty, N., Samuel, S.R., Alaparthi, G.K., Amaravadi, S.K., Joshua, A.M., & Pai, S., 2020. Comparison of Diaphragmatic Breathing Exercises, Volume, and Flow-Oriented Incentive Spirometry on Respiratory Function in Stroke Subjects: A Non-randomized Study. *Annals of Neurosciences*, 27(3–4), pp.232–241.

Summers, D., Leonard, A., Wentworth, D., Saver, J.L., Simpson, J., Spilker, J.A., Hock, N., Miller, E., & Mitchell, P.H., 2015. Comprehensive Overview of Nursing and Interdisciplinary Care of the Acute Ischemic Stroke Patient. August, *Stroke*, 40(8), pp.1–10.

Tangkudung, P., Girsang, T., & Ate., 2019. Characteristic of Factors Associated with Admission Time of Stroke Patients in Hospital. *Jurnal Sinaps*, 2(3), pp.5–8.

Yuwanda, K., Widyastuti, K., & Laksmidewi, A.A.A.P., 2020. Hubungan antara Lokasi Stroke Dengan Gangguan Kognitif Pada Penderita Stroke di RSUP Sanglah Denpasar, *Callosum Neurology*, 3(1), pp.3(1), 1–5.

Zhang, Y.S., Zhang, K., Huang, L., Wei, J.X., Bi, Z.T., Xiao, J.H., Huang, J., Luo, C.S., Li, Y.D., & Zhang, J.M., 2024. The Effects of Respiratory Muscle Training on Respiratory Function and Functional Capacity in Patients with Early Stroke: A Meta-Analysis. *European Review of Aging and Physical Activity*, 21(4).

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Central Obesity in Children and Adolescent: Current Themes and Future Potential Researches

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Abstract

The increasing prevalence of central obesity among children and adolescents is a significant concern for public health, as it can lead to various health risks and complications. This study aimed to provide comprehensive updates using the keywords "central obesity," and "children" or "adolescent". The Scopus electronic database was searched for relevant articles to compile the basic publishing and citation data found in the article's title, abstract, and keyword. The author, country, journal, and keyword networks were visualized using the bibliometric software program VOSviewer and biblioshiny. Of 1,190 articles, this study suggests the growth advancement with a 7.84% annual growth rate. The Plos One is the most international publication. The United States is the country leading in this topic. We find four theme clusters: obesity, central obesity, metabolic syndrome, and adolescents. The analysis shows that the diagnosis through anthropometric measurements, body fat assessment, metabolic syndrome, and complications were the major well-known research. The growing interest and future interest topics were waist-to-hip ratio, waist-to-height ratio, lifestyle, adiposity, and dyslipidemia. This bibliographic study showed the expanding publications of central obesity in children and adolescents and suggested several critical themes for future research.

Introduction

Concern about childhood and adolescent obesity is growing worldwide, with significant regional, socioeconomic, and gender variations (Wong *et al.*, 2020). The rates of obesity among children and adolescents vary widely, with older individuals, females, urban dwellers, Caucasians, and those from higher-income countries being more frequently affected. In Finland, the prevalence of childhood obesity is 8.7%. In the US, it is over 18%, and in some regions of China, it is as high as 28.6% (Sarkkola *et al.*, 2021; Deal *et al.*, 2020; Zhang *et al.*, 2021).

Central obesity in children and adolescents poses several health risks and complications that persist into adulthood and can impair quality of life. There are numerous short- and long-term health risks associated with this condition, such as those related to metabolism, cardiovascular health, and psychological problems (Bendor *et al.*, 2020; Faienza *et al.*, 2020; Jebeile *et al.*, 2021). However, there is a lack of published bibliometric studies, particularly using the Scopus database, that examine the scientific literature on this topic. Previous bibliometric studies used Web-of-Science (WoS) as a database (Coronado-Ferrer *et al.*, 2022; Kawuki *et al.*, 2022). The Scopus database is known to have the same status as WoS as a bibliographic data source. It is reliable and might be better than WoS (Pranckute, 2021). This study aims to provide comprehensive updates on the problems of central obesity in children and adolescents using the keywords "central obesity," and "children" or "adolescent".

Method

The Scopus database search engine was

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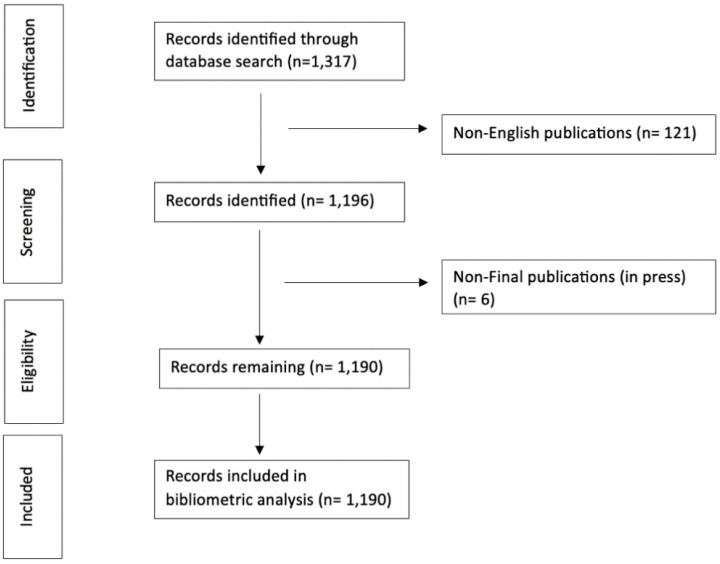


FIGURE 1. Flow-Chart Diagram of the Literature Search Process

applied in February 2024 to compile the basic publishing and citation data in the article's title, abstract, and keyword. The search terms included ("central obesity" AND child OR adolescent) and we were limited to only English publications regardless of the period of publication **(Fig.1).** After finding 1,190 articles, we exported them as CSV files. We used Scopus 'Analyze Result', VOSviewer 1.6.19, and Biblioshiny to visualize and analyze the co-occurrence of words and phrases in the titles and abstract keywords. We determined and limited the minimum 10 number of occurrences of the author keyword. Co-occurrence clusters represented by various colors were revealed by the author's keyword co-occurrence network analysis. The frame size corresponds to the occurrence of the keyword. The thickness is proportionate to the co-occurrence strength. The yellow keywords appeared later (2017 or later) than the blue ones (2015 or earlier), as the overlay visualization. The density visualization displayed the density of each term, and the thickness displayed more density.

Result And Discussion

Publications & publications growth

Out of 1,190 articles, we found a total of 1057 articles (88.8%), 88 reviews (7.4%), 15 conference papers (1.4%), and 14 book chapters (1.2%). The amount of research on central obesity in children and adolescents is growing. **(Fig.2)** The annual growth rate of publications was 7.84%, with international co-authorships, was 27.31%, and average citation perdoc was 32.93.

There were increments in articles regarding this subject since 2005, after a relatively low number of publications from 1990 to 2005. There was an annual increase in publications from 2005 to 2015, respectively (an average of 30 percent annual growth rate in publications). The publication rate (60–80 documents/year) remained relatively constant from 2015 until 2023. (**Fig.1**) Previous bibliometric studies revealed that the number of articles increased with the annual number of articles increasing steadily from 7.6% in 2010 to 12.1% in 2019, with the total number of articles more than twelve thousand (Coronado-Ferrer *et al*., 2022). The significant increase could be due to global awareness of obesity problems worldwide (Spinelli *et al*., 2021; González-Álvarez *et al*., 2020; Caprio *et al*., 2020).

Journal sources, countries, authors, and most cited articles

The Plos One is the most international publication with 30 documents, followed by the International Journal of Obesity (27), BMC Public Health (21), and Nutrients (21). The

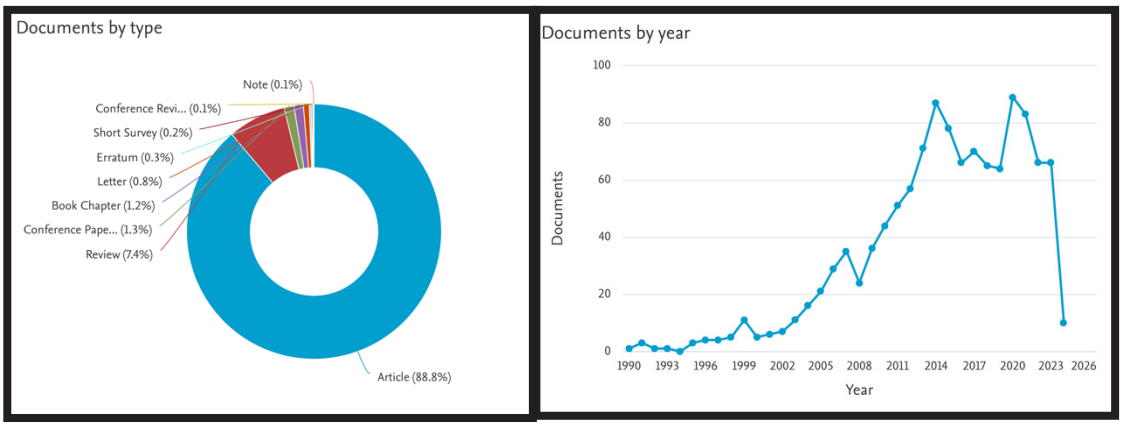


FIGURE 2. Publications types and publications growth

next other journals were Journal of Clinical Endocrinology and Metabolism (16), Journal of Pediatric Endocrinology And Metabolism (16), International Journal of Environmental Research And Public Health (15), Metabolic Syndrome And Related Disorders (13), Nutrition Metabolism And Cardiovascular Diseases (12), and Public Health Nutrition (12), respectively. Eight of the top ten journals had SNIP (Source Normalized Impact per Paper) scores higher than 1. Only one of the top 10 journals focuses on pediatric endocrinology, and three focus on nutrition. A similar result from a previous bibliometric study in WoS found that the International Journal of Obesity, BMC Public Health, and Plos One were the fourth largest journal sources despite Pediatric Obesity (Coronado-Ferrer *et al.*, 2022). Our study revealed that Pediatric Obesity had only 6 articles. Journals focused on pediatric obesity had fewer articles than other journals not focused/specific on this topic.

Most publications with 245 articles (20.6%) were provided by the United States, followed by China with 176 (14.8%), the United Kingdom with 109 (9.2%), and India with 87 (7.3%). The following most productive countries were Brazil, Iran, Spain, Australia, Italy, and Greece, respectively. US and UK were also the most articles in previous studies (Coronado-Ferrer *et al.*, 2022; Kawuki *et al.*, 2022). Southeast Asia contributed only 43 articles (3.61%). Our research and the previous one had similar results in the Southeast countries (Coronado-Ferrer *et al.*, 2022). Southeast Asia countries had a small contribution (less than 20 articles/country in our study). The most prolific author on this topic is Youfa Wang (13), followed by Roya Kelishadi R (10), Labros S. Sidossis (9), and Jie Mi (9). **(Fig.3)**

Table 1 describes the top ten most cited articles. The most cited article is "A systematic

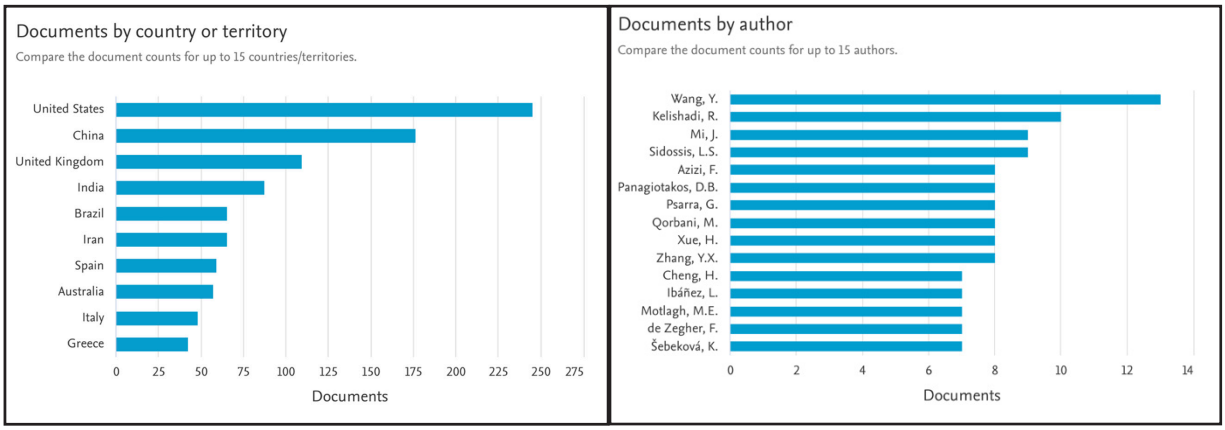


FIGURE 3. The source of countries and authors

TABLE 1. Top ten most cited articles

	Authors	Title	Year	Source title	Citation
1	Browning L.M.; Hsieh S.D.; Ashwell M (Browning *et al*., 2010)	A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0.5 could be a suitable global boundary value	2010	Nutrition Research Reviews	937
2	Oken E.; Gillman M.W (Oken & Gillman, 2003)	Fetal origins of obesity	2003	Obesity Research	715
3	Beales P.L.; Elcioglu N.; Woolf A.S.; Parker D.; Flinter F.A (Beales *et al.,* 1999)	New criteria for improved diagnosis of Bardet-Biedl syndrome: Results of a population survey	1999	Journal of Medical Genetics	663
4	Lim S.S.; Davies M.J.; Norman R.J.; Moran L.J (Lim *et al*., 2012)	Overweight, obesity and central obesity in women with polycystic ovary syndrome: A systematic review and meta-analysis	2012	Human Reproduction Update	553
5	De Heredia F.P.; Gómez-Martínez S.; Marcos A (de Heredia *et al.,* 2004)	Chronic and degenerative diseases: Obesity, inflammation and the immune system	2012	Proceedings of the Nutrition Society	511
6	Armitage J.A.; Khan I.Y.; Taylor P.D.; Nathanielsz P.W.; Poston L (Armitage *et al.,* 2004)	Developmental programming of the metabolic syndrome by maternal nutritional imbalance: How strong is the evidence from experimental models in mammals?	2004	Journal of Physiology	458
7	Daniels S.R.; Khoury P.R.; Morrison J.A (Daniels *et al*., 1997)	The utility of body mass index as a measure of body fatness in children and adolescents: Differences by race and gender	1997	Pediatrics	426
8	Ibáñez L.; Ong K.; Dunger D.B.; De Zegher F(Ibáñez *et al*., 2006)	Early development of adiposity and insulin resistance after catch-up weight gain in small-for-gestational-age children	2006	Journal of Clinical Endocrinology and Metabolism	419
9	Gunay-Aygun M.; Schwartz S.; Heeger S.; O'Riordan M.A.; Cassidy S.B (Gunay-Aygun *et al*., 2001)	The changing purpose of Prader-Willi syndrome clinical diagnostic criteria and proposed revised criteria.	2001	Pediatrics	394
10	Sahakyan K.R.; Somers V.K.; Rodriguez-Escudero J.P.; Hodge D.O.; Carter R.E.; Sochor O.; Coutinho T.; Jensen M.D.; Roger V.L.; Singh P.; Lopez-Jimenez F (Sahakyan *et al*., 2015)	Normal-weight central obesity: Implications for total and cardiovascular mortality	2015	Annals of Internal Medicine	361

review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0.5 could be a suitable global boundary value" by Browning L.M *et al* (2010) with 937 citations; followed by "Fetal origins of obesity" by Oken E. and Gillman M.W. (2003) (715 citations); and "New criteria for improved diagnosis of Bardet-Biedl syndrome: Results of a population survey" by Beales P.L *et al* (1999) (663 citations). The most cited articles with a focus on children and obesity were "The Utility of Body Mass Index as a Measure of Body Fatness in Children and Adolescents: Differences by Race and Gender" (Daniels 1997; 426 citations); and "Early Development of Adiposity and Insulin Resistance After Catch-up Weight Gain in Small-for-gestational-age Children" (Ibanez 2006; 419 citations). The most cited article topic is a waist-to-height ratio to diagnose obesity, although it is not discussed specifically for children and adolescents in this article (Browning *et al*., 2010). Previous bibliometric studies mentioned that the most cited article is a definition for diagnosing child overweight and obesity (Kawuki *et al*., 2022). The challenge in diagnosing central obesity in children and adolescents is to select the best anthropometric measurement with high specificity and sensitivity.

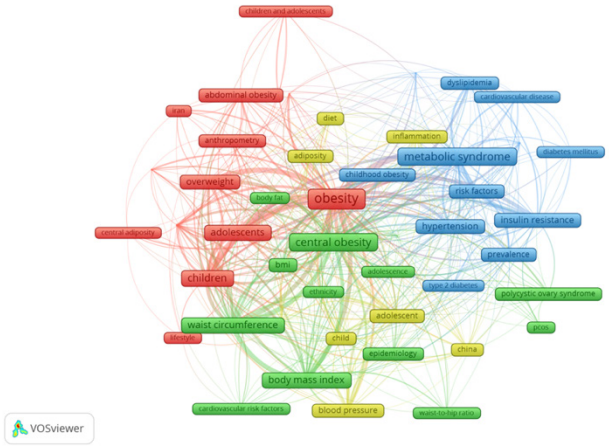
Co-occurrence clusters

Four theme clusters were found in the author's keyword co-occurrence network analysis (**Table 2, Fig. 4A**), which has a total of 46 item keywords, and "obesity", "central obesity", "metabolic syndrome", and "adolescents" are the densest terms in each cluster. The growing interest from 2016 until 2024 was overweight and obesity in children and adolescents, waist-to-hip ratio, waist-to-height ratio, lifestyle, adiposity, and dyslipidemia (**Fig. 4B**). Waist-to-hip ratio, waist-to-height ratio, lifestyle, and dyslipidemia could be chosen as the future interest topics to be further investigated because of the less density in our density visualization map **(Fig. 4C)**. The thematic evolution was performed in **Fig. 5A**. The themes in 2019-2024 were described in **Fig.5B.** Abdominal obesity and childhood obesity were the new interesting topics in this period.

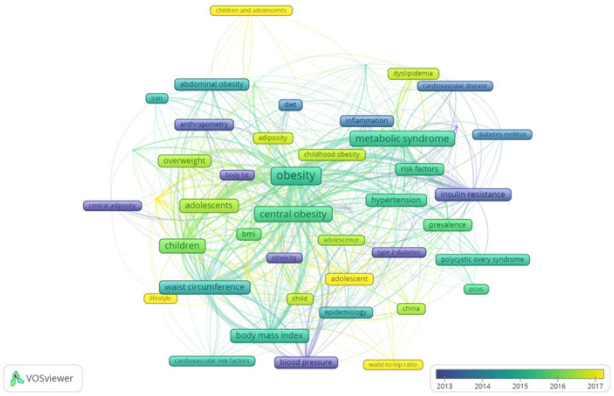
Cluster 1 revolves around broad themes of obesity, abdominal obesity, and central adiposity in children and adolescents, with various anthropometric measurements to diagnose them. In this cluster, we found the topic of lifestyle. The AAP clinical practice guidelines mentioned intensive health behavior lifestyle treatment as an approach to treat obesity in children and adolescent (Hampl *et al*., 2023). Cluster 2 revolves around a somewhat similar theme to Cluster 1, but has a more specific and narrower theme on central obesity, body fat, adolescent body composition, and several anthropometric measurements (body mass

TABLE 2. The author's keyword co-occurrence clusters

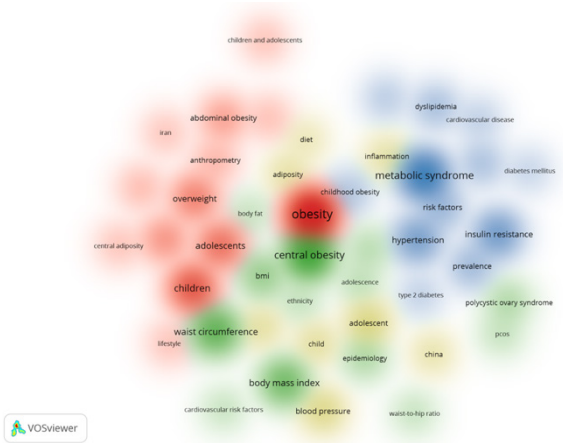
Cluster 1 (13 item)	Cluster 2 (13 item)	Cluster 3 (12 item)	Cluster 4 (8 item)
abdominal obesity	adolescence	cardiovascular disease	adiposity
adolescents	bmi	cardiovascular risk	**adolescent**
anthropometry	body composition	childhood obesity	blood pressure
central adiposity	body fat	diabetes	child
childhood	body mass index	diabetes mellitus	china
children	cardiovascular risk factor	dyslipidemia	diet
children and adolescents	**central obesity**	hypertension	inflammation
iran	epidemiology	insulin resistance	physical activity
lifestyle	ethnicity	**metabolic syndrome**	
neck circumference	pcos	prevalence	
obesity	polycystic ovary syndrome	risk factors	
overweight	waist circumference	type 2 diabetes	
waist-to-height ratio	waist-to-hip ratio		



A

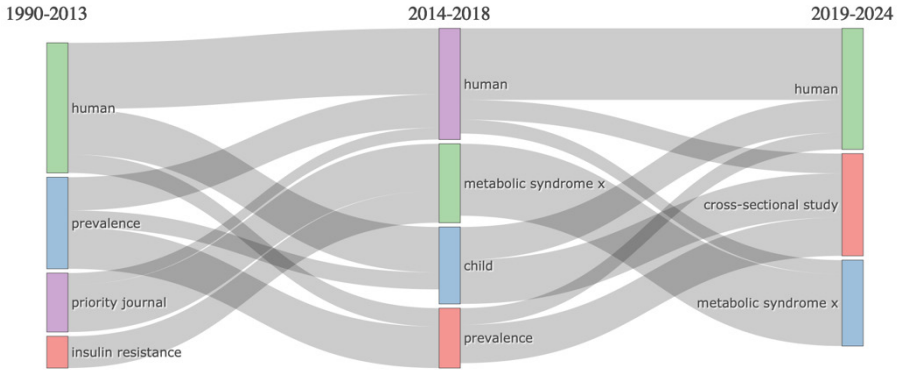


B

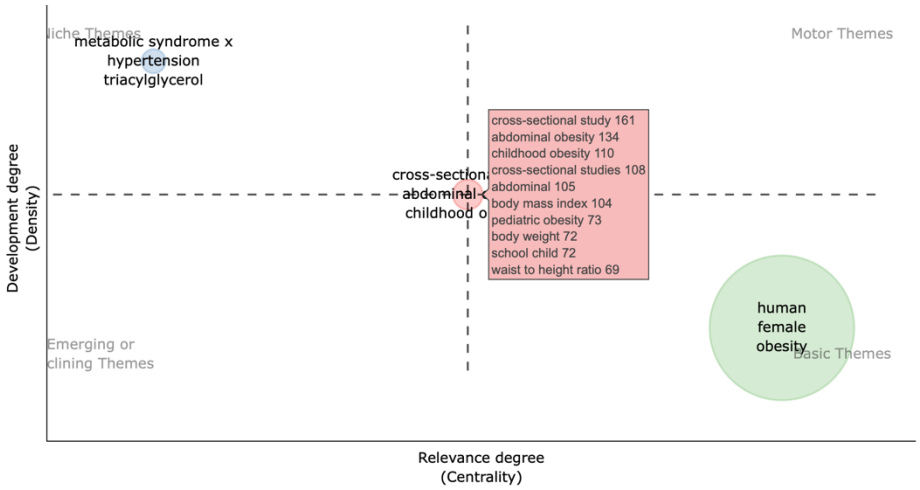


C

FIGURE 4. The Author's Keyword Co-Occurrence Network Analysis (A), The Overlay Visualization (B), The Density Visualization (C)



A



B

FIGURE 5. Thematic Evolution: 1990-2013; 2014-2018; 2019-2024 (A); Themes in 2019-2024 (B)

index, waist circumference, and waist-to-hip). Topics related to epidemiology and ethnicity emerged in this cluster. Along with limited articles from southeastern countries, future research from this region will be important to add information on ethnicity.

Cluster 3 revolves around the topic of metabolic syndrome, including cardiovascular disease, type 2 diabetes mellitus, dyslipidemia, and hypertension. The AAP clinical practice guidelines discuss the comorbidities of childhood obesity in detail (Skinner *et al.*, 2023). Cluster 4 had a more limited topic network. This cluster highlighted interesting topics related to physical activity and nutrition. Physical activity and diet are the most significant factors in the treatment of obesity in children and adolescents, although they are difficult to apply. AAP clinical practice guidelines signify pharmacotherapy and bariatric surgery to treat severe obesity.

Bibliometric analysis shows that in the context of obesity and/or central obesity, diagnosis is made through anthropometric measurements (body mass index, waist-to-height ratio, waist-to-hip ratio, waist circumference, and neck circumference), body fat assessment (abdominal obesity, adiposity), metabolic syndrome and its complications (insulin resistance, dyslipidemia, hypertension, cardiovascular, and polycystic ovary syndrome) was the most important known research results. Waist-to-hip ratio (cluster 2), waist-to-height ratio (cluster 1), lifestyle (cluster 1),

and dyslipidemia (cluster 3) should be selected as the future topics of interest to be further investigated in childhood obesity (**Fig. 4B**). These results comparable with the biblioshiny's result that concluded childhood obesity and abdominal obesity as the new interesting topics. Restricted terms illustrate the treatment of obesity and/or central obesity in children and adolescents.

Conclusion

A comprehensive review of central obesity in children and adolescents was conducted. The expanding publications largely came from the US, China, the UK, India, and suggesting that further research from other regions is needed. Future research is expected to focus on several important topics, including waist-to-hip ratio, waist-to-height ratio, lifestyle, and dyslipidemia. The treatment of obesity in children and adolescents is also a crucial topic to be studied in the future.

References

Armitage, J.A., Khan, I.Y., Taylor, P.D., Nathanielsz, P.W., & Poston, L., 2004. Developmental Programming of The Metabolic Syndrome by Maternal Nutritional Imbalance: How Strong is The Evidence From Experimental Models in Mammals?. *The Journal of Physiology*, 561(2), pp.355–77.

Beales, P.L., Elcioglu, N., Woolf, A.S., Parker, D., & Flinter, F.A., 1999. New Criteria for Improved Diagnosis of Bardet-Biedl Syndrome: Results of a Population Survey. *Journal of Medical Genetics*, 36(6), pp.437-46.

Bendor, C., Bardugo, A., Pinhas-Hamiel, O., Afek, A., & Twig, G., 2020. Cardiovascular Morbidity, Diabetes and Cancer Risk Among Children and Adolescents with Severe Obesity. *Cardiovascular Diabetology, 19(1), pp.79*.

Browning, L.M., Hsieh, S.D., Ashwell, M., 2010. A Systematic Review of Waist-To-Height Ratio as a Screening Tool for The Prediction of Cardiovascular Disease and Diabetes: 0·5 Could Be a Suitable Global Boundary Value. *Nutrition Research Review*. 23(2), pp.247-69

Caprio, S., Santoro, N., & Weiss, R., 2020. Childhood Obesity and The Associated Rise in Cardiometabolic Complications. *Nature Metabolism*, 2, pp.223-232

Coronado-Ferrer, S., Ferrer-Sapena, A., Aleixandre-Benavent, R., Valderrama, Z.J.C., & Cogollos, L.C., 2022. Global Trends in Scientific Research on Pediatric Obesity. *International Journal of Environmental Research and Public Health*, 19(3), pp.1251.

Daniels, S.R., Khoury, P.R., & Morrison, J.A., 1997. The Utility of Body Mass Index as a Measure of Body Fatness in Children and Adolescents: Differences by Race and Gender. *Pediatrics*, 99(6), pp.804-7.

De Heredia, F.P., Gómez-Martínez, S., & Marcos, A., 2012. Obesity, Inflammation and The Immune System. *Proceedings of the Nutrition Society*, 71(2), pp.332-338.

Deal, B., Huffman, M., Binns, H., & Stone, N., 2020. Perspective: Childhood Obesity Requires New Strategies for Prevention. *Advances in Nutrition*, 11(5), pp.1071-78

Faienza, M., Chiarito, M., Molina-Molina, E., Shanmugam, H., Lammert, F., Krawczyk, M., D'Amato, G., & Portincasa, P., 2020. Childhood Obesity, Cardiovascular and Liver Health: a Growing Epidemic with Age. *World Journal of Pediatrics*, 16, pp.438-45.

González-Álvarez, M., Lazaro-Alquezar, A., & Simón-Fernández, M., 2020. Global Trends in Child Obesity: Are Figures Converging?. *International Journal of Environmental Research and Public Health, 17*, pp.9252.

Gunay-Aygun, M., Schwartz, S., Heeger, S., O'Riordan, M.A., & Cassidy, S.B., 2001. The Changing Purpose of Prader-Willi Syndrome Clinical Diagnostic Criteria and Proposed Revised Criteria. *Pediatrics*, 108(5), pp.E92.

Hampl, S.E., Hassink, S.G., Skinner, A.C., Armstrong, S.C., Barlow, S.E., Bolling, C.F., Edwards, K.C.A., Eneli, I., Hamre, R., Joseph, M.M., Lunsford, D., Mendonca, E., Michalsky, M.P., Mirza, N., Ochoa, E.R., Sharifi, M., Staiano, A.e., Weedn, A.E., Flinn, S.K., Lindros, J., & Okechukwu, K., 2023. Clinical Practice Guideline for The Evaluation and Treatment of Children and Adolescents with Obesity. *Pediatrics*, 151, pp.e2022060640.

Ibáñez, L., Ong, K., Dunger, D.B., & de Zegher, F., 2006. Early Development of Adiposity and Insulin Resistance After Catch-up Weight Gain in Small-for-gestational-age Children. *The Journal of Clinical Endocrinology & Metabolism*, 91(6), pp.2153-58.

Jebeile, H., Lister, N., Baur, L., Garnett, S., & Paxton, S., 2021. Eating Disorder Risk in Adolescents with Obesity. *Obesity Reviews*, 22, pp.e13173.

Kawuki, J., Musa, T.H., Ghimire, U., Obore, N., & Papabathini, S.S., 2022. The 100 Top-

Cited Articles on Childhood Obesity: A Bibliometric Analysis. *J Glob Health*, 6(3), pp.136-48

Lim, S.S., Davies, M.J., Norman, R.J., & Moran, L.J., 2012. Overweight, Obesity and Central Obesity in Women with Polycystic Ovary Syndrome: A Systematic Review and Meta-Analysis. *Human Reproduction Update*, 18(6), pp.618-637

Oken, E., & Gillman, M.W., 2003. Fetal Origins of Obesity. *Obesity Research*, 11(4), pp.496-506.

Pranckutė, R., 2021. Web of Science (WoS) and Scopus: The Titans of Bibliographic Information in Today's Academic World. *MDPI*, 9(1), pp.12.

Sahakyan, K.R., Somers, V.K., Rodriguez-Escudero, J.P., Hodge, D.O., Carter, R.E., Sochor, O., Coutinho, T., Jensen, M.D., Roger, V.L., Singh, P., & Lopez-Jimenez, F., 2015. Normal-Weight Central Obesity: Implications for Total and Cardiovascular Mortality. *Annals of Internal Medicine*. 163(11), pp.827-35.

Sarkkola, C., Viljakainen, J., Figueiredo, R.A.O., Saari, A., Lommi, S., Engberg, E., & Viljakainen, H., 2021. Prevalence of Thinness, Overweight, Obesity, and Central Obesity in Finnish School-Aged Children: A Comparison of National and International Reference Values. *Obesity Facts*, 15, pp.240-47.

Skinner, A.C., Staiano, A.E., Armstrong, S.C., Barkin, S.L., Hassink, S.G., Moore, J.E., Savage, J.S., Vilme, H., Weedn, A.E., Liebhart, J., Lindros, J., & Reilly, E.M., 2023. Appraisal of Clinical Care Practices for Child Obesity Treatment. Part II: Comorbidities. *Pediatrics*, 151(2), pp.e2022060643.

Spinelli, A., Buoncristiano, M., Nardone, P., Starc, G., Hejgaard, T., Júlíusson, P.B., Fismen, A., Weghuber, D., Milanović, S.M., García-Solano, M., Rutter, H., Rakovac, I., Cucu, A., Brinduse, L.A., Rito, A.I., Kovacs, V.A., Heinen, M.M., Nurk, E., Mäki, P., Abdrakhmanova, S., Rakhmatulleoeva, S., Duleva, V., Sant'Angelo, V.F., Fijałkowska, A., Gualtieri, A., Sacchini, E., Hassapidou, M., Hyska, J., Kelleher, C.C., Kujundžić, E., Kunešová, M., Ioannidou, E.M., Ostojic,. S.M., Peterkova, V., Petrauskienė, A., Popović, S., Pudule, I., Jonsson, K.R., Dal-Re Saavedra, M.A., Salanave, B., Shengelia, L., Spiroski, I., Tanrygulyyeva, M., Tichá, L., Usupova, Z., Ozcebe, L.H., Abildina, A., Schindler, K., Weber, M.W., Hadžiomeragić, A.F., Melkumova, M., Stojisavljević, D., Boymatova, K., Williams, J., & Breda, J., 2021. Thinness, Overweight, and Obesity in 6- to 9-Year-Old Children from 36 Countries: the World Health Organization European Childhood Obesity Surveillance Initiative—COSI 2015–2017". *Obesity Reviews*, 22.

Wong, M., Huang, J., Wang, J., Chan, P., Lok, V., Chen, X., Huang, J., Wang, J., Chan, P.S.F., Lok, V., Chen, X., Leung, C., Wang, H.H.X., Lao, X.Q., & Zheng, Z., 2020. Global, Regional and Time-Trend Prevalence of Central Obesity: A Systematic Review and Meta-Analysis of 13.2 Million Subjects. *European Journal of Epidemiology*, 35(7), pp.673-83.

Zhang, L., Chen, J., Zhang, J., Wu, W., Huang, K., Chen, R., Maimaiti, M., Chen, S., Cao, B., Zhu, M., Wang, C., Su, Z., Liang, Y., Yao, H., Wei, H., Zheng, R., Du, H., Luo, F., Li, P., Mo, M., Yu, Y., Wang, E., Dorazio, R.M., & Fu, J., 2021. Regional Disparities in Obesity Among a Heterogeneous Population of Chinese Children and Adolescents. *JAMA Network Open*, 4(10), pp.e2131040.

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Non-Pharmacological Therapy to Reduce Pain Intensity in Patients

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Abstract

Pain is still the main problem for patients being treated in the treatment room. To overcome pain, analgesic drugs are often given. Even though the first step to help reduce pain can be to use non-pharmacological therapy. This study aims to see effect of non-pharmacological therapy in reducing patient pain levels. The type of research is a quasi-experiment with a one-group pre-test and post-test design approach. Sampling using accidental sampling technique over a period of 1 month obtained 50 respondents who matched the characteristics of the respondents in the research. Overall non- pharmacological therapy (beson relaxation, murotal, guide imagery, zikr, warm compresses, and hypnosis techniques) can reduce pain intensity in respondents who experience pain. Pain management in patients does not always involve immediate administration of medication. Non-pharmacological measures must always be prioritized to treat pain. Non-pharmacological therapy has been proven to be able to overcome or reduce pain levels.

Introduction

Pain is an unpleasant sensory and emotional experience resulting from actual and potential tissue damage. In this case, pain is a production mechanism for the body, arises when tissue is damaged, and causes the individual to react to eliminate painful stimuli (Aiysah, 2017). The International Association for the Study of Pain (IASP) defines pain as an unpleasant subjective sensory and emotional experience related to actual or potential tissue damage or perceived in incidents where the damage occurs (IASP, 2020). In Indonesia, pain is the most common reason for patients to visit healthcare facilities and is the most common reason given for self-medication. Continuous analgesics are the primary therapy in treating pain. However, one of the reasons for inappropriate pain management is a lack of knowledge about non-pharmacological therapies. Although pain can be reduced by using medication, several non-pharmacological techniques can also help control or reduce the pain felt by patients such as benson relaxation, murotal therapy, guide imagery, dhikr, warm compresses, and hypnosis techniques.

The physical impact of pain is rapid breathing, increased pulse, blood pressure, stress, inhibited healing, and decreased immune function. Pain problems management can be done pharmacologically and non-pharmacologically. A combination of pharmacological and non-pharmacological techniques to reduce pain. One of the pharmacological techniques used is relaxation techniques. Relaxation techniques can reduce muscle tension caused by pain (Permatasari & Sari, 2016). Non-pharmacological therapy is

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crucial before treatment carried out to avoid the impact or side effects of consuming drugs (Nurjanah et al., 2020). The research explains the non-pharmacological therapy of benson relaxation, murotal therapy, guide imagery, dhikr, warm compresses, and hypnosis techniques can reduce the intensity of pain in patients in Toto Kabila Hospital Bone Bolango, Gorontalo, Indonesia.

Method

This research used a pre-experimental design method with a one-group pre-post-test design approach. Purposive sampling was used to select respondents, namely adult patients treated in the internal medicine ward. A total of 50 patients were selected for this research. The dependent variable in this study is the intensity of pain in patients being treated in the internal medicine ward, while the independent variable is non-pharmacological therapy. This research has received permission from the Health Research Ethics Commission of Universitas Negeri Gorontalo No: 125A/UN47. B7/KE/2023.

The research was carried out for 1 month and carried out 5 (benson relaxation, murotal therapy, guide imagery, dhikr, warm compresses, and hypnosis techniques) selected interventions to reduce pain. The researcher was assisted by 5 young nurses on clinical specialization work in the internal medicine room in Toto Kabila Bone Bolango, Gorontalo, Indonesia. Each nurse will be assigned one intervention on 10 respondents who meet the respondent criteria. Before carrying out an intervention, every young nurse is provided with standard operational procedures for each intervention. The instrument used to measure pain is a pain intensity scale using the numerical rating scale (NRS) method. NRS is a pain screening tool, commonly used to assess pain severity at that moment in time using a 0-10 scale, with zero meaning "no pain" and 10 meaning "the worst pain imaginable". Statistical analysis using SPSS 26.0.

Result And Discussion

A total of 50 patients who experienced pain problems became respondents in this study.

Table 1. Respondent Characteristics Related to Pain Perception (n=50)

Characteristics	N	%
Gender		
Male	20	40
Female	30	60
Age (year)		
17-25	4	8
26-35	5	10
36-45	9	18
46-55	10	20
56-65	22	44
Medical diagnosis		
Abdominal colic	12	24
Dyspepsia	18	36
Gout	9	18
Gastroesophageal Reflux Disease (GERD)	3	6
Cephalgia	2	4
Hypertension	2	4
Brochopneumonia	1	2
Gastroenteritis (GEA)	1	2
Chronic Kidney Disease	1	2
	1	2

Table 1 shows that most respondents were female, as many as 30 respondents (60%). The age of the respondents was in the range of 56-65 years, as many as 22 people (44%). While the most common medical diagnosis was dyspepsia with 18 respondents (36%).

Based on the research conducted, statistical test results were obtained using the paired t-test on respondents after being given hypnotherapy (five-finger hypnotherapy) intervention once a day for 3 days of treatment with an intervention duration of 5-10 minutes. The p-value is 0.000 (<0.05). It shows a positive influence of five-finger hypnotherapy on reducing the pain scale in the internal room of RSUD Toto Kabila Bone Bolango, Gorontalo. Five-finger hypnotherapy is a psychological intervention. Hypnotherapy causes a person to relax so that it is easier to accept suggestions from the therapist. Hypnotherapy deliberately utilizes the state of fantasy to reduce changes in both the patient's conscious and subconscious mind. In this way, hypnotherapy utilizes the patient's psychological condition to change the perception of pain, including pain, into a more comfortable feeling. Hypnotherapy can divert the client's attention with the suggestions given so that the client will forget the pain they are feeling. Hypnotherapy affects the ACC (Anterior Cingulated Cortex) which will have an effect on the affective process regarding the experience of pain. Affection modules will influence the brain's perception of the pain experience so that it can lead to positive coping (Halim & Khayati, 2020).

The working mechanism of five-finger hypnotherapy is by directly providing a stimulus to the brain in the thalamus, the thalamus will send words of suggestion which will influence alpha waves. Alpha waves will affect the limbic system, namely the amygdala. Then the amygdala will send information to the locus coeruleus and transmit it to the hypothalamus. The hypothalamus will control CRF so that cortisol and ACTH hormones are reduced and secrete endorphin and serotonin neurotransmitters so that the intensity and scale of pain can be reduced (Fitrianingrum et al., 2018). The results of this research are supported by the theory of Wilson and Nelson (2015), which states that hypnotherapy involves hypnosis induction, which can change perception and behavior and even act as a coping mechanism for pain management. Hypnotherapy is a non-pharmacological therapy that works on the client's subconscious. Auditory sensory suggestions that induce the conscious mind cause a trance state, because this condition is an open critical factor and weak supervision. The suggestions will directly reach the pain-reducing mind that has been implanted through suggestions in a hypnotic state and will trigger permanent changes that can reduce pain activity and even eliminate pain. Because the brain changes according to the hypnotist's suggestion. Five-

Table 2. Analysis of Differences in Pain Levels Before and After Intervention (n=50)

	Pain scale						P
	Pre test			Post test			
	Not painful	Mild	Moderate	Not painful	Mild		
	0	0	10	4	6	0	0.000
Guide imagery	0	0	10	0	8	2	0.003
Benson & murotal	0	0	10	0	9	1	0.003
Dhikr	0	0	10	0	9	1	0.003
Warm compresses	0	0	10	1	9	0	0.002

P = Wilcoxon signed-rank test

finger hypnosis in post-laparotomy patients is very effective in reducing the patient's pain intensity. Five-finger hypnosis consists of 4 steps that work on the subconscious mind. The advantage of five-finger hypnosis compared to other hypnotherapy is that apart from being easy to learn, it is also easy for anyone to do (Wahyudi, 2019). Hypnotherapy can also be used for mothers giving birth to reduce pain and stress levels (PS & Widiawati, 2017).

Providing relaxation and distraction therapy to patients with uterine myoma can also cause the patient to relax because it can stimulate an increase in endorphin hormones, which then stimulate a morphine-like substance supplied by the body, when peripheral neurons send signals to synapses. Synapses occur between peripheral neurons and neurons that go to the brain, where substance P conducts impulses. So endorphins block the transmission of pain impulses in the spinal cord, so that the sensation of pain is reduced (Fitriyanti & Machmudah, 2020). Based on research results, supporting theories and relevant journals. Researchers assume that hypnotherapy is a non-pharmacological pain management technique by relaxing patients, so they can stimulate the brain to release neurotransmitters, namely encephalins, and endorphins. Endorphins function to improve mood so that they can change an individual's acceptance of pain. Hypnotherapy can divert the client's attention with the suggestions given. So the client will forget the pain they are feeling.

The Wilcoxon Signed Ranks Test statistic shows a difference in the pain scale before and after giving Guide Imagery therapy with a p-value of 0.005 <α=0.05. So, it can be concluded that there is significant and significant effectiveness in providing Guide Imagery therapy in reducing pain in patients. Guided imagery is using one's imagination in a way specifically designed to achieve a particular positive effect. Guided imagery is used to relax and relieve pain and lower blood pressure, which can consist of combining slow rhythmic breathing with a mental image of relaxation and reality (Fiani, 2016). The benefits of Guide Imagery for health are reducing pain, relaxing body muscles, reducing stress levels, overcoming symptoms of depression, and maintaining health or achieving a relaxed state (Charette et al., 2014). Guide Imagery is a technique of creating an impression in the respondent's mind and then concentrating on that impression so that it can gradually reduce the respondent's perception of pain. When the patient imagines, the pain intensity will decrease because the patient's focus on pain will be diverted to pleasant imagination.

From the explanation explained above for Guide Imagery Therapy on Reducing Pain in Patients, the researchers assume that Guide Imagery Therapy is effective in reducing pain in patients. This therapy only involves imagining or imagining pleasant things so that the patient's previously tense body relaxes. And it can divert attention so that the patient forgets the pain they are feeling. The results showed that there was a difference in the pain scale in patients before being given Benson relaxation and Ar-Rahman murotal therapy and after being given Benson relaxation and Ar-Rahman murotal therapy with a p-value of 0.003 < α=0.05. So, it can be concluded that there is a meaningful and significant effect of Benson relaxation and Ar-Rahman murotal therapy in reducing pain in patients.

The effect of Benson relaxation on reducing pain is because, when an individual performs Benson relaxation, which is a relaxation technique combined with the beliefs held by the patient, Benson relaxation will inhibit sympathetic nerve activity, which can reduce oxygen consumption by the body, and then the body's muscles relax. Thus creating a feeling of calm and comfort (Rahman & Dewi, 2023). Other research explains that Benson relaxation is a development of the deep breathing relaxation method by involving the patient's belief factor in achieving a higher state of health and well-being. Benson relaxation helps the breathing process properly so that oxygen needs can be met, so the body's homeostasis becomes balanced and causes the body to become more relaxed and can reduce the pain felt by the patient (Respati, 2018). Meanwhile, murotal therapy is a therapy that uses the Al-Qur'an as a medium to help increase specific changes in the body both physiologically and psychologically which can reduce the intensity of pain felt because it has

a distracting effect on inhibition and perception (Pasaribu & Sumarni, 2023).

Pain management through murotal therapy can stimulate neuropeptides and stimulate the release of natural endogenous opioids through the stimulation of reading the Qur'an can reduce tension in the nervous system and create relaxation, providing this therapy has an impact on calm, changes in body cells and becomes a modality for reading Al -The Qur'an has a particular frequency that spreads waves that influence the brain positively and restore its balance, so that the pain felt by the client will slowly decrease (Hardianto et al., 2018).

Beta-endorphins release inflammatory mediators such as histamine, cytokines, prostaglandins, and bradykinin to inhibit nerve sensitivity to cause pain. Endorphins also work as an ejector for feelings of relaxation and providing calm, thereby releasing Gama Amino Butyric Acid (GABA), which functions as an inhibitor of pain impulses from one neuron to another by neurotransmitters in the synapse. Neurotransmitters will be stopped by the effects of the opioid beta-endorphin so that the sensory perception of pain decreases (Pranowo et al., 2021). Providing 15 minutes of Al-Qur'an murotal therapy intervention using Surah Ar-Rahman was able to reduce pain due to the release of beta-endorphin as a natural opioid which inhibits the release of inflammatory mediators so that pain impulses are reduced to be perceived (Puspitasari et al., 2023).

Based on the results of research conducted in the internal treatment room at RSUD Toto Kabila Gorontalo, the p-value was 0.003, which was smaller than the α value of 0.05, so it can be concluded statistically, that there is an effect of dhikr therapy by reducing the pain scale. Gate control theory explains that pain occurs in a person due to certain stimuli that can be blocked when an interaction occurs between the pain stimulus and the stimulus in the fibers that transmit non-painful sensations, which is blocked in the inhibitory gate circuit. This blocking can be through distraction or relaxation. Dhikr relaxation will reduce anxiety, which will also affect the intensity of pain felt by the patient (Risnah et al., 2022). Dhikr spiritual therapy will increase endorphin and enkephalin hormones, which cause calm and can reduce the perception of pain. Respondents who received dhikr therapy felt comfortable and relaxed when given the treatment, so respondents felt less pain.

Based on the results of research conducted in the internal care room at Toto Kabila Regional Hospital, the p-value of 0.002 was smaller than the value α=0.05, so it can be concluded statistically, that there is an influence of warm compresses using WWZ (Warm Water Zack) and lemon aromatherapy on the decline painful. Objective data, when given the intervention, respondents said they felt comfortable, reduced pain, and wanted to do warm compresses independently at home. Warm compress is a non-pharmacological therapy to eliminate or reduce pain by providing a feeling of warmth, meeting the need for comfort, reducing or relieving pain, and reducing the occurrence of muscle spasms by using warm water (Hidayati et al., 2021). Warm compress is a non-pharmacological therapy to eliminate or reduce pain by providing a feeling of warmth, fulfilling the need for comfort, reducing or relieving pain, and reducing the occurrence of muscle spasms by using warm water.

Applying a warm compress using Water Warm Zack (WWZ) will relax the muscles, reduce or eliminate pain, and improve blood flow (Prihandini, 2019). When providing lemon aromatherapy intervention, respondents said that apart from the fragrant smell, they also felt comfortable and even fell asleep when the lemon aromatherapy was given. Aromatherapy treatment decreased pain until the respondent did not feel it. The aroma is processed and converted by the body into action by releasing neurochemical substances in the form of endorphins and serotonin so that it has a direct effect on the olfactory organ and is perceived by the brain to provide a reaction that creates physiological changes in the body, mind, soul, and produces a calming effect on the body (Suwanti et al., 2018).

Conclusion

The results of research on 50

respondents found that non-pharmacological therapy consisting of 5-finger hypnosis, guided imagery, dhikr, beson, and murotal, warm compress with WWZ method combined with aromatherapy was proven to reduce pain intensity from moderate to mild scale. The non-pharmacological therapy should be continued by nurses. If they find a patient with pain (moderate scale) do not immediately provide analgesic treatment, which is a collaborative therapy.

References Volume Jurnal

Aiysah, S., 2017. Pain Management in the Elderly Using a Non-Pharmacological Approach. *Jurnal Kesehatan Muhammadiyah*, 2(1), pp.178-182.

Charette, S., Fiola, J. L., Charest, M.-C., Villeneuve, V., Theroux, J., Joncas, J., . . . May, S. L., 2014. Guided Imagery for Adolescent Post-spinal Fusion Pain Management: A Pilot Study. *Pain Management Nursing*, 16(3), pp.211-20.

Fitrianingrum, E.D., Rohmayanti, R., & Mareta, R., 2018. 5 Finger Hypnosis has an Effect in Reducing Post Sectio Caesarea pain. *Menara Medika*, 8(1), pp.1-12.

Fitriyanti, F., & Machmudah, M., 2020. Reducing Pain Intensity in Uterine Myoma Patients Using Relaxation and Distraction Techniques. *Ners Muda*, 1(1),pp.40-49.

Halim, A.R., & Khayati, N., 2020. The Effect of Five Finger Hypnotherapy on Reducing Pain Scale in Cervical Cancer Patients. *Ners Muda*, 1(3), pp.160-164.

Hardianto., Sulaiman, L., & Amrullah, M., 2018. The Effect of the Combination of Murottal Al-Quran Therapy with Deep Breathing Relaxation on Reducing Anxiety Levels in Preoperative General Surgery Patients at NTB Provincial Hospital. *Jurnal Kebidanan Universitas Islam Lamongan*,2018, pp.52-63.

Hidayati, H.B., Amelia, E.F., Turchnan, A., Rehatta, N.M., Atika, A., & Hamdan, M., 2021. Effect of Age and Gender on Patient Pain Scale Trigeminal Neuralgia. *Jurnal Aksona*, 1(2), pp.53-56.

IASP - International Association for Study of Pain., 2020. *Revised Definitions of Pain Translations.* Washington: IASP (International Association for the Study of Pain).

Legiati, T., & Widiawati, I., 2017. Hypnobirthing Effect on The Level of Pain in Labor. *Jurnal Kesehatan Masyarakat*, 13(2), pp.186-190.

Nurjanah, F.W., Hadisaputro, S., & Fatmasari, D., 2020. Long Bean Leaf Extract for Improving Haematological Status of Female Adolescent with Anemia that Gets Fe Supplementation. *Jurnal Kesehatan Masyarakat*, 16(1), pp.82-87.

Pasaribu, M.A., & Sumarni, T., 2023. The Effect of Providing Murotal Therapy on Reducing Pain Scale Post Ca Mastectomy Operation Ca Mammae. *Jurnal Keperawatan Merdeka*, 3(1), pp.60-64.

Permatasari, C., & Sari, I.Y., 2016. Benson Relaxation Therapy to Reduce Pain in Patients With Cylinary Femur Fractures: Case Study. *Jurnal Keperawatan Merdeka (JKM)*, 2(2), pp.2016-2020.

Pranowo, S., Dharma, A.K., & Kasron, K., 2021. Differences in The Effectiveness of Murrotal Therapy With Cold Compresses on Post-Operative Patients' Pain Response Laparatomy at Fatimah Islamic Hospital (RSI) CILACAP. *Jurnal Ilmiah Kesehatan Keperawatan*, 17(2), pp.178-188.

Prihandini, E., 2019. The Difference With Warm Compress Therapy Using A Bottle Glass and Water Warm Zack (Wwz) Compresses Against Intensity of Joint Pain in The Elderly in Werdhawisma Parents Asih Madiun. *Thesis*. Madiun, Jawa Timur, Indonesia: STIKES Bhakti Husada Mulia Madiun.

Puspitasari, A., Kosim, K., & Yudianto, K., 2023. Application of Murottal Al-Qur'an Therapy in Reducing Pain Intensity in Post Laparatomy Appendicitis Patients: A Case Study . *Sentri: Jurnal Riset Ilmiah*, 2(7),pp.2841-2849.

Rahman, I.A., & Dewi, R.L., 2023. Benson Relaxation Technique Intervention to Reduce The Pain Scale of Unstable Angina Pectoris Patients. *Jurnal Keperawatan*, 15(1), pp.33-40.

Respati, N.D., 2018. The Effect of Guided Imagery Therapy on Pain in Post-Operational Fracture Patients in the Bougainvillea Room at Dr. Hospital. R. Koesma Tuban . *Jurnal Midpro*, 10(2), pp.52-63.

Risnah, R., Risdawati, R., & Ilmi, A.A., 2022. Spirituality-Based Therapy in Pain Management in Breast Cancer Patients: A Literature Review. *Jurnal Midwifery*, 4(2), pp.53-61.

Suwanti, S., Wahyuningsih, M., & Liliana, A., 2018. Effect of Lemon Aromatherapy (Cytrus) to Reduction of Menstrual Pain in Students in Yogyakarta Respati University. *Jurnal Keperawatan Respati Yogyakarta*, 5(1), pp.345-349.

Wahyudi, B., 2019. The Influence of Five Fingers Hypnosis Auditori Towards Vital Sign: Blood Pressure, Pulse, Respirattion, and Pain on Patients With Fracture Extremity. *Skripsi*. Surabaya, Jawa Timur, Indonesia: Perpustakaan Universitas Airlangga.

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Mortality Among Dengue Infection Patients in Bandung City 2022

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Abstract

Background: Dengue infection is caused by the dengue virus. In 2021 in Indonesia, 705 mortalities were due to dengue infection, while in 2022, 1,232 mortalities. The CFR in 2019 was 0.67%, in 2020 it was 0.69%, and in 2021 it was 0.96%. Bandung City is one of the endemic areas. In 2022, found 21 reported mortality, with a CFR of 0.47% in 2020, 0.35% in 2021, and 0.19% in 2022. Risk factors for death due to dengue infection are old age, delay in treatment, platelet count, incidence of DSS, and hematocrit value. Methods: This is a quantitative observational study using a nested case-control research design. Uses secondary data from the Bandung City Health Service. Results: The results of this study confirmed association of mortality with age above 40 years (p-value: 0.008, OR: 6.320), high hematocrit value (p-value: 0.005, OR: 11.111), long gap between onset and diagnosis (p-value: 0.025, OR: 13.833), prolonged hospitalization (p-value: <0.001, OR: 8.125), and incidence of DSS (p-value <0.001, OR: 39.500). Low platelet count (p-value: 0.033, OR: 0.263) found to be protective. Conclusions: Age, hematocrit value, gap between onset and diagnosis, length of hospitalization, and incidence of DSS are risk factors for mortality among dengue infection patients.

Introduction

The rapid global expansion of dengue viruses poses challenges for public health officials and policymakers. Early detection and accessibility to medical services for dengue infection can reduce the death rate due to severe dengue infection from 50% to 2% (Messina *et al*., 2019). The target for controlling dengue is to reduce the mortality rate from 0.8% in 2020 to 0% in 2030 (WHO, 2020). In 2022, there were 1290 mortality, representing an almost three-fold increase in mortality compared with 2021 (437 mortality). In early 2023, there was a surge in cases of dengue infection resulting in nearly five million cases and more than 5,000 mortality related to dengue infection reported in more than 80 countries and five WHO regions (WHO, 2023). Based on data from the World Health Organization, mortality due to dengue in Indonesia reached 7938 (0.47%) of total deaths in 2020, with an age-adjusted death rate of 3.19 per 100,000 population, based on this data placed Indonesia in 2nd place in the world.

In the National Dengue Management Strategy, Indonesia has a target to reduce the dengue mortality rate to 0.5% by 2025 (Kementerian Kesehatan Republik Indonesia, 2019). In 2021 there were 705 mortality due to dengue infection, an increase in 2022 of 1,232 mortality (Kementerian Kesehatan Republik Indonesia, 2019). The CFR has increased, in 2019 it was 0.67%, in 2020 it was 0.69%, and in 2021 it was 0.96%. The CFR has exceeded the limit (0.7%) set in the National Dengue Control Strategy target (Kementerian Kesehatan Republik Indonesia, 2019). It can be concluded that the incidence of mortality due

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to dengue infection is still far from the target of the Ministry of Health of the Republic of Indonesia. West Java Province was ranked first as the highest incidence of mortality due to dengue with a total of 305 deaths and CFR: 0.83 (Kementerian Kesehatan Republik Indonesia, 2022).

The CFR in West Java Province in 2022 was still within the target (<1%), but there are 12 regencies/cities with a mortality rate of >1% in 2022. Bandung City is one of the endemic areas for dengue infection in Indonesia because of the high number of cases and deaths every year. Bandung City has the highest dengue infection incidence in Indonesia, with 5205 cases in 2022. Although the incidence of dengue infection is not always directly related to the incidence of mortality, the existence of other variables can support the occurrence of mortality among dengue infection patients (Abualamah *et al*., 2021) and with the availability of secondary data by the Bandung City Health Service, research can be carried out regarding the determinants of mortality in dengue infection patients in Bandung City. The government hopes to achieve the target of zero dengue in the Bandung City. In 2022, there were 21 reported mortality in Bandung City. The CFR of dengue infection in Bandung city was 0.35% in 2021, 0.19% in 2022, and 0.47% in 2023 (Dinas Kesehatan Kota Bandung, 2022). Based on the data presented by the Bandung City Health Service, it can be concluded that the incidence of mortality due to dengue infection is above the target.

The incidence of mortality due to dengue tends to be dominated by elderly patients, severe dengue infection, and subsequent secondary infections (Gauri *et al*., 2022), these results are supported by research from Mahmood *et al*., (2023) which concludes that for patients aged over 45 years, leukocytosis, and kidney injury acute disease can be a factor that influences the incidence of mortality due to dengue infection (Mahmood *et al*., 2023). Other research which revealed that there is a relationship between age, delay in treatment, and the incidence of DSS with the mortality of dengue infection patients (Supangat *et al*., 2023). Based on research by Medagama *et al*., (2020), signs of bleeding, changes in level of consciousness, plasma leakage, increased transaminases >500IU/L, and increased creatinine are signs and symptoms that lead to mortality (Medagama *et al*., 2020). Laboratory results include significantly high total leukocyte count, absolute neutrophil count, and total platelet count, and a significantly low mean platelet volume are causes of mortality among dengue infection patients (Gauri *et al*., 2022). Platelet monitoring during hospitalization is also important because of the association between initial platelet count and platelet changes and resulting mortality (Liu *et al*., 2020). According to research by Freitas Carvalho Branc *et al*., (2014)., an increase in hematocrit >20% from the initial value can increase the incidence of mortality among dengue infection patients by 1.38% (Freitas *et al*., 2014). This research aims to determine the determinants of the causes of mortality among dengue infection patients so that dengue management and treatment can be better managed to reduce the mortality rate due to dengue. Researchers have also carried out updates using calculations to predict the possibility of mortality among dengue infection patients. This research aims to determine the determinants of the causes of mortality among dengue infection patients so that dengue management and treatment can be better managed to reduce the mortality rate due to dengue. The hypothesis is that age, sex, platelets count, hematocrit value, the gap between onset and diagnosis, Length of hospital stay, and incidence of dengue shock syndrome are related to the incidence of mortality in dengue infection patients in Bandung City.

Method

This research has been approved by the Semarang State University Research Ethics Committee with number 232/KEPK/FK/KLE/2024. This research is a quantitative observational study using a nested case-control research design. The dependent variable in this study is the incidence of mortality among dengue infection patients. The independent variables in this study include age, sex, platelet count, hematocrit value, gap between onset and diagnosis, hospitalization, and incidence of DSS. Categorization of the age variable in this study uses the risk and non-risk categorize

based on previous research with the results that dengue infection patients aged ≥40 years had a greater risk of mortality than patients <40 years (Sujatha *et al*., 2021); categorization of the sex variable based on biological differences between men and women; categorization of platelet counts based on the WHO Comprehensive Guidelines for Prevention and Control of Dengue and Dengue Haemorrhagic fever is a risky condition is when thrombocytopenia occurs (i.e. a decrease in the platelet count <100,000 cells/mm3 in dengue infection patients) and the patient's condition is not at risk (i.e. when the platelet count is ≥100,000 cells/mm3); the categorization of the hematocrit value is based on the 2020 National Guidelines for Medical Services for the Management of Dengue Infection in Adults, there are ≤38% and >38%; categorization of gap between onset and diagnosis based on CDC sources regarding Dengue Testing Guidance, there are >7 days and ≤7 days; categorization of hospitalization uses patient's length of stay in hospital are >5 days and ≤5 days based on previous research which stated that dengue infection patients who were hospitalized for >5 days were at risk of mortality (Khalil *et al*., 2014; Mallhi *et al*., 2017); the categorization of incidence of DSS is based on the provisions of the Indonesian Ministry of Health regarding the criteria for diagnosing dengue infection, there are DF, DHF, and DSS (because no cases of DF were found so this research only discusses DHF and DSS); and the categorization of living and dead patients is based on the patient's final condition when discharge from the hospital, whether the

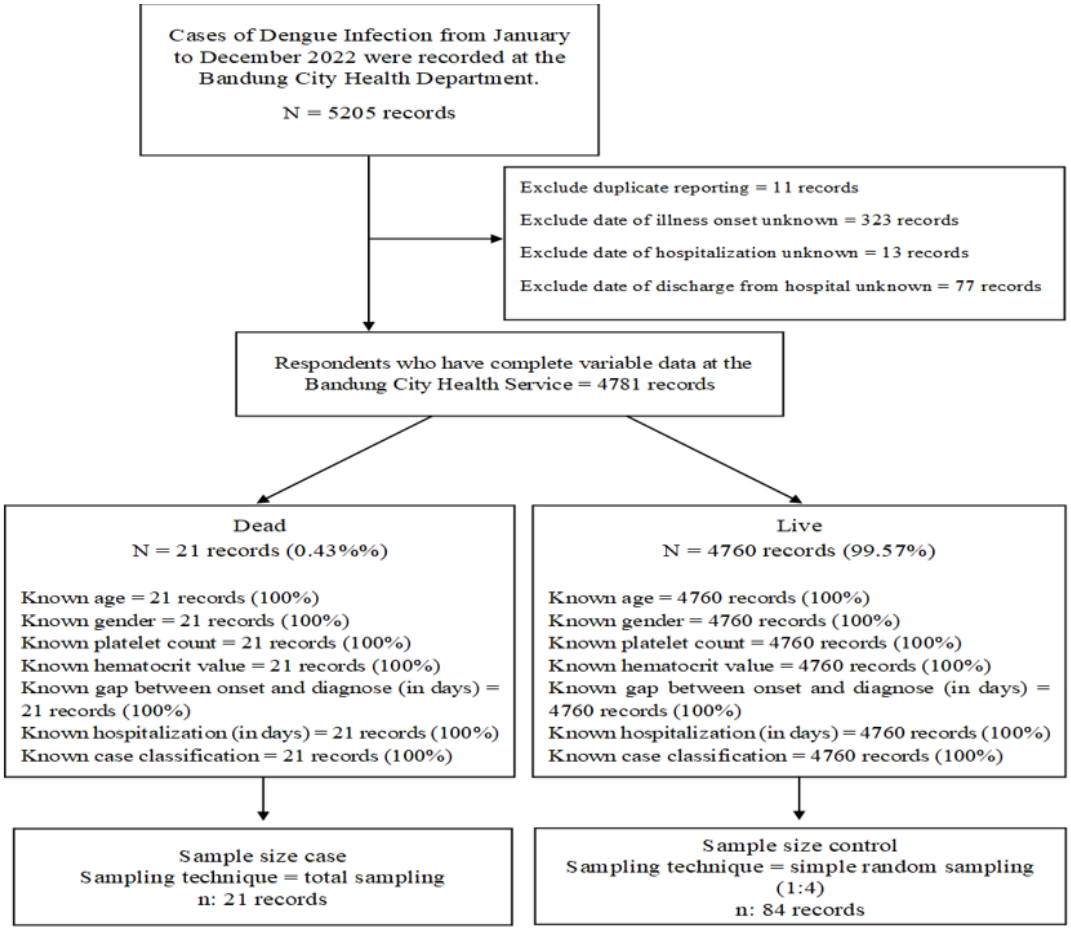

FIGURE 1. Sample Flowchart

patient is alive or dead.

The data source used in this research is obtained from the secondary data of the Bandung City Health Service from January to December 2022. The population in this study included 5205 subjects. The sample for this study was dengue infection patients in the city of Bandung from January to December 2022. The sample size used in this study was 105 subjects with 21 respondents as case subjects and 84 as control subjects. The instrument used in this research is a data collection table. Data analysis was carried out univariate, bivariate, and multivariate. Univariate analysis was carried out to obtain an overview of the frequency distribution of each variable studied. The bivariate analysis uses the Chi-Square test (or Fisher exact test as an alternative test). Multivariate analysis was carried out using a logistic regression test. Based on the sampling flow, it is known that the total data on dengue infections in the Bandung City Health Service is 5205 subjects then inclusion and exclusion criteria were identified. The inclusion criteria were 4781 records and the exclusion criteria were 424 records, resulting in a total population with complete data were 4781 records consisting of 21 case data and 4760 control data. The next stage was simple random sampling on the control group with a ratio of 1:4 to obtain a total control sample size of 84 records.

Result And Discussion

Based on the results of the univariate analysis in Table 1, out of a total of 105 patients with dengue infection, the subjects had a median age of 9 years, with a mode of 3 years. The age range spanned over 76 years, with the youngest subject being 1 year old and the oldest being 77 years old. Previous research shows that age is the dominant variable associated with the mortality of dengue infection patients in Tasikmalaya City with a p-value = 0.016 and OR = 1.873 (Supangat *et al*., 2023). Based on analysis of various studies, it has been identified that old age (p-value <0.001) is one of the factors that can cause mortality among dengue patients in hospitals (Fonseca-Portilla *et al*., 2021). This finding is supported by other studies that have shown that increasing age (OR 1.04, CI: 1.03–1.06) and female sex (OR 1.53, CI: 1.01–2.33) are associated with a higher risk of mortality from dengue infection (Liew *et al*., 2016). Patients who died had a median age of 73.9 years (interquartile range of 62 – 77 years), significantly older than those who survived, with a median age of 53.5 years (interquartile range of 37–64 years) (Lee *et al*., 2023).

The majority of dengue infection sufferers were male with 57 patients (54.3%) while 48 patients (45.7%) were female. This result is in line with previous research, the variable independently associated with an increase in overall mortality was the male gender (HR=1.28; 95% CI: 1.23-1.34) (Msaouel *et al*., 2014), but not in line with other previous research, reveals that women in the 30-39 year age group have a high risk of dengue infection and mortality, especially due to infection with the DEN-2 serotype (Padyana *et al*., 2019). Laboratory tests revealed that there were 91 patients (86.7%) who had platelet counts <100,000 cells/mm3 and 14 patients (13.3%) who had platelet counts ≥100,000 cells/mm3, 74 patients (70.5%) had hematocrit values >38% and 31 patients (29.5%) had hematocrit value ≤38%. Previous research has suggested that the absolute neutrophil count and average platelet volume were predictors associated with mortality (Gauri *et al*., 2022). Supported by research by Pinto, *et al*., (2016) which shows that age >55 years, hematuria, gastrointestinal bleeding, and low platelet counts are factors associated with high mortality (Pinto *et al*., 2016). Research by Gupta *et al*., (2016) revealed that a low platelet count can be used as a predictor severity of dengue infection (Gupta *et al*., 2016). Laboratory results indicating a significantly low platelet volume have been linked to mortality among dengue infection patients (Gauri *et al*., 2022). Therefore important to monitor platelet levels during hospitalization due to the association between initial platelet count, platelet changes, and resulting mortality (Liu *et al*., 2020). According to another study, patients who died had a lower platelet count (p-value: 0.017) compared to survivors when admitted to the hospital (Lee *et al*., 2023).

Based on the diagnosis results, it was found that 20 patients (19%) experienced an incident of dengue shock syndrome, and 85

TABLE 1. Univariate Analysis Results

Variable	Median	Mode	Range	Min.	Max.
Age (year)	9	3	76	1	77

Variable	Frequency (N)	Percent (%)
Gender		
Female	48	45.7
Male	57	54.3
Total	105	100
Platelet count		
<100.000 cells/mm3	91	86.7
≥100.000 cells/mm3	14	13.3
Total	105	100
Hematocrit value		
>38%	74	70.5
≤38%	31	29.5
Total	105	100
The gap between onset and diagnosis (in days)		
>7 days	4	3.8
≤7 days	101	96.2
Total	105	100
Hospitalization		
>5 days	27	25.7
≤5 days	78	74.3
Total	105	100
Incidence of DSS		
DSS	20	19.0
DHF	85	81.0
Total	105	100
Final state		
Dead	21	20.0
Live	84	80.0
Total	105	100

patients (81%) were diagnosed with dengue hemorrhagic fever. A previous study stated that the incidence of dengue shock syndrome (DSS) was related to the mortality of dengue infection patients (Supangat *et al.*, 2023). The gap between onset and diagnosis variables was grouped based on the date of onset until diagnosis by laboratory results using IgM, IgG, or NS1 tests, while the hospitalization variable was defined as the length of time the patient was in the hospital from admission to discharge from the hospital, whether the patient was alive or die. Among dengue infection patients, knowing that 4 patients (3.8%) were diagnosed with dengue infection more than 7 days after onset, while 101 patients (96.2%) were diagnosed in less than 7 days. During this period 27 patients (25.7%) were hospitalized for more than 5 days

while 78 patients (74.3%) were hospitalized for less than 5 days. In previous research, it was found that there was a correlation between the length of hospitalization and the incidence of patient mortality due to dengue infection (Campos *et al*., 2015).

The bivariate analysis uses the chi-square test (or Fisher's test as an alternative) to know the relationship between variables. Found that five variables were associated with the incidence of mortality in dengue infection, including the variable age over 40 years (p-value: 0.008, OR: 6.320, CI: 1.707-23.398), high hematocrit value (p-value: 0.005, OR: 11.111, CI: 1.420-86.947), long gap between onset and diagnosis (p-value: 0.025, OR: 13.833, CI: 1.360-140.741), prolonged hospitalization (p-value: <0.001, OR: 8.125, CI: 2.840-23.245), and the incidence of DSS (p-value: <0.001, OR: 39.500, CI: 10.669-146.235). Whereas high platelet count (p-value: 0.033, OR: 0.263, CI: 0.080-0.869) was found to be a protective factor. The details of the analysis can be found in Table 2. In Table 2, it is shown that the age variable has an OR: 6.320, which means that dengue infection patients in the at-risk age category have a risk of mortality 6.320 times greater than patients at non-risk category. Previous research found a positive correlation between mortality rates and the age category over 40 years, with a p-value of 0.010 and an OR of 3.48 (Sujatha *et al*., 2021). Several studies have shown that certain factors are associated with mortality in cases of severe dengue infection. These include older age (p-value <0.001) and lower platelet count (p-value <0.005) (Md-Sani *et al*., 2018). Dengue infection patients have a higher risk of mortality if they are over 55 years old (OR 4.98) (Pinto *et al*., 2016). Older age has previously been shown to cause a higher mortality rate in cases of dengue infection (Macias *et al*., 2021).

The hematocrit value variable has an OR 11.111, this means that dengue infection patients with a hematocrit value of more than 38% have an 11.111 times greater risk of mortality (p-value: 0.005). Previous research showed that lower hematocrit levels were significantly associated with mortality in dengue infection (p-value: <0.001) (Saroch *et al*., 2017). Supported by other research, factors associated with mortality from dengue infection are age >40 years (p=0.004) and hematocrit value >20% (p=0.001) (Mallhi *et al*., 2017). A previous study revealed that an increase of hematocrit >20% from the initial value can increase the incidence of mortality among dengue infection patients by 1.38% (Freitas *et al*., 2014). The supported study that dengue infection patients who had higher hematocrit levels from day 3 to day 102 could be the main symptom of severe dengue infection and could cause a medical emergency. Regular monitoring of hematocrit values purposes to evaluate the level of plasma leakage and determine the need for therapeutic intervention in patients (Sahassananda *et al*., 2021).

The variable gap onset and diagnosis has an OR 13.833, this means that dengue infection patients who have a time gap of more than 7 days between the onset and diagnosis of the infection have a 13.833 times greater risk of patient mortality (p-value: 0.025). Late diagnosis can cause delayed treatment and disease progression. The long time to diagnose the disease can cause severe infection and then cause respiratory failure, septic shock, and hypovolemic shock, which are reported as the main causes of mortality (Md-Sani *et al*., 2018). Based on previous research, the average distance of a health facility from home, the time gap between the onset of symptoms and the first medical consultation in days, as well as the time gap between the onset of symptoms and the final diagnosis, were significantly related to the mortality rate. The interval between the time of onset and the time of diagnosis is associated with mortality among dengue infection patients with p-value = 0.044 and OR = 0.72 (Sujatha *et al*., 2021).

The hospitalization variable has an OR of 8.125 (p-value: <0.001). Dengue infection can lead to prolonged hospitalization, and this may be associated with an increased risk of mortality (Shahid *et al*., 2021). Previous research explains that duration of hospital stay is a factor associated with mortality among dengue infection patients. Length of hospital stay can be an indicator of patient care and can contribute to severe dengue infection (Fonseca-Portilla *et al*., 2021). Supported by other research, shown a relationship between length of stay in hospital and the incidence of mortality

TABLE 2. Bivariate Analysis Results

Variable	Mortality of Dengue Infection Patients				OR (95% CI)	p-Value
	Dead (Case)		Live (Control)			
	N	%	N	%		
Age						
Risk (≥40 years)	6	28.6	5	6.0	6.320 (1.707-23.398)	0.008*
Non-Risk (<40 years)	15	71.4	79	94.0		
Total	21	100	84	100		
Gender						
Female	11	52.4	37	44.0	1.397 (0.536-3.644)	0.493
Male	10	47.6	47	56.0		
Total	21	100	84	100		
Platelet count						
<100.000 cells/mm3	15	71.4	76	90.5	0.263 (0.080-0.869)	0.033*
≥100.000 cells/mm3	6	28.6	8	9.5		
Total	21	100	84	100		
Hematocrit value						
>38%	20	95.2	54	64.3	11.111 (1.420-86.947)	0.005*
≤38%	1	4.8	30	35.7		
Total	21	100	84	100		
The gap between onset and diagnosis (in days)						
>7 days	3	14.3	1	1.2	13.833 (1.360-140.741)	0.025*
≤7 days	18	85.7	83	98.8		
Total	21	100	84	100		
Hospitalization						
>5 days	13	61.9	14	16.7	8.125 (2.840-23.245)	<0.001**
≤5 days	8	38.1	70	83.3		
Total	21	100	84	100		
Incidence of DSS						
DSS	15	71.4	5	6.0	39.500 (10.669-146.235)	<0.001**
DHF	6	28.6	79	94.0		
Total	21	100	84	100		

* = p-value <0.05, **= p-value<0.001

among dengue infection patients. The average time interval from onset of illness to hospital admission was 5 days. In patients who died, the median duration from disease onset to death was 8 days (Campos *et al*., 2015). One of the associated factors of mortality among dengue infection patients is prolonged hospitalization (Mallhi *et al*., 2017). In addition, time since the onset of dengue infection symptoms is one of the most significant predictors of length of hospital stay, regardless of disease severity (Recker *et al*., 2024).

The incidence of the dengue shock syndrome variable has an OR 39.500, which means that dengue infection patients who experienced the dengue shock syndrome (DSS) have a 39.5 times greater risk of mortality than dengue hemorrhagic fever (DHF) patients

TABLE 3. Multivariate Analysis Results

Variables	B	Wald	p-value	Adj OR (95% CI)
Incidence of DSS	3.632	20.565	<0.001**	37.806 (7.866 - 181.710)
Hospitalization	1.633	4.740	0.029*	5.118 (1.177 - 22.255)
Hematocrit value	2.653	3.825	0.050	14.197 (0.994 – 202.677)
Platelet count	-2.061	4.893	0.027*	0.127 (0.021 – 0.791)
Constant	-3.810	7.132	0.008	

* = p-value <0.05, **= p-value<0.001

(p-value <0.001). DSS is a severe and potentially life-threatening complication of dengue infection, that is particularly challenging in children due to the high mortality rate (Armenda *et al*., 2021). In previous research, it was known that the incidence of DSS was associated with mortality among dengue infection patients with an OR of 6.353. DSS occurs as a result of a more severe degree of infection (grade IV) (Supangat *et al*., 2023). Supported by other research, mortality often occurs in children diagnosed with DSS. The occurrence of DSS is associated with a strong immune response (Trisasri *et al*., 2018).

In the multivariate analysis with the logistic regression test, six variables met the requirements (p-value <0.25), including the variables age, platelet count, hematocrit value, gap between onset and diagnosis, hospitalization, and incidence of DSS. Table 3 shows that, after adjusting for other variables, the OR value obtained for the incidence of DSS is 37.806 (p-value: <0.001). The OR value for the hospitalization is 5.118 (p-value: 0.029). The Hematocrit value has an OR of 14.197 (p-value: 0.050). The platelet count has an OR of 0.127 (p-value: 0.027).

Based on the multivariate test table above, it can be concluded that after adjusting for other variables, the strongest contribution in predicting the incidence of mortality among dengue infection patients is the incidence of dengue shock syndrome. Based on previous research, revealed that DSS is a risk factor for mortality in elderly dengue infection patients (OR: 77.33, p-value <0.001) (Lee *et al*., 2008). One of the factors associated with probable dengue mortality was shock (OR 1805.37; CI:125.44 – 25982.98) (Liew *et al*., 2016). Supported by other research, which states that thrombocytopenia, liver dysfunction, AKI, and dengue shock syndrome (DSS) are associated with the risk of mortality (Shastri *et al*., 2020) and in another study which stated that all DSS patients died during the study period (Jain *et al*., 2017). Based on the results of the logistic regression analysis in the multivariate in Table 3, the logistic regression equation can be formulated as follows:

y = -3.810 + (3.632) (DSS) + (1.633)

TABLE 4. Probability of Mortality of Dengue Infection Patients in Bandung City

Respondent	Incidence of DSS	Hospitalization	Hematocrit value	Platelet count	Probability of mortality (%)
Respondent A	DSS	>5 days	>38%	<100.000 cells/mm3	93%
Respondent B	DBD	≤5 days	≤38%	≥100.000 cells/mm3	2%
Respondent C	DSS	>5 days	>38%	≥100.000 cells/mm3	98%
Respondent D	DSS	>5 days	≤38%	≥100.000 cells/mm3	81%
Respondent E	DSS	≤5 days	≤38%	<100.000 cells/mm3	9.6%
Respondent F	DSS	≤5 days	>38%	≥100.000 cells/mm3	92%
Respondent G	DBD	>5 days	≤38%	<100.000 cells/mm3	1.4%
Respondent H	DBD	≤5 days	>38%	<10.000 cells/mm3	3.8%
Respondent I	DBD	≤5 days	≤38%	<100.000 cells/mm3	0.2%
Respondent J	DBD	>5 days	>38%	≥100.000 cells/mm3	61%

(Hospitalization >5 days) + (2.653) (Hematocrit value >38%) + (-2.061) (Platelet count <100.000 cells/mm3)

The logistic regression equation above can be used to calculate the probability of mortality among dengue infection patients in Bandung City using the following formula: p =

Probability calculations with several scenarios are presented in the following probability table:

Based on the probability calculation table with several scenarios above, the results showed that respondent C, with the characteristics of an experience DSS, long time of hospitalization >5 days, hematocrit value >38%, and platelet count of ≥100.000 cells/mm3 had the highest probability of mortality among dengue infection patients, with the probability equal to 98%, while the lowest probability is respondent I with the percentage 0.2% and the characteristics of DHF, stay in hospital for ≤5 days, hematocrit value ≤38%, and platelet count <100.000cells/mm3.

Conclusion

Based on the results of this study, it can be concluded that the risk factors for the incidence of death among dengue infection patients are age, hematocrit value, the gap between onset and diagnosis, hospitalization, and incidence of DSS. Platelet count was found to be a protective factor of incidence of mortality among dengue infection patients. Meanwhile, an unrelated determinant is sex. After controlling other variables, the predictor related to the incidence of death among dengue infection patients was the incidence of DSS. After adjusting for other variables, the strongest contribution in predicting the incidence of mortality among dengue infection patients is the incidence of dengue shock syndrome. This research has a limitation in that it could only consider the variables available in the Bandung City Health Service data. Moreover, many respondents had incomplete data, so missing data had to be eliminated. The recommendation for the Bandung City Health Service is to improve early detection and management of dengue to prevent critical conditions that can lead to death. The Ministry of Health is also expected to enhance existing dengue prevention programs and increase monitoring and active surveillance activities for dengue cases. Suggestions for future researchers are expanding the research time and adding other variables.

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References

Abualamah, W.A., Akbar, N.A., Banni, H.S., & Bafail, M.A., 2021. Forecasting the Morbidity and Mortality of Dengue Fever in KSA: A Time Series Analysis (2006–2016). *Journal of Taibah University Medical Sciences*, 16(3), pp.448–455.

Armenda, S., Rusmawatiningtyas, D., Makrufardi, F., & Arguni, E., 2021. Factors Associated With Clinical Outcomes of Pediatric Dengue Shock Syndrome Admitted to Pediatric Intensive Care Unit: A Retrospective Cohort Study. *Annals of Medicine and Surgery*, 66(April), pp.102472.

Campos, K.B., Amâncio, F.F., de Araújo, V.E.M., & Carneiro, M., 2015. Factors Associated With Death from Dengue in The State of Minas Gerais, Brazil: Historical Cohort Study. *Tropical Medicine and International Health*, 20(2), pp.211–218.

Dinas Kesehatan Kota Bandung., 2022. *Profil Kesehatan Kota Bandung*.

Fonseca-Portilla, R., Martínez-Gil, M., & Morgenstern-Kaplan, D., 2021. Risk Factors for Hospitalization and Mortality Due to Dengue Fever in A Mexican Population: A Retrospective Cohort Study. *International Journal of Infectious Diseases*, 110, pp.332–336.

Freitas, C.B., M. Dos R., De Albuquerque, L.E.J., Braga, L.L., Barbosa, D.O.R.V., Moreira, R.L.T., Do Socorro, M., Do S., Lima, M.M.N., Silva, G.F., Amaral, F.N.F.C., Lima, T.J., Brito, J.A., Cardoso, D.O.A.C., & Pannuti, C.S., 2014. Risk Factors Associated With Death in Brazilian Children With Severe Dengue: A Case-Control Study. *Clinics*, 69(1), pp.55–60.

Gauri, L., Bhatnagar, K., Sameja, P., Nehara, H., Saini, K., Dutt, R., Bhatnagar, B., Khokhar, M.,

Kumar, V., & Garg, A., 2022. Hematological Indices as Predictors of Mortality in Dengue Shock Syndrome: A Retrospective Study. *Journal of Acute Disease*, 11(4), pp.150.

Gupta, B.K., Nehara, H.R., Meena, S.L., & Parmar, S., 2016. Evaluation of Platelet Indices in Patients With Dengue Infections. *International Journal of Scientific Research*, 5(7), pp.78–81.

Jain, S., Mittal, A., Sharma, S.K., Upadhyay, A.D., Pandey, R.M., Sinha, S., Soneja, M., Biswas, A., Jadon, R.S., Kakade, M.B., & Dayaraj, C., 2017. Predictors of Dengue-Related Mortality and Disease Severity in A Tertiary Care Center in North India. *Open Forum Infectious Diseases*, 4(2), pp.1–8.

Kementerian Kesehatan Republik Indonesia., 2019. *Strategi Nasional Penanggulangan Dengue 2021-2025*.

Kementerian Kesehatan Republik Indonesia., 2022. *Profil Kesehatan Indonesia 2021*. Pusdatin. Kemenkes.Go.Id.

Khalil, M.A.M., Tan, J., Khalil, M.A.U., Awan, S., & Rangasami, M., 2014. Predictors of Hospital Stay and Mortality in Dengue Virus Infection-Experience from Aga Khan University Hospital Pakistan. *BMC Research Notes*, 7(1), pp.1–7.

Lee, I.K., Lee, N.Y., Huang, W.C., Hsu, J.C., Tai, C.H., Yang, C.H., Huang, C.H., Lin, C.Y., Chang, K., & Chen, Y.H., 2023. In-Hospital Mortality Predictors Among Hospitalized Adults and Those With Chronic Kidney Disease With Dengue. *Journal of Microbiology, Immunology and Infection*, 56(5), pp.996–1006.

Lee, I.K., Liu, J.W., & Yang, K.D., 2008. Clinical and Laboratory Characteristics and Risk Factors For Fatality in Elderly Patients With Dengue Hemorrhagic Fever. *The American Journal of Tropical Medicine and Hygiene*, 79(2), pp.149–153.

Liew, S.M., Khoo, E.M., Ho, B.K., Lee, Y.K., Omar, M., Ayadurai, V., Yusoff, F.M., Suli, Z., Mudin, R.N., Goh, P.P., & Chinna, K., 2016. Dengue in Malaysia: Factors Associated with Dengue Mortality from a National Registry. *PLoS ONE*, 11(6), pp.1–14

Liu, Y., Sun, W., Guo, Y., Chen, L., Zhang, L., Zhao, S., Long, D., & Yu, L., 2020. Association Between Platelet Parameters and Mortality in Coronavirus Disease 2019: Retrospective Cohort Study. *Platelets*, 31(4), pp.490–496.

Macias, A.E., Werneck, G.L., Castro, R., Mascareñas, C., Coudeville, L., Morley, D., Recamier, V., Guergova-Kuras, M., Etcheto, A., Puentes-Rosas, E., Baurin, N., & Toh, M.L., 2021. Mortality Among Hospitalized Dengue Patients With Comorbidities in Mexico, Brazil, and Colombia. *American Journal of Tropical Medicine and Hygiene*, 105(1), pp.102–109.

Mahmood, A., Haq, A., Amin, S., Rahim, F., Noor, M., Gul, H., Zafar, S., Ahmed Qureshi, S., Batul, K., & Haq, M., 2023. Predictors of Mortality in Patients With Dengue Fever: Insights From a Comparative Analysis. *Cureus*, 1(3), pp.1–7.

Mallhi, T.H., Khan, A.H., Sarriff, A., Adnan, A.S., & Khan, Y.H., 2017. Determinants of Mortality and Prolonged Hospital Stay Among Dengue Patients Attending Tertiary Care Hospital: A Cross-Sectional Retrospective Analysis. *BMJ Open*, 7(7), pp.1–12.

Md-Sani, S.S., Md-Noor, J., Han, W.H., Gan, S.P., Rani, N.S., Tan, H.L., Rathakrishnan, K., A-Shariffuddin, M.A., & Abd-Rahman, M., 2018. Prediction of Mortality in Severe Dengue Cases. *BMC Infectious Diseases*, 18(1), pp.1–9.

Medagama, A., Dalugama, C., Meiyalakan, G., & Lakmali, D., 2020. Risk Factors Associated with Fatal Dengue Hemorrhagic Fever in Adults: A Case Control Study. *Canadian Journal of Infectious Diseases and Medical Microbiology*, 2020.

Messina, J.P., Brady, O.J., Golding, N., Kraemer, M.U.G., Wint, G.R.W., Ray, S.E., Pigott, D.M., Shearer, F.M., Johnson, K., Earl, L., Marczak, L.B., Shirude, S., Davis, W.N., Gilbert, M., Velayudhan, R., Jones, P., Jaenisch, T., Scott, T.W., Reiner, R.C., & Hay, S.I., 2019. The Current and Future Global Distribution and Population at Risk of Dengue. *Nature Microbiology*, 4(9), pp.1508–1515.

Msaouel, P., Lam, A.P., Gundabolu, K., Chrysofakis, G., Yu, Y., Mantzaris, I., Friedman, E., & Verma, A., 2014. Abnormal Platelet Count is An Independent Predictor of Mortality in The Elderly and is Influenced by Ethnicity. *Haematologica*, 99(5), pp.930–936.

Padyana, M., Karanth, S., Vaidya, S., & Gopaldas, J.A., 2019. Clinical Profile and Outcome of Dengue Fever in Multidisciplinary Intensive Care Unit of A Tertiary Level Hospital In India. *Indian Journal of Critical Care Medicine*, 23(6), pp.270–273.

Pinto, R.C., De Castro, D.B., De Albuquerque, B.C., Sampaio, V.D.S., Passos, R.A. Dos, D.C.C F., Sadahiro, M., & Braga, J.U., 2016. Mortality Predictors in Patients With Severe Dengue in The State of Amazonas, Brazil. *PLoS ONE*, 11(8), pp.1–10.

Recker, M., Fleischmann, W.A., Nghia, T.H., Truong, N., Van, N.V., Anh, D.D., Song, L.H., The, N.T., Anh, C.X., Hoang, V., Truong, N.M., Toan, N.L., Kremsner, P.G., & Velavan, T.P., 2024. Markers of Prolonged Hospitalisation in Severe Dengue. *PLoS Neglected Tropical Diseases*, 2024, pp.1–16.

Sahassananda, D., Thanachartwet, V., Chonsawat, P., Wongphan, B., Chamnanchanunt, S., Surabotsophon, M., & Desakorn, V., 2021. Evaluation of Hematocrit in Adults with Dengue by a Laboratory Information System. *Journal of Tropical Medicine*, 2021, pp.1–9.

Saroch, A., Arya, V., Sinha, N., Taneja, R.S., Sahai, P., & Mahajan, R.K., 2017. Clinical and Laboratory Factors Associated With Mortality in Dengue. *Tropical Doctor*, 47(2), pp.141–145.

Shahid, A.M., Jain, D., Harikumar, H., Rana, S., Gupta, S., Budhiraja, S., & Venkatesh, S., 2021. Identification of Predictors and Model for Predicting Prolonged Length of Stay in Dengue Patients. *Health Care Management Science*, 24(4), pp.786–798.

Shastri, P.S., Gupta, P., & Kumar, R., 2020. Original Article A Prospective 3 Year Study of Clinical Spectrum and Outcome of Dengue Fever in ICU from a Tertiary Care Hospital in North India. *Indian Journal of Anaesthesia*, 49(4), pp.257–262.

Sujatha, C., Sudha, R.R., Surendran, A.T., Reghukumar, A., Valamparampil, M.J., Sathyadas, I.P., & Chandrasekharan, P.K., 2021. Social, Health System and Clinical Determinants of Fever Mortality During An Outbreak of Fever in Kerala, India. *Journal of Family Medicine and Primary Care*, 6(2), pp.169–170.

Supangat, U., Badriah, D.L., Mamlukah, M., & Suparman, R., 2023. Faktor-Faktor Yang Berhubungan Dengan Kematian Kasus Demam Berdarah Di Kota Tasikmalaya 2022. *Journal of Health Research Science*, 3(1), pp.63–71.

Trisasri, R., Arguni, E., & Ahmad, R.A., 2018. Faktor Risiko Kematian Akibat Dengue di RSUP Dr. Sardjito Yogyakarta. *Berita Kedokteran Masyarakat*, 34(1), pp.1.

WHO., 2020. *Ending the Neglect to Attain the Sustainable Development Goals: A Road Map for Neglected Tropical Diseases 2021–2030*.

WHO., 2023. *Dengue SitRep*. 37(September), pp.37–40.

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Sun Exposure on the Incidence of Allergies in Adult Women

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Abstract

Exposure to UVB rays in humans largely affects vitamin D synthesis, and approximately 90%–95% of vitamin D is produced in the skin. Allergic diseases have a significant impact on the health of the affected individuals. This study aimed to determine the relationship between sun exposure and the incidence of allergies in adult women. This research used a quantitative cross-sectional design. This research was conducted in Bogor from August to November 2023. The population investigated consisted of the entire adult female population living in the city of Bogor. This study used simple random sampling to select representative respondents. The data were collected using a questionnaire. The study sample comprised of 395 people. The inclusion criteria were women aged between 19 and 49 years who permanently resided in Bogor City. The exclusion criteria are women who are pregnant, breastfeeding, experiencing menopause, using hormonal contraception, and diagnosed with diabetes or other infectious or non-communicable diseases. Bivariate data was analyzed using the chi-square test to determine the relationship between sun exposure and the incidence of allergies in women in Bogor City. Processed shellfish foods and products are a common cause of allergies in women in Bogor. The frequency of sunbathing and the use of sunscreen have a significant effect on allergies. Sunbathing 2 times/week reduces allergies, whereas never sunbathing causes allergies. Sunscreen use increases allergies, and more research is needed to develop effective prevention strategies.

Introduction

Allergic diseases have a significant impact on the health and well-being of the affected individuals (Sánchez-Borges *et al*., 2018; Schmitz *et al*., 2017). Allergies are also associated with hereditary factors. In contrast, several non-genetic causes are believed to be responsible for the significant increase in the prevalence of allergic diseases that have occurred in recent decades (Ober and Yao 2011; Rueter *et al*., 2021). The increase in allergic diseases coincides with the trend in indoor lifestyle (Choi *et al*., 2022). Findings from the German Health Update show that around a third of people, from 18 to 79 years of age, report experiencing allergic conditions and are more common in women than in men, and occur more frequently in people with the highest levels of education (Schmitz *et al*., 2017).

Risk factors for allergic reactions include decreased exposure to microorganisms and infectious agents, decreased incidence of parasitic diseases, increased exposure to allergens, environmental pollution, changes in intestinal flora, and changes in diet, lifestyle, and travel patterns (Church 2004; Takano and Inoue 2017). Although other factors are involved, decreased exposure to sunlight is a risk factor for persistent allergic reactions (Rueter *et al*., 2021). The potential link between reduced sun exposure and an increased allergy risk is attributed to the immunological effects of reduced direct UV light exposure. Many studies

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in photobiology have shown that UV light can trigger immunomodulatory effects (González Maglio *et al*., 2016; Rueter *et al*., 2021).

Exposure to UVB rays in humans largely affects vitamin D synthesis, and approximately 90%–95% of vitamin D is produced in the skin through this process. Therefore, it is not surprising that vitamin D deficiency has emerged as a global concern, affecting more than a billion people worldwide (Matthias Wacker and Michaela F. Holick 2013; Chen *et al*., 2015; Rueter *et al*., 2021). However, studies on vitamin D supplementation have yielded unsatisfactory results in terms of allergy prevention, thus highlighting the potential effects independent of ultraviolet (UV) exposure (Rueter *et al*., 2021). Various studies have investigated the effects of vitamin D on the immune system, particularly its role in the development and regulation of innate and adaptive immunity (Maruotti and Cantatore 2010; Prietl *et al*., 2013; Bui *et al*., 2021).

Recent studies have shown that vitamin D has a significant impact on women's health. Sunlight is the main source of vitamin D. Indonesia is a tropical country that accounts for 90% of the world's vitamin D production. Due to its predominantly Muslim population, the city of Padang is characterized by a high prevalence of women wearing the hijab and engaging in indoor activities (Silvia 2022). Despite Indonesia's tropical climate, women of reproductive age who work indoors have low vitamin D levels, which can be attributed to the lack of exposure to ultraviolet B rays, the main source of vitamin D (Yosephin *et al*., 2014). Exposure to sunlight as an external source of vitamin D is influenced by the frequency and duration of exposure, use of sunscreen, skin type, and use of headscarves/covered clothing (Husna *et al*., 2021).

This study aimed to determine the relationship between sun exposure and the frequency of allergies in adult women in Bogor. The novelty of this study is that it focuses on the adult female population in Bogor, which may have different patterns of sun exposure to other populations. This is important because sun exposure can affect the immune system and cause allergic reactions in susceptible individuals. In addition, this research can also provide a better understanding of the environmental factors that contribute to the frequency of allergies in adult women in Bogor.

Method

The research design was cross-sectional. This means that the data were collected at one particular point in time and there were no follow-up observations. Cross-sectional research is useful for identifying relationships between variables in different populations. This method allows researchers to efficiently collect data from various groups or populations. Thus, cross-sectional research can provide a comprehensive picture of the relationships among these variables in a broad population. This study was approved by the Ethics Commission of the Faculty of Health Sciences, Ibn Khaldun University, Bogor (number 008/ K.11/ Kepk/FIKES-UIKA/2023. Approval from the Ethics Commission of the Faculty of Health Sciences, Ibn Khaldun University, Bogor, indicates that this research has undergone an evaluation process that ensures compliance with ethical principles. Thus, this study can be considered to have high integrity and credibility.

This research was conducted in Bogor from August to November 2023. The population investigated consisted of the entire adult female population living in the city of Bogor. This study used simple random samplings to select representative respondents from the population. The data was collected using a well-developed questionnaire. In addition, all data obtained will be processed and analyzed statistically to obtain valid and reliable results.

The minimum sample size was determined using Equation (Lemeshow, S. and David 1997). This calculation produced a value of n = 358.04, rounded to 359. Then add 10%. The total number of participants in the study was 395. The sampling procedure used was random sampling with the following inclusion criteria: women aged between 19 and 49 years who permanently resided in the city of Bogor. Women who are pregnant, breastfeeding, have experienced menopause, use hormonal contraception, have been diagnosed with diabetes or other infectious or non-infectious diseases, including active malignancies in the last 5 years, and are experiencing acute

inflammation were not included as subjects in this study. The subjects' consent was obtained through an informed consent form, which was signed voluntarily without any coercion. Data were collected by filling out a questionnaire containing information on the subjects' characteristics, sun exposure, and allergy history. Data were analyzed using univariate analysis for subject characteristics, source of vitamin D intake, sun exposure, and allergy history. Bivariate data were analyzed using the chi-square test to determine the relationship between sun exposure and the incidence of allergies in women in the city of Bogor.

Results And Discussion

Table 1. Subject Characteristics (n=395)

Characteristics	Σ	%
Age		
19-29 years old	333	84.3
30-39 years old	31	7.8
40-49 years old	31	7.8
Work		
Doesn't work	6	1.5
Student	233	59.0
Freelancers	9	2,3
Housewife	32	8.1
Laborer	2	0.5
Self-employed	13	3.3
Private sector employee	70	17.7
Teacher	22	5,6
Lecturer	8	2.0
Education		
No school	1	0.3
Finished elementary school	6	1.5
Finished middle school	8	2.0
Finished high school	283	71.6
Graduated from College	97	24.6
Frequency of sunbathing		
Never	8	20
1 time/week	114	28.9
2 times/week	79	20.0
3 times/week	75	19.0
4 times/week	30	7.6
5 times/week	29	7.3
6 times/week	10	2.5
7 times/week	50	12.7
Duration of sunbathing		

< 15 minutes	273	69.1
≥ 15 minutes	122	30.9
Use of sunscreen		
No	86	21.8
Yes	309	78.2
History of allergies		
Yes	163	41.3
No	232	58.7
Types of Allergies		
No history of allergies	232	58.7
Ingredients containing gluten (cereals, barley, etc.)	1	0.3
Shellfish and their processed products	51	12.9
Fish and its processed products	3	0.8
Eggs and their processed products	8	2.0
Milk and its processed products	1	0.3
Certain medications	9	2,3
Dust	22	5,6
Cold weather	68	17.2
Frequency of allergic events		
Never	232	58.7
≤ 4 times/year	93	23.5
> 4 times/year	70	17.7
Total	395	100.0

Table 1 shows that most of the subjects aged 19-29 years had student status. The highest frequency of sunbathing among students (28.9 %) used sunscreens for less than 15 minutes (69.1 %). Most people wore the hijab, and 41.3% had allergies, with shellfish and processed products being the most common.

Table 2 shows that, based on the statistical test results, the Likelihood Ratio obtained is p=0.000. It can be concluded that there is a significant relationship between the frequency of sunbathing and allergies in adult women in Bogor City ($p<0.05$). Adult women who sunbathe 2 times/week are more likely to not experience allergies, whereas adult women who never sunbathe experience allergies > 4 times/year.

Based on the statistical test results, the Likelihood Ratio obtained was p = 0.010 (Table 3). It can be concluded that there is a significant relationship between sunscreen use and the frequency of allergies in adult women in Bogor City ($p<0.05$). Subjects who used sunscreen experienced allergies more often (> 4 times/ year).

The findings show that awareness of sun protection was very high among students. They have extensive knowledge of the harmful effects of sun exposure and understand the importance of using sunscreens and wearing protective clothing. Additionally, many schools and educational institutions actively promote sun safety measures, which further contribute to high levels of awareness among students (de Troya Martín *et al*., 2019; Guy *et al*., 2016; Almuqati *et al*., 2019). This can be seen from the school policy, which requires students to wear hats or umbrellas outdoors and provide free sunscreens to students (Raymond-Lezman and Riskin 2023). In addition, several schools also hold educational programs on sun

Table 2. Relationship Between Frequency of Sunbathing and Frequency of Allergies in Adult Women in Bogor City

Frequency of sunbathing	Frequency of allergies								Likelihood Ratio (P Value)
	Never		**≤ 4 times/year**		**> 4 times/year**		**Total**		
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	
Never	0	0.0	1	12.5	7	87.5	8	100.0	
1 time/week	50	43.9	29	25.4	35	30.7	114	100.0	
2 times/week	59	74.7	16	20.3	4	5.1	79	100.0	
3 times/week	47	62.7	17	22.7	11	14.7	75	100.0	
4 times/week	18	60.0	10	33.3	2	6,7	30	100.0	0.000
5 times/week	16	55.2	9	31.0	4	13.8	29	100.0	
6 times/week	4	40.0	4	40.0	2	20.0	10	100.0	
7 times/week	38	76.0	7	14.0	5	10.0	50	100.0	
Total	232	58.7	93	23.5	70	17.7	395	100.0	

Table 3. Relationship between Sunscreen Usage and Frequency of Allergies in Adult Women in Bogor City

Sunscreen Usage	Frequency of allergies								Likelihood Ratio (P Value)
	Never		≤ 4 times/year		> 4 times/year		Total		
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	
No	39	45.3	24	27.9	23	26.7	86	100.0	0.010
Yes	193	62.5	69	22.3	47	15.2	309	100.0	
Total	232	58.7	93	23.5	70	17.7	395	100.0	

protection, such as seminars or workshops, to increase students' understanding of the importance of protecting themselves from the sun (Seidel *et al*., 2021). These initiatives not only educate students about the potential risks of sun exposure but also empower them to take proactive measures to protect their skin. By instilling these habits at a young age, schools play an important role in fostering a sun-safety culture that can have a long-term impact on students' overall health and well-being (Guy *et al*., 2016). In addition, the involvement of educational institutions in promoting sun protection underscores the recognition of sun safety as an integral part of holistic education (Diehl *et al*., 2023).

There is a significant relationship between the frequency of sunbathing and allergies in adult women in Bogor City. Adult women who sunbathe 2 times/week are more likely not to experience allergies, whereas adult women who never sunbathe experience allergies >4 times/year. This suggests that sunbathing may have a protective effect against allergies in adult women. These findings highlight the potential benefits of regular sun exposure in reducing allergic symptoms in certain populations. However, keep in mind that excessive sun exposure can increase the risk of skin cancer (Diao & Lee, 2013). Therefore, adult women need to maintain a balance between sunbathing and protection such as sunscreens (Al Robaee AA. 2010; Sultana 2020). Adult women are advised to consult a health professional to determine the amount of sun exposure appropriate for their individual needs. Additionally, other factors, such as genetics and lifestyle choices, can contribute to the development of allergies in adult women (Chen *et al*., 2020; Rennie *et al*., 2023), and more research is needed to fully understand the link between sunbathing and allergies. In addition, adult women need to pay attention to other factors that can influence the risk of allergies, such as diet and living environment (Murrison *et al*., 2019; Skypala and McKenzie 2019).

There is a significant relationship between the use of sunscreen and the frequency of allergies in adult women in Bogor. Subjects who used sunscreen experienced allergies more often (> 4 times/year). This study shows that the use of sunscreen can increase the risk of allergies in adult women in Bogor City. However, further research is needed to understand other factors that may influence the relationship between sunscreen use and allergy frequency. These factors may include specific ingredients in the sunscreen product used, the individual's skin type, and potential interactions with other environmental factors (Ngoc *et al*., 2019; Reis-Mansur *et al*., 2023; Latha *et al*., 2013). Psychological factors such as anxiety regarding sun exposure and sunscreen use can also influence the frequency of allergies in women (Nahar *et al*., 2013).

Shellfish food and processed products are the most common allergies experienced by women in Bogor City. There is a significant relationship between the frequency of sunbathing and allergies in adult women in Bogor City. Research shows that women in Bogor City, who are frequently exposed to sunlight, have a lower risk of developing allergies to shellfish and processed products. This demonstrates the importance of sun exposure in reducing the risk of allergies in adult women in cities. These findings suggest that sunlight may have a protective effect against shellfish allergies in women living in Bogor City, Brazil. Vitamin D produced by sun exposure may play a role in modulating the immune response and reducing allergic reactions (Sîrbe *et al*., 2022; Nahar *et al*., 2013). It is important to consider the genetic factors that may influence the immune response to shellfish allergies. Understanding the effect of genetic factors on the immune response to shellfish allergies is critical for developing personalized prevention and treatment strategies (Johanson *et al*., 2021).

Adult women who sunbathe 2 times/week are more likely not to experience allergies, whereas adult women who never sunbathe experience allergies >4 times/year. This indicates that regular sun exposure can help reduce the risk of allergies in adult women. However, it is important to maintain balance during sunbathing so as not to be exposed to excessive UV light. Excessive exposure to UV rays can increase the risk of skin damage and cancer. It is recommended to follow safe sun practices, such as wearing sunscreens, seeking shade during peak hours, and wearing protective clothing, to enjoy the benefits of sun exposure while minimizing potential risks. In addition, adult women need to pay attention to the right time to sunbathe. Exposure to sunlight in the morning or evening is recommended, because the intensity of UV rays is lower than that during the day (D'Orazio *et al*., 2013). Therefore, it can reduce the risk of skin damage and cancer caused by sun exposure. Additionally, it is important to check the skin regularly for changes or abnormalities, as the early detection of skin cancer can greatly increase the chances of successful treatment (Arivazhagan *et al*., 2022). Additionally, it is important to educate oneself and others about the dangers of indoor tanning beds, as indoor tanning beds also emit harmful UV rays that can cause skin damage and increase the risk of skin cancer.

Conclusion

Shellfish food and processed products are the most common allergies among women in Bogor City. There is a significant relationship between the frequency of sunbathing and allergies in adult women in Bogor City. Adult women who sunbathe 2 times/week are more likely to not experience allergies, whereas adult women who never sunbathe experience allergies > 4 times/year. There was a significant relationship between sunscreen use and the frequency of allergies in adult women in Bogor City. Subjects who used sunscreen experienced allergies more often (> 4 times/year). This shows that the frequency of sunbathing and the use of sunscreen can influence the level of allergies in adult women in Bogor. Further research is needed to understand the mechanisms underlying this relationship and develop effective prevention strategies.

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Reference

Almuqati, R.R., Alamri, A.S., & Almuqati, N.R., 2019. Knowledge, Attitude, and Practices Toward Sun Exposure and Use of Sun Protection Among Non-Medical, Female, University Students in Saudi Arabia: A Cross-Sectional Study. *International Journal of Women's Dermatology*, 5(2), pp.105–109.

Al Robaee, A.A., 2010. Awareness to Sun Exposure and Use of Sunscreen by The General Population. *Bosnian Journal of Basic Medical Sciences,* 10(4), pp.314–318.

Arivazhagan, N., Mukunthan, D.M.A., Sundaranarayana, A., Shankar, S., Kumar, R.V., Chandrasekaran, M.K.S., Devi, K.S., Nisha, M.U.B., & Abebe, T.G., 2022. Analysis of Skin Cancer and Patient Healthcare Using Data Mining Techniques. *Computational Intelligence and Neuroscience*, 2022, pp.1–9.

Bui, L., Zhu, Z., Hawkins, S., Cortez-Resendiz, A., & Bellon, A., 2021. Vitamin D Regulation of the Immune System and Its Implications for COVID-19: A Mini Review. *SAGE Open Medicine*, 9, pp.1–8.

Chen, S., & Suny, K.A.D., 2015. Deficiency, Vitamin D Hypertension, Essential. *J Am Soc Hypertens*, 9(11), pp.885–901.

Chen, Y., Lyu, J., Xia, Y., Zhu, J., Tong, S., Ying, Y., Qu, J., & Li, S., 2020. Effect of Maternal Sleep, Physical Activity and Screen Time During Pregnancy on The Risk of Childhood Respiratory Allergies: A Sex-Specific Study. *Respiratory Research*, 21(1), pp.1–12.

Choi, H.G., Kim, S.Y., Joo, Y.H., Cho, H.J., Kim, S.W., & Jeon, Y.J., 2022. Incidence of Asthma, Atopic Dermatitis, and Allergic Rhinitis in Korean Adults Before and During the COVID-19 Pandemic Using Data from the Korea National Health and Nutrition Examination Survey. *International Journal of Environmental Research and Public Health*, 19(21), pp.1–12.

Church, D.L., 2004. Major Factors Affecting The Emergence and Re-Emergence of Infectious Diseases. *Clinics in Laboratory Medicine*, 24(3), pp.559–586.

De Troya, M.M., Sánchez, N.B., Harana, C.G., Morano, T.F., Montero, C.J.T., Mesa, L.J., Ruiz, F.R., Sánchez, N.D., Martínez, A.G.R., López, V.S., & Aranda, M.V.G., 2019. Creation of the «Toludable» Sun Protection Accreditation Program for Schools. *Actas Dermo-Sifiliográficas (English Edition)* 110(10), pp.830–840.

D'Orazio, J., Jarrett, S., Amaro-Ortiz, A., & Scott, T., 2013. UV Radiation and the Skin. *International Journal of Molecular Sciences*, 14(6), pp.12222–12248.

Diao, D.Y., & Lee, T.K., 2013. Sun-Protective Behaviors in Populations at High Risk For Skin Cancer. *Psychology Research and Behavior Management*, 7(December), pp.9–18.

Diehl, K., Battenberg, M.C., Jansen, C., & Görig, T., 2023. Sun Protection Counseling at the Pharmacy: A German Qualitative Study on Status Quo, Potential Deficits, and Sources of Information. *Healthcare (Switzerland)*, 11(13).

González, M.D.H., Paz, M.L., & Leoni, J., 2016. Sunlight Effects on Immune System: Is There Something Else in addition to UV-Induced Immunosuppression?. *BioMed Research International*, 2016, pp.1–10.

Guy, G.P., Holman, D.M., & Watson, M., 2016. The Important Role of Schools in The Prevention of Skin Cancer. *JAMA Dermatology*, 152(10), pp.1083–1084.

Husna, K., Widajanti, N., Sumarmi, S., & Firdaus, H., 2021. Hubungan antara Skor Paparan Matahari dan Asupan Vitamin D dengan Kadar 25(OH)D Serum pada Wanita Usia Lanjut. *Jurnal Penyakit Dalam Indonesia*, 8(2).

Johanson, E., Tesfaye., & Mersha., 2021. Genetics of Food Allergy. *Immunol Allergy Clin North Am*, 41(2), pp.301–319.

Latha, M.S., Martis, V.J., Shinde, S.R.S., Bangera, S., Krishnankutty, B., Bellary, S., Varughese, S., Rao, P., & Kumar, B.R.N., 2013. Sunscreening Agents: A Review. *Journal of Clinical and Aesthetic Dermatology*, 6(1), pp.16–26.

Lemeshow, S., & David, J., 1997. *Besar Sampel dalam Penelitian Kesehatan (Terjemahan)*. Yogyakarta: Gadjah Mada University Press.

Maruotti, N., & Cantatore, F.P., 2010. Vitamin D and the Immune System. *Journal of Rheumatology*, 37(3), pp.491–495.

Matthias, W., & Holick, M.F., 2013. Sunlight and Vitamin D - A Global Perspective for Health. *Dermato-Endocrinology*, 5(1), pp.211–217.

Murrison, L.B., Brandt, E.B., Myers, J.B., &

Khurana, H.G.K., 2019. Environmental Exposures and Mechanisms in Allergy and Asthma Development. *Journal of Clinical Investigation*, 129(4), pp.1504–1515.

Nahar, V.K., Ford, M.A., Hallam, J.S., Bass, M.A., & Vice, M.A. 2013. Sociodemographic and Psychological Correlates of Sun Protection Behaviors among Outdoor Workers: A Review. *Journal of Skin Cancer*, 2013, pp.1–10.

Ngoc, L.T.N., Tran, V., Van, M.J.Y., Chae, M., Park, D., & Lee, Y.C., 2019. Recent Trends of Sunscreen Cosmetic: an Update Review. *Cosmetics*, 6(4), pp.1–15.

Ober, C., & Yao, T.C., 2011. The Genetics of Asthma and Allergic Disease: A 21st Century Perspective. *Immunological Reviews*, 242(1), pp.10–30.

Prietl, B., Treiber, G., Pieber, T.R., & Amrein, K., 2013. Vitamin D and Immune Function. *Nutrients*, 5(7), pp.2502–2521.

Raymond-Lezman, J.R., & Riskin, S., 2023. Attitudes, Behaviors, and Risks of Sun Protection to Prevent Skin Cancer Amongst Children, Adolescents, and Adults. *Cureus*, 15(2), pp.1–15.

Reis-Mansur, M.C.P.P., da Luz, B.G., & Dos Santos, E.P., 2023. Consumer Behavior, Skin Phototype, Sunscreens, and Tools for Photoprotection: A Review. *Cosmetics* 10(2), pp.1–13.

Rennie, G.H., Zhao, J., Camus-Ela, M., Shi, J., Jiang, L., Zhang, L., Wang, J., & Raghavan, V., 2023. Influence of Lifestyle and Dietary Habits on the Prevalence of Food Allergies: A Scoping Review. *Foods*, 12(17), pp.1–22.

Rueter, K., Jones, A.P., Siafarikas, A., Chivers, P., Prescott, S.L., & Palmer, D.J., 2021. The Influence of Sunlight Exposure and Sun Protecting Behaviours on Allergic Outcomes in Early Childhood. *International Journal of Environmental Research and Public Health*, 18(10), pp.1–10.

Sánchez-Borges, M., Martin, B.L., Muraro, A.M., Wood, R.A., Agache, I.O., Ansotegui, I.J., Casale, T.B., Fleisher, T., Hellings, P.W., Papadopoulos, N.G., Peden, D.B., Sublett, J.L., Tilles, S.A., & Rosenwasser, L., 2018. The Importance of Allergic Disease in Public Health: An iCAALL Statement. *World Allergy Organization Journal*, 11(1), pp.10–12.

Schmitz, R., Kuhnert, R., & Thamm, M., 2017. 12-Month Prevalence of Allergies in Germany. *Journal of Health Monitoring*, 2(1), pp.70–74.

Seidel, N., Fieber, V., Breitbart, E.W., Bornhäuser, M., & Stölzel, F., 2021. Cluster Randomized Trial: Sun Protection Intervention 'Clever in Sun and Shade for Preschools'-Effectiveness and Dissemination. *Children*, 8(8), pp.1–27.

Silvia, E., 2022. Perbedaan Kadar 25(OH)D Serum menurut Lama Paparan Sinar Matahari pada Perempuan Remaja Akhir di Kota Padang. *GALENICAL: Jurnal Kedokteran dan Kesehatan Mahasiswa Malikussaleh*, 1(2).

Sîrbe, C., Rednic, S., Grama, A., & Pop, T.L., 2022. An Update on the Effects of Vitamin D on the Immune System and Autoimmune Diseases. *International Journal of Molecular Sciences*, 23(17), pp.1–29.

Skypala, I.J., & McKenzie, R., 2019. Nutritional Issues in Food Allergy. *Clinical Reviews in Allergy and Immunology*, 57(2), pp.166–178.

Sultana, N., 2020. Sun Awareness and Sun Protection Practices. *Clinical, Cosmetic and Investigational Dermatology*, 13, pp.717–730.

Takano, H., & Inoue, K.I., 2017. Environmental Pollution and Allergies. *Journal of Toxicologic Pathology*, 30(3), pp.193–199.

Yosephin, B., Khomsan, A., Briawan, D., & Rimbawan, R., 2014. Peranan Ultraviolet B Sinar Matahari terhadap Status Vitamin D dan Tekanan Darah pada Wanita Usia Subur. *Kesmas: National Public Health Journal*, 8(6).

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Work-Related Factors and Individual Characteristics on Asthenopia Symptoms among "Pecanting Batik" Workers in Klaten, Indonesia

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Abstract

Asthenopia is associated with close work, such as blurred vision, diplopia, dry eyes, and headaches. The incidence of asthenopia is quite common among workers who perform intensive visual tasks. The goal is to analyze the risk factors most related to astenopia complaints. This type of observational research with a cross-sectional study design took time in July 2024 on 155 batik canters in 45 batik-making home industries in Jarum Village, Klaten Regency, Central Java, Indonesia. Variables were measured using a general questionnaire on age, length of service, length of work, and length of rest. In addition, the Pittsburgh Sleep Quality Index (PSQI) questionnaire is used to measure sleep quality. The worker's awkward posture was measured using the Rapid Upper Limb Assessment Worksheet. The distance to see the object is measured using the JOYKO brand 30cm Butterfly Iron Ruler between the object and the worker's eyes. The Visual Fatigue Index (VFI) questionnaire measured asthenopia complaints. The analysis of bivariate data with Spearman rank and multivariate correlation was used multiple linear regression test. This study showed that most respondents were 44,368 years old on average, felt that their sleep quality was not good, and had been working as a batik maker for ≥ 10 years. The risk factors most related to astenopia complaints are sleep quality (p=0.000), age (p=0.001), and working period (p=0.019).

Introduction

Asthenopia, also known as eye fatigue, is characterized by symptoms associated with close work, such as blurred vision, diplopia, dry eyes, and headaches (Zhang *et al.*, 2023). These symptoms can be divided into three categories. They are visual disturbances, eye irritation, and extraocular symptoms (Anbesu & Lema, 2023). Data from the World Health Organization (WHO) shows that the incidence of asthenopia or eye fatigue ranges from 40% to 90% (World Health Organization, 2022; Abuallut *et al.*, 2022). The prevalence of asthenopia in computer operators in India is 87.3%, with various symptoms, one of which is blurred vision, as much as 18.7% (Arshad *et al.*, 2019).

Asthenopia can be diagnosed by paying attention to the subjective symptoms experienced by the individual, such as eye pain and blurred vision (Wang *et al.*, 2022). The causes of asthenopia vary but are generally related to factors that overstress the visual system (Ferreira *et al.*, 2024). Age and longer working life are often correlated with an increase in complaints of asthenopia, due to a decrease in the ability of the eye to adapt with age (Chowdhury & Chakraborty, 2017). Long working hours without adequate rest also increase the risk of eye fatigue (López *et al.*, 2020; Prasetio *et al.*, 2023). In addition, non-ideal visibility, poor sleep quality, and unergonomic work posture can worsen the symptoms of asthenopia (Anbesu & Lema,

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2023).

The incidence of asthenopia is quite common among workers who perform intensive visual tasks (Ostrovsky & Ilchenko, 2022). Previous research showed that as many as 79.16% of visual display terminal operators at Federal International Finance Group Bali experienced symptoms of asthenopia, with headache complaints being the most common (Primantara & Putere, 2020). Another study found that 38.7% of male professional tailors experienced symptoms of asthenopia (Sharma *et al.*, 2021). In the United States, 57.9% of manufacturing workers reported experiencing eye strain, with work stress and shift schedules as the main causes (Lu *et al.*, 2017). Physiologically, asthenopia occurs due to excessive strain on the eye muscles, disturbances in blood circulation in the eye, or problems with the nervous system that regulates visual functions (Hashemi *et al.*, 2019). When the eyes are forced to work continuously without rest, the eye muscles become tense and tired (Ostrovsky & Ilchenko, 2022). It can lead to impaired accommodation and convergence, which in turn triggers symptoms of eye fatigue (Kim *et al.*, 2023).

Previous research has identified that prolonged exposure of five to six hours without rest and working at a distance of 50 cm from a computer monitor poses a danger of eye fatigue (Irwan *et al.*, 2023). Other research conducted on wig manufacturing workers showed a relationship between work position and eye fatigue (Ruliati *et al.*, 2020). Age 28-29 years is an independent factor related to the incidence of asthenopia in college students (Hashemi *et al.*, 2019). One of the informal sector jobs involved in short-distance work and requires high precision is the batik industry, especially in the batik canting section (Oginawati *et al.*, 2023). Several specific phenomena may contribute to asthenopia complaints. The work process of making batik is still traditional. So workers often have to look at objects at a very close distance for a long period. The work postures are not always follow the anthropometry of the worker's body. In addition, long work patterns without adequate rest and a work environment with less than optimal lighting can exacerbate this condition (Prasetio *et al.*, 2023).

Although much research has been done on asthenopia, there is a gap in the literature on asthenopia research in the informal sector. This study aims to fill this gap by providing empirical data on factors that affect asthenopia in informal sector industrial workers, namely in the batik industry. This study suspects that in addition to the factors described, there is a chance that sleep quality factors can also contribute to asthenopia in batik workers. Lengthy work in the editing section, with additional work at home for four to five hours after hours, can lead to a lack of sleep. It is possible to aggravate asthenopia complaints.

Methods

This type of observational research with a cross-sectional study design was carried out in July 2024 in 45 *batik-making* home industries in Jarum Village, Klaten Regency, Central Java, Indonesia. The population is 285 *batik-making* workers with sampling using the purposive sampling technique. All *batik canting* workers became respondents in this study, namely 155 respondents. The independent variables were individual factors (Sleep Quality, Age) and Work-Related (Distance to See Objects, Rest Duration, Length of Work, Working Period, and Odd Work Posture). The bound variable is astenopia complaints. Variables were measured using a general questionnaire on age, length of service, length of work, and length of rest. In addition, the Pittsburgh Sleep Quality Index (PSQI) questionnaire is used to measure sleep quality. BMI with weight measurement using Omron HN 289 Digital Scales and height using Stature Adult Height Meter MT-701. The worker's awkward posture was measured using the Rapid Upper Limb Assessment Worksheet. The distance to see the object is measured using the JOYKO brand 30cm Butterfly Iron Ruler between the object and the worker's eyes. The Visual Fatigue Index (VFI) questionnaire measured asthenopia complaints consisting of 22 questions. Each question has four possible answer options (never, sometimes, often, and always).

This research has received ethical approval from the Ethics Committee for Health Research, Faculty of Nursing and Health Sciences, University of Muhammadiyah Semarang, with certificate number 417/KE/06/2024. The research began with the informed consent signing, after which a questionnaire interview was conducted, and ended with the measurement of BMI, distance to see objects, and unusual work posture. Data analysis starts from univariate analysis, namely individual and occupational characteristic variables are presented in the form of a frequency

table with mean values ± standard deviation or as a median (minimum-maximal). Then, the bivariate analysis of the relationship between risk factors and complaints of asthenopia was tested with a Spearman rank correlation because all data were numerical. Finally, multivariate analysis to determine the variables most related to asthenopia complaints used multiple linear regression tests. The data analysis was carried out using IBM SPSS Statistics 21.

Result and Discussion

Most research respondents were 44,368±8,412 with an average BMI of 24,716±2,761. Most respondents felt their sleep quality was not good (77.4%). Distribution analysis showed that 69% of respondents saw work objects with a standard distance of ≥ 25 cm. Most respondents took an average break of 60,130±16,768, with an average length of work of 8,587±1,252. More than half of *batik*

Table 1. Individual and Work-Related Characteristics of The Study Population (n=155)

Factors	Mean±SD	Median (Min-Max)	f(%)
Individual			
IMT *(kg/m²)*	24,71±2,76	24,6 (17,2-31,9)	
< 18,5			7 (4,5)
18,5-22,9			22(14,2)
23-24,9			59(38,1)
25-29,9			66(42,6)
≥ 30			1 (0,6)
Sleep Quality (skor)	7,01 ± 1,53	8,0 (4,0 -11,0)	
Bad			120(77,4)
Good			35(22,6)
Age (years)	44,36±8,41	46,0 (24,0-66,0)	
20-44			47(30,3)
45-64			106(68,4)
≥ 65			2 (1,3)
Work-Related			
Object Viewing Distance (cm)	25,21±2,91	26,0 (18,0- 30,0)	
< 25			48(31,0)
≥ 25			107(69,0)
Rest Length (minutes/day)	60,13±16,76	60,0 (20,0-120,0)	
< 60			21(13,5)
≥ 60			134(86,5)
Length of Work (hours/day)	8,58 ± 1,25	8,0 (7,0-14,0)	
< 8			25(16,1)
≥ 8			130(83,9)

Factors	Mean±SD	Median (Min-Max)	f(%)
Working Period (years)	13,20±9,94	12,0 (1,0-54,0)	
< 10			54(34,8)
≥ 10			101(65,2)
Unergonomic posture (score)	5,14±1,45	5,0 (2,0-8,0)	
Unergonomic			134(86,5)
Ergonomic			21(13,5)
Astenopia Complaints (skor)	0,47±0,15	5,0 (0,25-0,9)	
None			53(34,2)
Exist			102(65,8)

(Source: Primary Data, 2024)

artisans have been working as *batik* artisans for ≥ 10 years (65.2%). As many as 86.5% of *batik* workers work with unergonomic posture. A total of 65.8% of respondents experienced complaints of asthenopia (Table 1).

More than half of the respondents sometimes felt blurred vision (50.3%), double or shadowed vision (55.5%), and hot eyes (56.8%). The frequency of symptoms that were often experienced by the majority of respondents was frequent scratching of the eyes (50.3%), twitching or spasms of the eyelids (50.3%), and

Tabel 2. Response to Eye Fatigue Complaint Statement (n=155)

Asthenopia Symptoms	**Response to Asthenopia Symptoms**			
	Never	**Sometimes**	**Often**	**Always**
	f(%)	**f(%)**	**f(%)**	**f(%)**
Pain or throbbing sensation around the eyeball	96(61,9)	54(34,8)	4(2,6)	1(0,6)
Painful eyes	70(45,2)	70(45,2)	14(9,0)	1(0,6)
Eyes feel heavy	95(61,3)	28(18,1)	5(3,2)	27(17,4)
Blurred vision	74(47,7)	78(50,3)	2(1,3)	1(0.6)
Double or shadowed vision	56(36,1)	86(55,5)	10(6,5)	3(1,9)
Eyes feel hot	53(34,2)	88(56,8)	12(7,7)	2(1,3)
Watery eyes	65(41,9)	37(23,9)	1(0,6)	52(33,5)
Sleepy	62(40.0)	52(33,5)	41(26,5)	0(0,0)
Eyes feel tense	50(32,3)	68(43,9)	24(15,5)	13(8,4)
Dry eyes	74(47,7)	47(30,3)	13(8,4)	21(13,5)
Itchy eyes	50(32,3)	38(24,5)	56(36,1)	11(7,1)
Headache	94(60,6)	27(17,4)	25(16,1)	9(5,8)
Eyes reddened	90(58,1)	37(23,9)	14(9,0)	14(9,0)
Difficulty focusing vision	113(72,9)	4(2,6)	15(9,7)	23(14,8)
Eyes are often rubbed	48(31,0)	15(9,7)	78(50,3)	14(9,0)
Glare	88(56,8)	1(0,6)	41(26,5)	25(16,1)
Eyelid twitching or spasms	53(34,2)	12(7,7)	78(50,3)	12(7,7)
Eyelids that are difficult to close	91(58,7)	24(15,5)	16(10,3)	24(15,5)

Pain when the eye moves the eyeball	29(18,7)	13(8,4)	101(65,2)	12(7,7)
Pain when closed firmly	114(73,5)	0(0,0)	16(10,3)	25(16,1)
Eyes feel sore	53(34,2)	1(0,6)	13(8,4)	88(56,8)
Eyes feel sandy	117(75,5)	1(0,6)	12(7,7)	25(16,1)

(Sumber: Data Primer, 2024)

pain when the eyes moved the eyeballs (65.2%). Meanwhile, as many as 56.8% of respondents always experience asthenopia complaints in the form of stinging eyes (Table 2).

There was a significant relationship between Sleep Quality and Age with asthenopia Symptoms in *batik* artisans in Klaten Regency with each value of p=0.000. In the occupational factor, there was a significant relationship between the distance to see the object (p=0.018), the length of work (p=0.015), and the duration of work (p=0.000) and complaints of asthenopia in batik craftsman in Klaten Regency (Table 3).

The multivariate analysis showed 3 independent variables that were most related to asthenopia complaints in *batik canting workers* in Klaten Regency, namely sleep quality (p=0.000), age (p=0.001), and working period (p=0.019) (Table 4). The *canting* part of *batik* workers is the work of repainting patterns on

Tabel 3. Relationship of Work-Related Factors and Individual Characteristics on Astenopia Symptoms (n=155)

Factors	**Asthenopia Symptoms**	
	p*	**Information**
Individual		
Sleep Quality	0,000	There is a relationship **
Age	0,000	There is a relationship **
Work-Related		
Object Viewing Distance	0,018	There is a relationship **
Rest Length	0,692	No relationship ***
Length of Work	0,015	There is a relationship **
Working Period	0,000	There is a relationship **
Unergonomic Work Posture	0,353	No relationship ***

**Spearman's Rank Correlation; **p≤0,05; ***p>0,05*
(Source: Primary Data, 2024)

Tabel 4. Multiple Regressions Linear Model for Asthenopia Symptoms

Factors	ß	SE	**BETA**	***p***
Individual				
Sleep Quality	0,034	0,008	0,333	0,000*
Age	0,005	0,001	0,257	0,001*
Work-Related				
Object Viewing Distance	0,004	0,004	0,081	0,271**
Rest Length	0,000	0,001	0,017	0,826**
Length of Work	0,004	0,009	0,028	0,703**
Working Period	0,003	0,001	0,175	0,019*
Unergonomic Work Posture	0,003	0,008	0,024	0,756**

*p≤0,05; **p>0,05
(Source: Primary Data, 2024)

batik fabric. This job requires visual effort every time it works. Visual efforts in *batik* workers showed the results of a study with a prevalence of asthenopia symptoms of 65.8% in *batik* workers in the *canting* section. Research on students who use computers shows a prevalence of asthenopia of 53.3%(Xu *et al.*, 2019). In our study, three-quarters of respondents complained that their eyes felt sandy, their eyes hurt when closed firmly, and they had difficulty focusing their vision. In contrast to the results of other studies that explain that the complaints of asthenopia experienced by students are symptoms such as headaches, blurred vision, and eye fatigue that interfere with concentration and work efficiency (Chowdhury & Chakraborty, 2017).

This study shows that age is associated with asthenopia complaints. Young workers do not dominate because they are studying and working outside the village, so the sample is dominated by elderly. Old age is a risk factor for asthenopia (Deng *et al*., 2019; Wang *et al.*, 2022). Our sample was mostly workers aged 45-64 who had complaints of astenopia. Eye commodity decreases with age, and individuals over 40-45 years old are susceptible to asthenopia after prolonged close work (Deng *et al*., 2019; Negishi *et al.*, 2021). This study revealed that respondents had difficulty sleeping. Sleep quality in this multivariate analysis was related to complaints of asthenopia. It happens because the quality of sleep is not good, as felt by most batik workers. Asthenopia causes symptoms of dry eyes and headaches, which can negatively affect sleep quality, thus worsening asthenopia (Stack et al., 2017).

Workers who have worked longer than 10 years dominate (65.2%). The period of employment is the accumulation of activities that a person does over a long period. It is proven in this study that the working period is related to asthenopia. In line with previous research, a long working period can increase the risk of eye fatigue (Jang *et al.*, 2023; Rahman *et al.*, 2024). Work that requires precision causes the eyes to continue to be accommodated, causing tension in the eye muscles and fatigue of the eye nerves. Our study showed that object viewing distance was not associated with complaints of asthenopia. It happens because most of the distance to see the object of the batik workers when "*canting*" is safe, which is ≥ 25 cm, as much as 69%. Closer pitch spacing causes more severe eye strain (Long *et al.*, 2017).

Most respondents' working time is ≥ 8 hours, which means overtime. Most of these workers are "wholesale workers" who bring the work at home so that workers are not supervised by the owner of the industrial home. Eye fatigue due to work is higher in workers who spend their time on visual efforts using electronic devices (Jang *et al.*, 2023). The rest duration in this study sample was mostly ≥ 60 minutes. The result is in line with previous research that explained that rest is not related to asthenopia in tailors (Zafar *et al.,* 2021). Unergonomic working posture is not associated with complaints of asthenopia. It is because most of the *canting* batik workers have an unergonomic posture. The results of this study are not aligned with the theory that an increase in ideal posture deviation indicates a health problem (Souchet *et al.*, 2023).

The symptoms of asthenopia that appear a lot affect a person's psychological condition, surrounding environment, health status, diet, and lifestyle behaviors (Zafar *et al*., 2021). Ongoing symptoms can cause significant discomfort, affecting their personal and social lives (Wang *et al.*, 2022). Asthenopia can lead to decreased productivity because workers have difficulty maintaining the focus and details of the work required in the *batik-making* process (Ruliati *et al*., 2020). The quality of *batik* is greatly influenced by its accuracy and precision. If workers experience Astenopia, it can cause the risk of errors in batik-making and will reduce the quality of the batik produced. It will, of course, affect the image of the *batik* industry. This research has several limitations. We only conducted studies based on subjective perceptions of asthenopia complaints compared to measurements with more objective tools. There are still other factors related to asthenopia. Future research should include more potential factors and thoroughly explore risk factors for asthenopia.

Conclusion

Aging age is inevitably a natural risk factor for batik canting workers related to symptoms of asthenopia. In addition, poor

sleep quality is associated with confirming the symptoms of asthenopia. There are also work factors related to asthenopia symptoms. The longer the working period, the more the risk of asthenopia symptoms will increase because working only by experience and not based on applicable rules. Workers should maintain their sleep quality well and also work consistently according to the rules to minimize the onset of asthenopia symptoms. Further research is needed regarding risk factors for poor sleep quality, such as what can accelerate the appearance of asthenopia and continue using biological parameters that mark the occurrence of asthenopia.

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References

Abuallut, I., Qumayi, E.A., Mohana, A.J., Almalki, N.M.,Ghilan, M.E., Dallak, F.H., Mahzari, S.M., Makrami, A., Tawhari, A, Ajeebi, R.E., & Bakri, S.M., 2022. Prevalence of Asthenopia and Its Relationship with Electronic Screen Usage During the COVID-19 Pandemic in Jazan, Saudi Arabia: A Cross-Sectional Study. *Clinical Ophthalmology*, 16(9), pp.3165–3174.

Anbesu, E.W., & Lema, A.K., 2023. Prevalence of Computer Vision Syndrome: A Systematic Review and Meta-Analysis. *Scientific Reports (Nature Publisher Group)*, 13(1), pp.1801.

Arshad, S., Khan, A., Pal, D.K., Melwani, V., Verma, S., & Sawlani, H., 2019. Prevalence of Asthenopia Among Computer Operators in Central India and Effectiveness of Educational Intervention. *International Journal Of Community Medicine And Public Health*, 6(5), pp.2091.

Chowdhury, S., & Chakraborty, P., 2017. Universal Health Coverage - There Is More to It Than Meets The Eye. *Journal of Family Medicine and Primary Care*, 6(2), pp.169–170.

Deng, R., Zhu, Y., Zhang, J., Lin, N., Li, X., Lin, Y., Zheng, J., & Lu, F., 2019. Investigation of Asthenopia and Related Factors in the General Public in China. *Chin J Optom Ophthalmol Vis Sci.*, 21, pp.668–76.

Ferreira, K.S.L., Lucena, A.D., de Oliveira, F.N., & Lucena, H.M.A., 2024. Visual Fatigue from Occupational Environment: A Review Study. *Occupational and Environmental Safety and Health V*, 492, pp. 813–824.

Hashemi, H., Saatchi, M., Yekta, A., Ali, B., Ostadimoghaddam, H., Nabovati, P., Aghamirsalim, M., Khabazkhoob, M., 2019. High Prevalence of Asthenopia Among A Population of University Students. *Journal of Ophthalmic and Vision Research*, 14(4), pp.474–482.

Irwan., Ridha, N.R., Katili, D.I., & Una, M., 2023. Risk Factor Analysis of Occupational Diseases in Computer Users. *International Journal of Environmental, Sustainability, and Social Science*, 4(5), pp.1295–1301.

Jang, Y.S., Lee, J.H., Lee, N.R., Kim, D.W., Lee, J.H., & Lee, K.J., 2023. Association Between Receiving Work Communications Outside of Work Hours Via Telecommunication Devices and Work-Related Headaches And Eyestrain: A Cross-Sectional Analysis of the 6th Korean Working Conditions Survey. *Annals of Occupational and Environmental Medicine*, 35(1), pp.1–11.

Kim, G., Cho, S., Kim, J., Yoon, S., Kang, J., & Kim, S., 2023. Relationship Between Visual Display Terminal Working Hours and Headache/ Eyestrain in Korean Wage Workers During the COVID-19 Pandemic: the Sixth Korean Working Conditions Survey. *Annals of Occupational and Environmental Medicine*, 32, pp.1–12.

Ruliati, L.P., Maisal, F.M., Junias, M.S., & Santi, L.E.N., 2020. Ergonomic Analysis of Work Fatigue and Eyestrain Among Wig Makers at PT. SCI Indonesia Kupang City', *Proceedings of the 4th International Symposium on Health Research (ISHR 2019)*, pp. 434–439.

Long, J., Cheung, R., Duong, S., Paynter, R., & Asper, L., 2017. Viewing Distance and Eyestrain Symptoms with Prolonged Viewing of

Smartphones. *Clinical & Experimental Optometry*, 100(2), pp.133–137.

López, J., Rojas, L., & Osada, J., 2020. Frecuencia de Factores Ocupacionales Asociados A Astenopía en Trabajadores Usuarios de Pantallas de Visualización de Datos de Empresas Del Rubro Construcción en Huaraz, 2019. *Rev Asoc Esp Med Trab*, 29(2), pp.1–95.

Lu, L., Megahed, F.M., Sesek, R.F., & Cavuoto, L.A., 2017. A Survey of The Prevalence of Fatigue, Its Precursors and Individual Coping Mechanisms Among U.S. Manufacturing Workers. *Applied Ergonomics*, 65, pp.139–151.

Negishi, K., Ayaki, M., Kawashima, M., & Tsubota, K., 2021. Sleep and Subjective Happiness Between The Ages 40 and 59 in Relation to Presbyopia and Dry Eye. *Plos One*, 16(4), pp.e0250087.

Oginawati, K., Nathanael, R.J., Chazanah, N., Prabandari, S.D., Basuki, M.F., Oclandhi, B., Santoso, M., Febriana, S.A., Nugrahaningsih, D.A., Suhartini, S., Prakoeswa, C.R.S., & Tanziha, I., 2023. Occupational Lead Exposure Health Risk Assessment and Heme Biosynthesis: A Study on Batik Artisans in Yogyakarta, Indonesia. *Heliyon*, 9(9), pp.e19994.

Ostrovsky, A., & Ilchenko, A., 2022. Subjective Assessment of the Severity of the Main Symptoms of Visual Asthenopia in Medical Students. *Oftalmologija. Vostochnaja Evropa*, 12(4), pp.476–481.

Prasetio, D.B., Setyaningsih, Y., Suhartono., & Suroto., 2023. Identification of Subjective Fatigue Accompanied by Hypertension in Female Workers Making Tiles in Indonesia: A Cross-Sectional Survey. *International Journal of Occupational Safety and Health*, 13(4), pp.484–493.

Prasetio, D.B., Setyaningsih, Y., Suhartono., & Suroto., 2023. Individual, Habits, and Work Environment Factors Associated With Blood Lactic Acid Levels in Roof Tile Manufacturing Workers. *Malaysian Journal of Public Health Medicine*, 23(1), pp.253–260.

Primantara, I.P., & Putere, S.P.M.L.M., 2020. Prevalence of Asthenopia in Visual Display Terminal Operators at Federal International Finance Group Bali. *The Proceedings of the 1st Seminar The Emerging of Novel Corona Virus*, pp.4–9.

Rahman, A., Amir, S.P., Novriansyah, Z.K., Maharani, R.N., & Aulia, N., 2024. Hubungan Durasi dan Lama Kerja Penjahit dengan Kejadian Kelelahan Mata. *Journal Of Social Science Research*, 4(3), pp. 2215–2227.

Ruliati, L.P., Maisal, F.M.M., Junias, M.S., & Santi, L.E.N., 2020. Ergonomic Analysis of Work Fatigue and Eyestrain Among Wig Makers at PT. SCI Indonesia Kupang City. *Proceedings of the 4th International Symposium on Health Research (ISHR 2019)*, pp.434–439.

Sharma, S., Sitaula, R.K., Mishra, S., Shrestha, G.B., & Sharma, A.K., 2021. The Ocular Health and Visual Function Status of Sewing Professionals of Garment Factories of Kathmandu Valley. *Cogent Medicine*, 8(1).

Souchet, A.D., Lourdeaux, D., Pagani, A., & Rebenitsch, L., 2023. A Narrative Review of Immersive Virtual Reality's Ergonomics and Risks at The Workplace: Cybersickness, Visual Fatigue, Muscular Fatigue, Acute Stress, and Mental Overload. *Virtual Reality*, 27, pp.19-50.

Stack, R.J., Southworth, S., Fisher, B.A., Barone, F., Buckley, C.D., Rauz, S., & Bowman, S.J., 2017. A Qualitative Exploration of Physical, Mental and Ocular Fatigue in Patients With Primary Sjögren's Syndrome. *PloS One*, 12(10), pp.e0187272.

Wang, J., Zeng, P., Deng, X., Liang, J., Liao, Y., Fan, S., & Xiao, J., 2022. Eye Habits Affect the Prevalence of Asthenopia in Patients with Myopia. *Journal of Ophthalmology*, 1.

Xu, Y., Deng, G., Wang, W., Xiong, S., & Xu, X., 2019. Correlation Between Handheld Digital Device Use and Asthenopia in Chinese College Students: A Shanghai Study. *Acta Ophthalmologica*, 97(3), pp.e442–e447.

Zafar, A., Ahmad, S., Ali, K.N., Khalid, B., & Ayyub, F., 2021. Frequency of Asthenopia Symptoms Among Tailors of Rawalpindi: A Cross-Sectional Survey. *J. Shifa Tameer-e-Millat Univ.,* 5(1).

Zhang, H., Song, T., Kang, R., Ren, F., Liu, J., & Wang, J., 2023. Plant Bioactive Compounds Alleviate Photoinduced Retinal Damage and Asthenopia: Mechanisms, Synergies, and Bioavailability. *Nutrition Research*, 120, pp.115–134.

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Moringa Leaf Extract Capsules Enriched with Royal Jelly on Cortisol and Stress

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Abstract

During pregnancy, physiological and psychological changes often increase stress and cortisol levels. Administering moringa leaf extract capsules fortified with royal jelly presents a viable intervention to alleviate this stress. This study investigates the specific effects of these capsules on cortisol and stress levels in pregnant women. The study was conducted as a valid experimental, single-blind, randomized controlled trial involving 61 pregnant women. The intervention group (n = 31) received moringa leaf extract capsules enriched with royal jelly, while the control group (n = 30) received multi-micronutrient supplements. The findings revealed a noteworthy reduction in cortisol levels within the intervention group (p = 0.030), from 26.61 ± 8.15 to 19.98 ± 14.00, as well as in the control group (p = 0.003), from 21.13 ± 7.76 to 13.26 ± 16.09. Likewise, stress levels exhibited a significant decrease within the intervention group (p = 0.016), decreasing from 18.68 ± 3.74 to 28.75 ± 15.02, and the control group (p = 0.000), declining from 19.17 ± 3.64 to 16.20 ± 3.38. Moringa leaf extract capsules enriched with royal jelly, as a natural remedy, merit the recommendation for inclusion in initiatives to enhance maternal and infant health.

Introduction

Pregnancy represents a period marked by profound psychological shifts, characterized by emotional variability and the oscillation between positive and negative affect commonly observed during this phase. These changes facilitate preparing for and adapting to parenthood, self-identity exploration, nurturing couple relationships, and fostering parent-infant bonding (Bjelica *et al.*, 2018). Hormonal fluctuations inherent to pregnancy can exert an influence on mood, precipitating sensations of anxiety, melancholy, ire, and stress. Furthermore, the advent of physical alterations, coupled with symptoms such as nausea, fatigue, and discomfort, can further impinge upon emotional well-being (Fahami *et al.*, 2018). The American College of Obstetricians and Gynecologists (ACOG) advocates for the assessment of stress levels during each trimester of pregnancy and postpartum periods as a preventive measure against stress-related complications during gestation. This guidance stems from the recognition that stress holds the potential to significantly impact pregnancy outcomes, manifesting in phenomena such as low birth weight, preterm delivery, and neurological impairments (Gondwe &

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Chapman, 2022).

The physical and mental health of mothers and their babies are negatively impacted by poor maternal mental health. (Mccarthy *et al*., 2021). Furthermore, heightened stress levels among pregnant women can precipitate decreased engagement with antenatal and postnatal care services, insufficient nutritional support, elevated susceptibility to pre-eclampsia, heightened likelihood of encountering breastfeeding challenges, and suboptimal parenting practices (Mcnab *et al*., 2022). A 2018 Basic Health Research study carried out in Indonesia found that moms who choose not to obtain prenatal treatment at healthcare facilities have a 2.4-fold increased risk of developing depression in comparison to those who receive the proper prenatal care. (Wurisastuti *et al*., 2018). As a result, prenatal depression is one of the most common mental health conditions during the perinatal period and places a significant cost on public health (Hu *et al*., 2019).

In 2022, one in five pregnant women worldwide will face poor mental health conditions both during and after pregnancy, according to the World Health Organization (WHO). Additionally, according to WHO data from 2019, mental health issues, particularly depression, affected 10% of pregnant women and 13% of new moms worldwide. Poor mental health can result from a variety of health issues faced by mothers, babies, or their families. In developing countries, these estimates are significantly higher, with rates reaching 15.6% during pregnancy and 19.8% postpartum. (WHO, 2022). Primary healthcare services in Indonesia are provided by 10,321 Community Health Centers (Pusat Kesehatan Masyarakat, or PUSKESMAS) dispersed throughout 7,230 districts. Still, these services are not fully utilized to meet the needs of the people living in 8,506 urban sub-districts and 76,941 villages. As a result, strengthening networks and partnerships with community health centers become essential, requiring capacity building and the creation of effective referral systems (Kemenkes, 2023).

As an outgrowth of community health centers, Integrated Health Service Posts (Indonesian: Pos Pelayanan Terpadu [POSYANDU]) are essential to improving health outcomes. These include lowering morbidity and mortality rates for mothers and children, encouraging healthy lifestyles, increasing community participation and ability in health-related activities, and advocating for family planning. Pregnant women, postpartum and nursing moms, infants, toddlers, preschoolers, school-age children, adolescents, productive age groups, and elderly are among the targeted populations of integrated health service posts. However, because their primary focus is still on physical examinations, integrated health service units in Indonesia have not yet implemented mental health assessments for these cohorts. Furthermore, the competence to perform mental health assessments at this entry level is insufficient (Kemenkes, 2022).

During pregnancy, stress increases metabolism, leading to heightened nutritional demands. Adequate and nourishing dietary intake becomes imperative to address this need (Hidayati *et al*., 2024). Government regulations mandate the provision of iron-folic acid (IFA) tablets, totaling a minimum of 90 tablets for all pregnant women throughout gestation. In specific regions, particularly those grappling with high stunting rates, the distribution of IFA is substituted with multi-micronutrient supplements, exemplified in the Banggai Regency, Central Sulawesi (Widasari *et al*., 2020). The implementation of these multi-micronutrient supplements constitutes a targeted intervention program aimed at averting low birth weight infants resulting from premature delivery and pregnancy-induced stress (Widasari *et al*., 2019). Nevertheless, this initiative still falls short of its optimal potential, as evidenced by data revealing low adherence rates among pregnant women in Banggai Regency, standing at a mere 51.6% (Thahir *et al*., 2023).

In addition to supplementation, fulfilling nutritional requirements can be accomplished by consuming foods rich in micro and macronutrients. Moringa—a nutrient-dense vegetable—contains polyphenols that reduce cortisol levels (Hadju *et al*., 2020). A study by Kumalasary (2022) illustrates that administering honey-infused moringa effectively reduces stress among pregnant women, underscoring

moringa's superiority over other vegetables. The abundant polyphenol content in moringa is advantageous in mitigating pregnancy-related stress owing to its calming properties. Furthermore, moringa contains gamma-aminobutyric acid (GABA) (Kumalasary, 2021). Non-essential amino acid GABA inhibits stress-related impulses and interacts with central nervous system receptors to support proper brain function (Roshan-Milani *et al*., 2021). Additionally, GABA can alleviate feelings of anxiety and address emotional stress-related disorders (Bagheri *et al*., 2020). The presence of GABA in moringa leaves can relieve stress in pregnant women, mainly due to psychological changes such as feelings of depression, anxiety, fear, discomfort, and others (Gilfarb & Leuner, 2022).

Apart from moringa, royal jelly is also a valuable dietary source offering significant benefits for the health of pregnant women. It contains many complex nutrients renowned for their antibacterial, antitumor, anti-allergic, and anti-inflammatory properties. Royal jelly functions as an immunomodulator and includes a wide range of bioactive substances, such as proteins, fatty acids, adenosine monophosphate, adenosine, acetylcholine, polyphenols, and hormones like estrogen, progesterone, testosterone, and prolactin. Under stressful circumstances, royal jelly can boost the antioxidant system and increase corticosterone levels. It was evidenced in a study by (Teixeira *et al*., 2017), showcasing a reduction in cortisol levels among Wistar rats following royal jelly administration. This study aims to evaluate the distinct impacts of administering moringa leaf extract capsules enriched with royal jelly on alterations in cortisol levels and stress levels in pregnant women.

Methods

This study employed a valid experimental design with a single-blind randomized controlled trial. The research took place in South Batui District and Moilong District, Banggai Regency, Central Sulawesi Province. The region is an area within the Pertamina-Medco Tomori Joint Operating Body company area. This research took time from July to October 2023. The study population comprised all pregnant women, and sample selection was based on specific inclusion criteria: pregnant women in the first and second trimesters. The exclusion criteria are pregnant women who do not have chronic diseases. The dropout criteria were not taking the capsules for more than 7 consecutive days, experiencing severe side effects from the intervention, and moving to a location unreachable by health workers. Cortisol levels and stress levels are measured through pre and post-assessments to determine the difference between the two. Measurements were carried out by taking a specimen of the mother's saliva in the morning (between 8 – 9 am) for cortisol level analysis, and they were asked to complete the Depression Anxiety Stress Scales (DASS 42) questionnaire to evaluate their stress levels. At the beginning of the study, the initial sample size comprised 66 pregnant women who were randomly allocated into two groups: the intervention group, consisting of 33 pregnant women receiving moringa leaf extract capsules enriched with royal jelly (2×500 mg), and the control group, consisting of 33 pregnant women receiving multi-micronutrient supplements (1×500 mg). However, by the end of the study, the sample size had decreased to 61 pregnant women, with 31 in the group receiving moringa leaf extract capsules enriched with royal jelly and 30 in the group receiving multi-micronutrient supplements. This reduction was attributed to factors such as miscarriage, relocation, use of other medications prescribed by doctors, and irregular medication intake.

The instruments used in this study consisted of an interview guide, explanation sheet for respondents, consent form, screening questionnaire, observation sheet for the implementation of the intervention, Depression Anxiety Stress Scales (DASS 42) questionnaire to measure stress levels, and salivary cortisol ELISA kit to measure cortisol levels. Univariate analysis was employed to determine the distribution of research subjects and calculate frequencies and percentages of each variable using the chi-squared test. Bivariate analysis in this study involved statistical tests like the independent *t*-test, Mann-Whitney test, and Wilcoxon test. All statistical analyses were performed using SPSS version 25. Ethical Considerations in this study were conducted

by the research ethics approval filed (Ethical Clearance) to the Research Ethics Committee of the Faculty of Public Health, Hasanuddin University Number 4352/UN4.14.1/TP.01.02/2023. Mothers prove this willingness to participate in research activities by signing informed consent forms after receiving explanations. Explanations of mothers in the study included the confidentiality of research results.

Results and Discussion

Table 1 presents the characteristics of participants across all groups. The average age fell within the low-risk category (20 – 35 years), with 100% in the intervention group (receiving moringa leaf extract capsules enriched with royal jelly) and 83.3% in the control group (receiving multi-micronutrient supplements). Most participants were multigravida, constituting 77.4% in the intervention group and 70% in the control group. The most common pregnancy interval fell under the low-risk category (≥ 2 years) in both the intervention group (83.9%) and the control group (93.3%). Regarding nutritional intake, the majority were still deficient, with 80.6% in the intervention group and 53.3% in the control group. Most participants had a high level of education, with 71.0% in the intervention group and 53.3% in the control group. However, the majority were unemployed, comprising 87.1% in the intervention group and 83.3% in the control group. Regarding income, the majority still had low income, with 74.2% in the intervention group and 63.3% in the control group.

Based on the findings from Table 2, it is evident that the average cortisol levels in both the MRJ and MMS groups showed a notable decrease after the intervention. Specifically, the Wilcoxon test revealed a statistically significant *p*-value of 0.030 for the MRJ group, indicating a significant reduction in cortisol levels post-intervention. Similarly, the paired sample *t*-test conducted for the MMS group demonstrated an even lower *p*-value of 0.000, underscoring a highly significant decrease in cortisol levels following the intervention. Given that both *p*-values are less than 0.05, these results collectively highlight a substantial and statistically significant decline in cortisol levels within both groups from pre- to post-intervention stages.

Based on the data presented in Table 3, it

Table 1. Distribution of Respondents' Characteristics

Characteristics	Categories	Groups			
		MRJ		MMS	
		n	%	n	%
Age	Low risk	31	100	25	83.3
	High risk	0	0	5	16.7
Parity	Primigravida	7	22.6	9	30
	Multigravida	24	77.4	21	70
Pregnancy Interval	Low risk	26	83.9	28	93.3
	High risk	5	16.1	2	6.7
Nutritional Intake	Adequate	6	19.4	14	46.7
	Inadequate	25	80.6	16	53.3
Education	Low	9	29.0	14	46.7
	High	22	71.0	16	53.3
Occupation	Unemployed	27	87.1	25	83.3
	Employed	4	12.9	5	16.7
Income	Low	23	74.2	19	63.3
	High	8	25.8	11	36.7

Source: Primary Data, 2024

Table 2. Differences in Cortisol Level Changes Before and After Intervention in The Group Receiving Moringa Leaf Extract Capsules Enriched With Royal Jelly (MRJ) and The Group Receiving Multi-Micronutrient Supplements (MMS)

Variables	Pre	Post	*p*-value
	(mean ± SD)	(mean ± SD)	
MRJ	26.61 ± 8.15	19.98 ± 14.00	0.030*
MMS	21.26 ± 7.86	10.97 ± 10.33	0.000**

Note: *Wilcoxon, **Paired Sample Test

Table 3. Stress Level Changes Before and After Intervention in The Group Receiving Moringa Leaf Extract Capsules Enriched With Royal Jelly (MRJ) and The Group Receiving Multi-Micronutrient Supplements (MMS)

Variables	Pre	Post	*p*-value
	(mean ± SD)	(mean ± SD)	
MRJ	18.68 ± 3.74	15.90 ± 5.60	0.016*
MMS	19.17 ± 3.64	16.20 ± 3.37	0.000*

Note: *Wilcoxon Test

Table 4 Differences in Cortisol Level and Stress Level Changes in The Group Receiving Moringa Leaf Extract Capsules Enriched With Royal Jelly (MRJ) and The Group Receiving Multi-Micronutrient Supplements (MMS)

Variables	MRJ (mean ± SD)	MMS (mean ± SD)	*p*-value
Cortisol level	(-6.63) ± 15.04	(-10.27) ± 13.09	0.321*
Stress level	(-2.77) ± 6.00	(-2.97) ± 2.59	0.653**

Note: *Independent Sample Test, **Mann Whitney

is observed that the average stress levels in both the MRJ and MMS groups exhibited a notable decrease following the intervention. Specifically, the Wilcoxon test yielded a statistically significant *p*-value of 0.016 for the MRJ group, indicating a significant reduction in stress levels after the intervention. Similarly, for the MMS group, the Wilcoxon test resulted in a highly significant *p*-value of 0.000, underscoring a substantial decrease in stress levels post-intervention. With *p*-values below 0.05, these results highlight a robust and statistically significant decline in stress levels within both groups from pre- to post-intervention phases.

Based on the data presented in Table 4, there are distinct observations regarding the changes between the MRJ and MMS groups. The MRJ group exhibited an average reduction in cortisol levels of -6.63 (SD = 15.04), whereas the MMS group showed a slightly higher reduction of -10.27 (SD = 13.09). Regarding stress levels, the MRJ group had an average reduction of -2.77 (SD = 6.00), compared to -2.97 (SD = 2.59) in the MMS group. Statistical analyses comparing the changes in cortisol levels between the MRJ and MMS groups yielded a *p*-value of 0.321. Similarly, for changes in stress levels, the calculated *p*-value was 0.653. These findings indicate no statistically significant difference in the changes observed in cortisol levels and stress levels between the MRJ and MMS groups following the intervention. These results suggest comparable effectiveness of the interventions in both groups in terms of cortisol and stress reduction.

Based on the research findings, the

analysis of cortisol level changes among participants before the intervention indicated distinct patterns between the MRJ and MMS groups. Initially, significantly most participants in the MRJ group exhibited abnormal cortisol levels, which subsequently normalized following the intervention. This normalization suggests that the MRJ intervention effectively regulated cortisol levels among initially stressed participants. In contrast, the MMS group showed a different trend, where several participants already had normal cortisol levels before the intervention. Despite this, some participants maintained normal cortisol levels throughout the study period. It indicates that the MMS intervention contributed to maintaining stable cortisol levels among participants without initially experiencing abnormal stress. Statistical analysis using the Wilcoxon test demonstrated a significant decrease in cortisol levels after intervention in the MRJ group (p = 0.030). Similarly, the paired sample t-test for the MMS group indicated a relevant reduction in cortisol levels before and after intervention (p = 0.000). Moreover, the data comparison indicated no significant difference in the extent of cortisol level reduction between the MRJ and MMS groups (p = 0.321). It suggests that both MRJ and MMS interventions exert a comparable effect in reducing cortisol levels, underscoring their equivalent efficacy in this regard.

This study corroborates Florensia's findings (2020), demonstrating that the combination of *Moringa oleifera* and royal jelly supplements significantly reduces cortisol levels (Florensia *et al.*, 2020). Hasni & Evie (2022) highlighted moringa's nutritional superiority over other vegetables, attributing its high content of calming polyphenols as beneficial for managing pregnancy-related stress. Furthermore, moringa contains GABA—a non-essential amino acid crucial for maintaining normal brain function by modulating stress-related impulses within the central nervous system (Hasni & Evie, 2022). Research by Hadju *et al.* (2020) indicated that moringa leaf extracts and powders, akin to honey, can enhance maternal weight, hemoglobin levels, and birth weight. Moreover, both interventions are effective in reducing stress and shielding mothers and infants from the adverse effects of oxidative stress (Hadju *et al.*, 2020).

Stress levels in pregnant women decrease, leading to a reduction in cortisol levels. High cortisol levels are closely associated with stress, and vice versa. Cortisol plays a crucial role in stress adaptation. Any type of stress significantly stimulates increased cortisol secretion, mediated by the central nervous system through the activation of the CRH-ACTH-cortisol axis. The magnitude of cortisol concentration typically corresponds to the intensity of the stressor, with greater cortisol secretion occurring in response to severe stress compared to mild stress (Russell & Lightman, 2019). This finding aligns with the study by Handayani *et al.* (2018), which examined 50 second-trimester pregnant women and identified a significant correlation between stress levels and increased cortisol hormone levels. Women experiencing stress are at a higher risk of elevated cortisol levels compared to those who are not stressed.

In Suhartatik's study (2019), moringa leaf powder was found to provide benefits similar to iron (Fe) in reducing cortisol levels during pregnancy, although these effects were not significant during breastfeeding. In contrast, Hijrawati's research (2021) revealed no significant difference in cortisol levels between the group receiving moringa extract and iron tablets and one receiving only iron tablets among preconception women. Pregnant women require balanced nutrition to meet their physiological needs. Regardless of whether their nutritional requirements are fully met, they are often provided with iron or other supplements. One such supplement is moringa leaf extract, which is rich in polyphenols and can help reduce stress and suppress cortisol production.

Cortisol plays a crucial role in the normal development of the fetus (Castro-Quintas *et al.*, 2024). During pregnancy, maternal cortisol levels increase two- to fourfold (Shriyan *et al.*, 2023). This elevation positively impacts neural development. However, excessive fetal exposure to maternal cortisol can lead to brain development disorders due to neurotoxicity. Elevated cortisol levels reach the fetus and alter the activity of the fetal HPA axis. These modifications negatively affect growth and

development through a series of complex endocrine mechanisms.

Based on the research findings, the stress levels before the intervention indicated that most respondents in the MRJ and MMS groups experienced mild stress. Following the intervention, most respondents in both groups reported normal stress levels. Initially, there were two respondents with severe stress—one in the MRJ group and one in the MMS group. After the intervention, only one respondent in the MRJ group continued to experience severe stress. This respondent was a first-time pregnant woman with a low income whose husband resided and worked outside the district. First-time pregnant women often lack experience, leading to feelings of unpreparedness and low confidence in coping with the changes during pregnancy. Additionally, low income exacerbates anxiety about meeting the needs during pregnancy, childbirth, and postpartum. Furthermore, being separated from her husband contributed to feelings of loneliness and increased sensitivity.

After the intervention, both groups experienced lower stress levels, with the MRJ group showing a *p*-value of 0.016 and the MMS group showing a *p*-value of 0.000. It indicates a significant change in each group. The data comparison revealed no significant difference in the magnitude of change between the MRJ and MMS groups, with a *p*-value of 0.653, suggesting that both interventions were equally effective in reducing stress levels. These findings demonstrate that MRJ can help reduce stress in pregnant women. Moringa leaves are rich in polyphenols and GABA (gamma-aminobutyric acid), a non-essential amino acid supporting normal brain function by inhibiting stress-related signals and interacting with receptors in the central nervous system. Additionally, GABA can reduce feelings of anxiety and help manage conditions related to emotional stress. The GABA in moringa leaves can alleviate stress in pregnant women, who often experience psychological changes such as feelings of pressure, anxiety, fear, and discomfort during pregnancy.

This study corroborates Rida Hafid's research (2023), which indicated a significant reduction in stress levels among pregnant women receiving moringa leaf extract capsules. Moringa leaves are rich in essential nutrients crucial for preventing various diseases. They also provide essential amino acids, including arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine. Furthermore, moringa leaves contain a wealth of nutrients such as protein, fats, beta-carotene (A), thiamine (B1), riboflavin (B2), niacin (B3), vitamin C, calcium, calories, carbohydrates, copper, fiber, iron, magnesium, and phosphorus. They are also known for their high levels of polyphenols and GABA, making them an exceptional and superior nutritional source than other vegetables (Hafid & Aulia, 2023). Polyphenols are recognized for their antioxidant, anti-inflammatory, and neuroprotective properties, contributing to stress reduction and mood enhancement. GABA is implicated in reducing stress both during pregnancy and postpartum. Pregnancy entails psychological changes, including feelings of depression, anxiety, fear, and discomfort. These changes may stem from alterations in GABAergic function, given that GABA serves as the principal inhibitory neurotransmitter in the brain and regulates responses to anxiety and stress. Numerous studies have suggested that GABA supplementation can effectively alleviate stress and anxiety (Kabra *et al*., 2022).

Stress represents a complex state influenced by an individual's physiological response to environmental changes (Pais & Pai, 2018). The foundational concept of stress response centers on homeostasis, which involves self-regulation to uphold stability in crucial bodily systems for each person. According to Cohen *et al*., stress occurs when environmental demands surpass an individual's adaptive capacity, resulting in psychological and biological changes, heighten susceptibility to illness (Traylor *et al*., 2020). Pregnancy represents a transitional phase marked by significant emotional changes and increased pressures. During this period, various factors come into play, including maternal psychological stressors. These stressors can have adverse effects on both fetal and neonatal development and can also impact the physical health of the mother. Furthermore,

maternal psychosocial stress has been linked to increased inflammation and disturbances in the hypothalamic-pituitary-adrenal (HPA) axis. These physiological disruptions can have significant implications for fetal neural development. Research suggests that maternal stress during pregnancy may contribute to the onset or exacerbation of neural developmental disorders through these mechanisms (Kabale, 2023).

Mild stress refers to stress that does not disturb an individual's physiological functions. It is a common experience for everyone, manifesting in forgetfulness, oversleeping, criticism, and traffic congestion. Mild stress frequently arises in daily life and serves to maintain individual vigilance. Moderate stress persists longer, typically spanning from several hours to several days. Its effects include disruptions in gastrointestinal function, such as gastritis and irregular bowel movements, muscle tension, disturbed sleep patterns, menstrual cycle irregularities, decreased concentration, and memory impairment. Examples of stressors leading to moderate stress include unresolved agreements, excessive workloads, anticipation of new job responsibilities, and prolonged absence of family members. Severe stress, on the other hand, represents chronic stress lasting from several weeks to years. Severe stress responses can have profound effects on the body. They can impact digestion, causing disruptions and discomfort. The heart rate may increase, and individuals may experience shortness of breath. Tremors and heightened feelings of anxiety and fear can also occur. In addition, severe stress can lead to confusion and panic, further exacerbating the overall psychological and physiological toll. Examples of stressors contributing to severe stress include discordant marital relationships, financial hardships, and prolonged physical illnesses.

Recent research conducted by Kumalasary (2021) suggests that administering moringa + honey (MH) to pregnant women may reduce stress and lower cortisol levels more effectively compared to regular honey (RH). This intervention resulted in a notable decrease in stress among pregnant women in the moringa honey group. According to Kusnadi (2015), moringa leaf powder contains a variety of essential nutrients and compounds, including GABA (which is 100 times more abundant than in brown rice) and polyphenols (known for their calming properties that contribute to stress reduction during pregnancy). Furthermore, capsules of moringa leaf extract enriched with royal jelly have been shown to alleviate stress, attributed to the antioxidants found in moringa leaf extract, which are beneficial in mitigating pregnancy-related stress (Ummah *et al*., 2023). These antioxidants—encompassing flavonoids, phenolic acids, and other phytochemicals—enhance the antioxidant capacity of moringa leaves, thereby lowering stress levels and promoting overall maternal and fetal health, as supported by the findings of this study (Zarenejad *et al*., 2020; Hamed *et al*., 2022).

Conclusion

Significant differences in cortisol and stress level variations exist between the group receiving moringa leaf extract capsules enriched with royal jelly and the group receiving multi-micronutrient supplements after the intervention. However, the magnitude of change between the groups is not different. It can be inferred that moringa leaf extract capsules enriched with royal jelly and multi-micronutrient supplements yield nearly identical results in this study. For governmental agencies, it is expected that efforts will be carried out to conduct routine screening for pregnant women to detect mental health issues during pregnancy and postpartum. Interventions for pregnant women experiencing stress or aimed at preventing stress could involve recommending natural products such as moringa leaf extract capsules enriched with royal jelly, thus supporting programs to enhance maternal and infant health.

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References

Bagheri, M., Saboory, E., Nejatbakhsh, M., Roshan-Milani, S., Derafshpour, L., Sayyadi, H., & Rasmi, Y., 2020. Prenatal Stress

Increased Γ2 GABAA Receptor Subunit Gene Expression in Hippocampus and Potentiated Pentylenetetrazol-Induced Seizure in Rats. *Iranian Journal of Basic Medical Sciences*, 23(6), pp.724–29.

Bjelica, A., Nenad, C., Aleksandra, T-P., & Ljiljana, M-S., 2018. The Phenomenon of Pregnancy-a Psychological View. *Ginekologia Polska*, 89(2), pp.102–6.

Castro-Quintas, Á., Eixarch, E., Martin-Gonzalez., N.S., Daura-Corral, M., Marques-Feixa, L., Palma-Gudiel, H., Rocavert-Barranco, M., Miguel-Valero, A., Monteserín-García, J.L., Fuente-Tomás, L.D., Crispi, F., Arias, B., García-Portilla, M.P., & Fañanás, L., 2024. Diurnal Cortisol throughout Pregnancy and Its Association with Maternal Depressive Symptoms and Birth Outcomes. *Psychoneuroendocrinology*, 161, pp.106930.

Fahami, F., Maryam, A-A., & Asghar, A., 2018. The Relationship between Psychological Wellbeing and Body Image in Pregnant Women. *Iranian Journal of Nursing and Midwifery Research*, 23(3), pp.167.

Florensia., Hadju, V., Muis, M., Citrakesumasari., Sirajuddin, S., & Zulkifli, A., 2020. The Effect of Moringa Oleifera Leaves Plus Royal Jelly Supplement on Cortisol Hormone and Stress Levels on Anemia of Pregnant Women in Takalar Regency. *Journal La Lifesci*, 1(3), pp.30–36.

Gilfarb, R.A., & Leuner, B., 2022. GABA System Modifications During Periods of Hormonal Flux Across the Female Lifespan. *Frontiers in Behavioral Neuroscience*, 16.

Gondwe, T., & Chapman, D.A., 2022. Measuring Psychosocial Stress during Pregnancy: A Multiple-Group Confirmatory Factor Analysis across Race/Ethnicity among Medicaid-Covered Pregnant Women in the United States. *Journal of Psychosomatic Obstetrics & Gynecology*, 43(3), pp.85–91.

Hadju, V., Muhammad, D., Sadapotto, A., Putranto, A., Marks, G., & Arundhana, A.I., 2020. Effects of Moringa Oleifera Leaves and Honey Supplementation during Pregnancy on Mothers and Newborns: A Review of the Current Evidence. *Open Access Macedonian Journal of Medical Sciences*, 8, pp.208–14.

Hadju, V., Geoffrey, M., Marks, G.C., Nontji, W., Yusnidar., Hasni., Hafid, R.A., Misrawati., & Arundhana, A.I., 2020. Moringa Oleifera Leaf Powder Supplementation Improved the Maternal Health and Birth Weight: A Randomised Controlled Trial in Pregnant Women. *Australian Journal of Herbal and Naturopathic Medicine*, 32(3).

Hafid, R., Sarinah, B.K., & Ulfa, A., 2023. The Influence of Giving Moring Capsules on Stress Levels In Pregnant Women. *International Journal of Public Health Excellence (IJPHE)*, 3(1), pp.154–58.

Hamed, H.S., Amen, R.M., Elelemi, A.H., Mahboub, H.H., Elabd, H., Abdelfattah, A.M., Moniem, H.A., El-Beltagy, M.A., Alkafafy, M., Yassin, E.M.M., & Ismail, A.K., 2022. Effect of Dietary Moringa Oleifera Leaves Nanoparticles on Growth Performance, Physiological, Immunological Responses, and Liver Antioxidant Biomarkers in Nile Tilapia (Oreochromis Niloticus) against Zinc Oxide Nanoparticles Toxicity. *Fishes*, 7(6), pp.360.

Hasni., & Evie, S., 2018. Efektivitas Pemberian Kapsul Tepung Daun Kelor Terhadap Stres Ibu Primigravida. *Poltekita, Jurnal Ilmu Kesehatan*, 15(4).

Hidayati, E., Rauf, S., Hatta, M., Lisal, S.T., Wibisono, J.J., Syamsuddin, S., Chalid, M.T., Saleh, A., Zainuddin, A.A., Hamidah., Fatimah., Hapsah., Permatasari, T.A.E., & Lusida, N., 2024. Interactive Pregnancy Education on Stress, Cortisol, and Epinephrine Level in Primigravida of Trimester III Pregnant: A Quasi-Experimental. *Annals of Medicine & Surgery*, 86(3), pp.1386–95.

Hu, Y., Wang, Y., Wen, S., Guo, X., Xu, L., Chen, B., Chen, P., Xu, X., & Wang, Y., 2019. Association between Social and Family Support and Antenatal Depression: A Hospital-Based Study in Chengdu, China. *BMC Pregnancy and Childbirth*, 19(1), pp.420.

Kabale., Bekele, G.G., Roga, E.Y., Gonfa, D.N., & Yami, A.T., 2023. Perceived Stress and Associated Factors Among Pregnant Women in Western Ethiopia: Community Based Cross-Sectional Study, pp.1–8.

Kabra, A., Garg, R., Brimson, J., Živković, J., Almawash, S., Ayaz, M., Nawaz, A., Hassan, S.S.U., & Bungau, S., 2022. Mechanistic Insights into the Role of Plant Polyphenols and Their Nano-Formulations in the Management of Depression. *Frontiers in Pharmacology*, 13(11).

Kemenkes R.I., 2022. *Laporan Akuntabilitas Kinerja Instansi Pemerintah Tahun 2022 - LAKIP-2022*. Dinas Komunikasi Dan Informatika.

———. 2023. *Panduan Pengelolaan Posyandu Bidan Kesehatan*.

Kumalasary., 2021. The Effect of Giving Moringa Honey on Stress and Cortisol Levels in Pregnant Women in Maros Regency. *Turkish Journal of …* 12(14), pp.2669–76.

Mccarthy, M., Catherine, H., & Karen, M.S., 2021. Women ' s Experiences and Perceptions of Anxiety and Stress during the Perinatal Period : A Systematic Review and Qualitative Evidence Synthesis. *BMC Pregnancy and Childbirth*, 2021, pp.1–12.

Mcnab, S.E., Dryer, S.L., Fitzgerald, L., Gomez, P., Bhatti, A.M., Kenyi, E., Somji, A., Khadka, N., & Stalls, S., 2022. The Silent Burden : A Landscape Analysis of Common Perinatal Mental Disorders in Low - and Middle - Income Countries. *BMC Pregnancy and Childbirth*, 2022, pp.1–14.

Pais, M., & Murlidhar, V.P., 2018. Stress among Pregnant Women: A Systematic Review. *Journal of Clinical and Diagnostic Research*, 12(5), pp.1–4.

Roshan-Milani, S., Seyyedabadi, B., Saboory, E., Parsamanesh, N., & Mehranfard, N., 2021. Prenatal Stress and Increased Susceptibility to Anxiety-like Behaviors: Role of Neuroinflammation and Balance between GABAergic and Glutamatergic Transmission. *Stress*, 24(5), pp.481–95.

Russell, G., & Stafford, L., 2019. The Human Stress Response. *Nature Reviews Endocrinology*, 15(9), pp.525–34.

Shriyan, P., Paulomi, S., Onno, C.P., Van, S., & Giridhara, R.B., 2023. Articles Association of High Cortisol Levels in Pregnancy and Altered Fetal Growth . Results from the MAASTHI , a Prospective Cohort Study, Bengaluru. *The Lancet Regional Health - Southeast Asia*, 14, pp.100196.

Teixeira, R.R., De Souza, A.V., Peixoto, L.G., Machado, H.L., Caixeta, D.C., Vilela, D.D., Baptista, N.B., Franci, C.R., & Espindola, F.S., 2017. Royal Jelly Decreases Corticosterone Levels and Improves the Brain Antioxidant System in Restraint and Cold Stressed Rats. *Neuroscience Letters*, 655, pp.179–85.

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Relation between Nose Scale and Sleep Disorder Breathing Among Spice Factory Workers in Semarang

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Abstract

Sleep-disorder breathing covers a broad spectrum of breathing-related sleep disorders. Nasal obstruction has been identified as a modifiable risk of sleep-disordered breathing and is a common complaint in sleep-disordered breathing patients. The nose scale is a simple standard instrument that can estimate those at risk of developing sleep-disordered breathing. To determine the relationship between nose scale and sleep disorder breathing in spice factory workers in Semarang. Analytical observational research with a cross-sectional design involving 530 spice factory workers in Semarang. The independent variable of the study was the risk of developing sleep-disordered breathing based on the body mass index value. The dependent variable of the research is the Nose Scale score. Analysis was by the Independent T-test, Mann- Whitney, Chi-square, and Fisher exact tests. Results are significant if p<0.05. Complaints of a blocked nose (6% vs 3%), blocked nose (8% vs 7%), difficulty breathing (4% vs 3%), difficulty sleeping due to nasal problems (5% vs 3%), and difficulty breathing air (6 % vs 4%) was more common in the high risk sleep disorder breathing group (BMI >25kg/m2) than in the low risk sleep disorder breathing group (BMI <25kg/m2), respectively. The high risk sleep disorder breathing group (BMI >25kg/m2) also reported a higher mean Nose Scale score than the low risk sleep disorder breathing group (BMI <25kg/m2), namely 5.81 vs 3.95. Individuals with high risk sleep disorder breathing (BMI >25kg/m2) have higher complaints of nasal problems than individuals with low risk sleep disorder breathing (BMI <25kg/m2).

Introduction

Sleep disorder breathing encompasses a broad spectrum of respiratory-related sleep disorders, including obstructive sleep apnea (OSA), central sleep apnea, sleep-related hypoventilation, and sleep-related hypoxemia. The prevalence of sleep-disorder breathing is estimated between 6.5%-9% in women and between 17%-31% in men. Several predisposing factors for the condition include obesity, genetic or congenital, nasal/pharyngeal abnormalities, and structural abnormalities of the upper airway (Foldvary-Schaefer *et al.*, 2017).

The diagnosis of sleep disorder breathing is established by conducting anamnesis regarding sleep patterns, physical examination, radiological examination, and special supporting examinations. Nasal obstruction has been identified as a modifiable risk of sleep-disordered breathing and is a common complaint in patients with sleep-disordered breathing. Several studies have reported that there is a subpopulation of patients with nasal obstruction who also experience undiagnosed sleep-disordered breathing (Sawa *et al.*, 2020).

A simple standard instrument, the nose scale, assesses knowledge of snoring status, and clinical examination, can predict individuals at risk for sleep-disordered breathing and refer patients for further management. This literature

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review discusses the relationship between NOSE scores and sleep-disordered breathing. This study aims to determine the relationship between nose scale and breathing sleep disorder in spice factory workers in Semarang.

Method

This analytical observational study used a cross-sectional design involving 530 spice factory workers in Semarang. The inclusion criteria were 1) age 18-55 years and 2) willingness to be a research subject. The exclusion criteria of the study were 1) a history of head trauma and 2) suffering from nasal polyps or tumors. The independent variable was the risk of sleep-disordered breathing based on body mass index values. The dependent variable of the study was the Nose Scale score. The analysis used the Independent T-test, Mann-Whitney, Chi-square, and Fisher exact tests. Significant results if $p < 0.05$.

Results

Evaluation of nose scale and sleep disorder breathing scores was conducted on 600 spice factory workers around Semarang City. As many as 550 workers met the inclusion criteria, and 20 subjects had exclusion criteria. So, a total of 530 workers became subjects in this study. Subjects were grouped regarding the risk of sleep disorder breathing by referring to BMI scores. As many as 258 workers were included in the low-risk sleep disorder breathing group (BMI <25kg/m^2), and 272 workers were in the high-risk sleep disorder breathing group (BMI>25kg/m^2).

Subjects in the low-risk sleep disorder breathing group (BMI <25kg/m^2) had an average age of 35.91 years with a standard deviation of 12.12 years, a median value of 30 years with the youngest age of 18 years, and the oldest age of 55 years. Meanwhile, the high-risk sleep disorder breathing group (BMI>25kg/m^2) had an average of 40.17 years with a standard deviation of 11.10 years, a median value of 42 years, with the youngest age of 19 years and the oldest age of 55 years. There was a significant difference in the distribution of age between the study groups ($p<0.001$), where older ages were found in the high-risk sleep disorder breathing group (BMI>25kg/m^2). Subjects in the low-risk sleep disorder breathing group (BMI <25kg/m^2), were 234 (91%) male and 24 (9%) female. In the high-risk sleep disorder breathing group (BMI >25kg/m^2), there were 255 male subjects (94%) and 17 female subjects (6%). There was no significant difference in gender distribution between study groups ($p=0.189$).

Regarding the history of hypertension, in the low-risk sleep disorder breathing group (BMI <25kg/m^2), there were 12 subjects (5%) who had a history of hypertension. In the high-

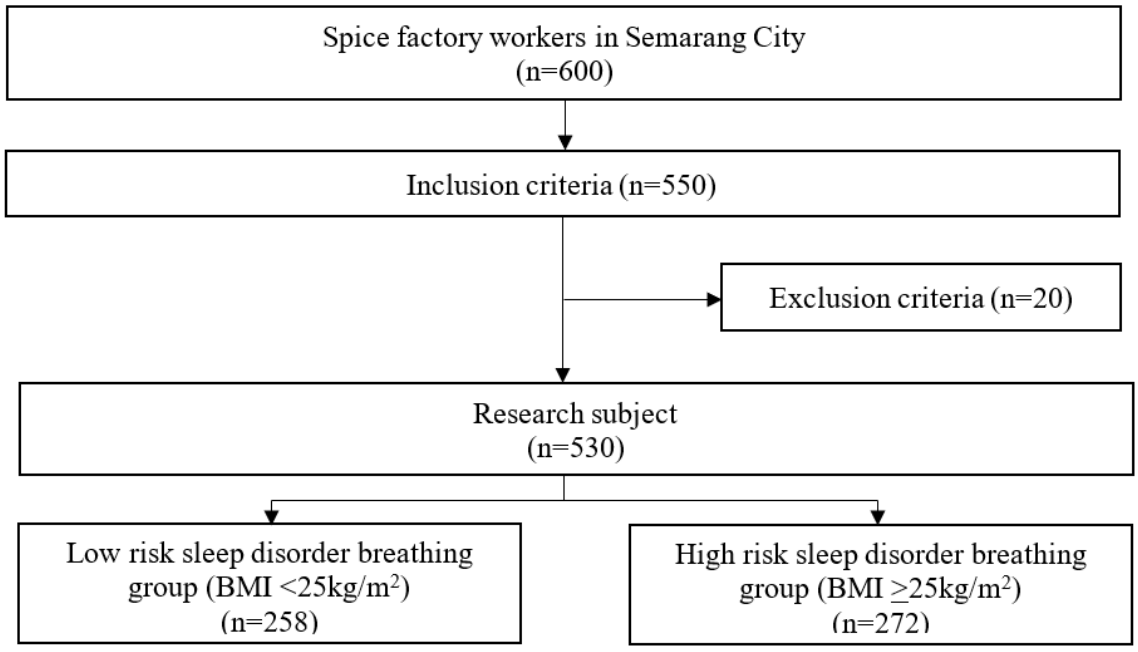

Table 1. Demographics of Research Subjects

Variables	*Low risk sleep disorder breathing* (BMI <25kg/m²)		*High risk sleep disorder breathing* (BMI >25kg/m²)		*p*
	n (%)	Mean ± SD; Median (min-max)	n (%)	Mean ± SD; Median (min-max)	
Age	-	35.91 ± 12.12; 30 (18-55)	-	40.17 ± 11.10; 42 (19-55)	**<0.001**¶
Gender Male Female	 234 (91) 24 (9)	-	 255 (94) 17 (6)	-	0.189£
Hypertension history Yes No	 12 (5) 246 (95)	-	 39 (14) 233 (86)	-	**<0.001**£
History of diabetes mellitus Yes No	 7 (3) 251 (97)	-	 16 (6) 256 (94)	-	0.073£

¶Mann Whitney U; £Chi-square; significance p<0.05

Table 2. Nose Scale Score and Risk of Sleep Disorder Breathing Based on Body Mass Index

Variables	*Low Risk Sleep Disorder Breathing* (BMI <25kg/m²)		*High Risk Sleep Disorder Breathing* (BMI >25kg/m²)		*p*
	n (%)	Mean ± SD; Median (min-max)	n (%)	Mean ± SD; Median (min-max)	
Weight	-	60.30 ± 7.06; 60.35 (37-81)	-	76.67 ± 10.30; 74.75 (55-125)	
Height	-	165.40 ± 6.74; 165 (144-184)	-	164.43 ± 6.35; 164.5 (143-188)	0.087‡
Body mass index	-	22.03 ± 2.13; 22.45 (15.5-24)	-	28.32 ± 3.23; 27.3 (25-44.8)	
Complaints of stuffy nose Yes No	 8 (3) 250 (97)	-	 17 (6) 255 (94)	-	0.087£
Complaints of blocked nose Yes No	 17 (7) 241 (93)	-	 21 (8) 251 (92)	-	0.614£
Complaints of difficulty breathing Yes No	 8 (3) 250 (97)	-	 11 (4) 261 (96)	-	0.559£

Variables	*Low Risk Sleep Disorder Breathing* (BMI <25kg/m²)		*High Risk Sleep Disorder Breathing* (BMI >25kg/m²)		*p*
	n (%)	Mean ± SD; Median (min-max)	n (%)	Mean ± SD; Median (min-max)	
Difficulty sleeping due to nasal problems		-		-	0.322£
Yes	8 (3)		13 (5)		
No	250 (97)		259 (95)		
Complaints of difficulty breathing air		-		-	0.214£
Yes	10 (4)		17 (6)		
No	248 (96)		255 (94)		
NOSE SCALE Score		3.95 ± 15.01; 0 (0-100)		5.81 ± 19.59; 0 (0-100)	0.486ᶠ
No blockage	233 (90)		242 (89)		
Mild obstruction	14 (5)		10 (4)		
Moderate blockage	4 (2)		8 (3)		
Heavy blockage	2 (1)		2 (1)		
Very heavy blockage	5 (2)		10 (4)		

¶Mann Whitney U;‡Independent T-test; £Chi-square;ᶠFischer exact; significance p<0.05

risk sleep disorder breathing group (BMI>25kg/m²), there were 39 subjects (14%) who had a history of hypertension. There was a significant difference in the distribution of hypertension history between study groups (p<0.001). Where the incidence of hypertension was more common in the high-risk sleep disorder breathing group (BMI>25kg/m²). Regarding the history of diabetes mellitus, in the low-risk sleep disorder breathing group (BMI <25kg/m²), there were 7 subjects (3%) who had a history of diabetes mellitus. In the high-risk sleep disorder breathing group (BMI>25kg/m²), there were 16 subjects (6%) who had a history of diabetes mellitus. There was no significant difference in the distribution of diabetes mellitus history between study groups (p=0.073).

Regarding body weight, the low-risk sleep disorder breathing group (BMI <25kg/m²) had an average of 60.3 kg with a standard deviation of 7.06 kg, a median value of 60.35 kg with the smallest body weight of 37 kg, and the largest body weight of 81 kg. The high-risk sleep disorder breathing group (BMI>25kg/m²) had an average of 76.67 kg with a standard deviation of 10.3 kg, a median value of 74.75 kg with the lowest body weight of 55 kg, and the highest body weight of 125 kg. There was a significant difference in the distribution of body weight between study groups (p<0.001), where greater body weight was found in the high-risk sleep disorder breathing group (BMI>25kg/m²).

Regarding height, the low-risk sleep disorder breathing group (BMI <25kg/m²) had an average of 165.4 cm with a standard deviation of 6.74 cm, a median value of 165 cm with the lowest height of 144 cm, and the highest height of 184 cm. The high-risk sleep disorder breathing group (BMI>25kg/m²) had an average of 164.43 cm with a standard deviation of 6.35 cm, a median value of 164.5 cm with the lowest height of 143 cm, and the highest height of 188 cm. There was no significant difference in the height distribution between the study groups (p=0.087).

Regarding body mass index, the low-risk sleep disorder breathing group (BMI <25kg/m²) had an average of 22.03 kg/m² with a standard deviation of 2.13 kg/m², a median value of 22.45 kg/m² with the lowest body mass index of 15.5 kg/m² and the highest body mass index of 24 kg/m². The high-risk sleep disorder breathing group (BMI>25kg/m²) had an average of 28.32 kg/m² with a standard

deviation of 3.23 kg/m^2, a median value of 27.3 kg/m^2 with the lowest body mass index of 25 kg/m^2 and the highest body mass index of 44.8 kg/m^2. There was a significant difference in the distribution of body mass index between study groups (p<0.001), where a higher body mass index was found in the high-risk sleep disorder breathing group (BMI>25kg/m^2).

Regarding stuffy noses, in the low-risk sleep disorder breathing group (BMI <25kg/m^2), there were 8 subjects (3%) complaining of stuffy noses. In the high-risk sleep disorder breathing group (BMI >25kg/m^2), 17 subjects (6%) complained of stuffy nose. There was no significant difference in the distribution of stuffy noses between study groups (p=0.087). Regarding nasal congestion, in the low-risk sleep disorder breathing group (BMI <25kg/m^2), there were 17 subjects (7%) complaining of nasal congestion. In the high-risk sleep disorder breathing group (BMI >25kg/m^2), 21 subjects (8%) complained of nasal congestion. There was no significant difference in the distribution of nasal congestion complaints between study groups (p=0.614).

Regarding difficulty breathing in the low-risk sleep disorder breathing group (BMI <25kg/m^2), 8 subjects (3%) complained of difficulty breathing. In the high-risk sleep disorder breathing group (BMI>25kg/m^2), 11 subjects (4%) complained of difficulty breathing. There was no significant difference in the distribution of complaints of difficulty breathing between research groups (p=0.557). Regarding difficulty sleeping, in the low-risk sleep disorder breathing group (BMI <25kg/m^2), 8 subjects (3%) complained of difficulty sleeping. In the high-risk sleep disorder breathing group (BMI >25kg/m^2), 13 subjects (5%) complained of difficulty sleeping. There was no significant difference in the distribution of complaints of difficulty sleeping due to nasal problems between study groups (p=0.322). Regarding difficulty in breathing, in the low-risk sleep disorder breathing group (BMI <25kg/m2), 10 subjects (4%) complained of difficulty in breathing. In the high-risk sleep disorder breathing group (BMI >25kg/m2), 17 subjects (6%) complained of difficulty in breathing. There was no significant difference in the distribution of complaints of difficulty in breathing between research groups (p=0.214).

Regarding the NOSE SCALE score, the low-risk sleep disorder breathing group (BMI <25kg/m^2) obtained an average score of 3.95 with a standard deviation of 15.01, a median value of 0 with the lowest score of 0, and the highest score of 100. There were 233 subjects (90%) who did not have nasal obstruction, 14 subjects (5%) had mild nasal obstruction, 4 subjects (2%) had moderate nasal obstruction, 2 subjects (1%) had severe nasal obstruction and 5 subjects (2%) had very severe nasal obstruction. In the high-risk sleep disorder breathing group (BMI >25kg/m^2), the average score was 5.81 with a standard deviation of 19.59, a median value of 0 with the lowest score of 0 and the highest score of 100. There were 242 subjects (89%) who had no nasal obstruction, 10 subjects (4%) had mild nasal obstruction, 8 subjects (3%) had moderate nasal obstruction, 2 subjects (1%) had severe nasal obstruction and 10 subjects (4%) had very severe nasal obstruction. There was no significant difference in the NOSE SCALE score between study groups (p=0.486).

Significantly older age was found in the high-risk sleep disorder breathing group (BMI >25kg/m^2) with an average of 40 years compared to the low-risk sleep disorder breathing group (BMI <25kg/m^2) with an average of 35 years. A history of hypertension was also significantly more common in the high-risk sleep disorder breathing group (BMI >25kg/m^2). Khabazkhoob M *et al*., who assessed the prevalence of overweight and obesity in the middle-aged population, found that individuals aged > 54 years tended to have a BMI > 25kg/m2 compared to individuals aged 40-44 years with a significant difference (p <0.001). 3 As age increases, hormonal changes, decreased physical activity, and particular cultural beliefs may contribute to the incidence of overweight and obesity. Punjabi N *et al*., who evaluated the prevalence of hypertension in patients with sleep-disordered breathing (SDB), found that the prevalence of hypertension and SDB (AHI3a ≥ 5 events/hour) was high, with estimates of 53.8% and 82.8%, respectively. In men without HIV, SDB was associated with the risk of hypertension (OR: 2.93; 95% CI: 1.46 to 5.86) (Feng *et al*., 2023; Punjabi *et al*., 2023).

OSA and resistant hypertension share some very similar risk factors, such as obesity and metabolic syndrome, and indeed, a high prevalence of OSA has been reported in patients with resistant hypertension, estimated to range from 64% to 83%. OSA is now recognized as the most common cause of secondary hypertension. An association between OSA and hypertension has been demonstrated in wide cross-sectional studies as well as longitudinal ones in the general population. Although some of the association is explained by established risk factors, such as obesity, there is substantial data to suggest that the role of OSA in resistant hypertension is independent of other confounding factors. In the Wisconsin Sleep Cohort study, a significant dose-response relationship was observed between baseline sleep-disordered breathing and hypertension 4 years later, independent of confounding factors. Subjects with an AHI of 0.1 to 4.9 events per hour at baseline had a 1.4-fold increased odds of developing hypertension, whereas subjects with an AHI of 5.0 to 14.9 events per hour showed an almost 3-fold increased odds of hypertension compared with subjects with 0 events per hour. Similarly, another large prospective cohort study with a median follow-up period of 12.2 years showed that the presence of OSA was associated with an increased risk of incident hypertension. These data provide vital evidence that OSA is an independent risk factor for hypertension and that the severity of hypertension increases with increasing severity of OSA (Wang, 2014).

Several mechanisms have been proposed to play a significant role in the development of resistant hypertension in OSA. OSA causes chronic intermittent hypoxia, which induces an imbalance of parasympathetic and sympathetic nerves, resulting in sympathetic activation, activation of the renin-angiotensin-aldosterone system, inflammation, and increased oxidative stress, increased endothelin release with vasoconstriction and endothelial dysfunction (Parati *et al.,* 2013). Patients with OSA commonly have a narrow pharynx due to neck fat deposits, micrognathia, tonsillar hypertrophy, or pharyngeal edema, which reduces the pharyngeal lumen. At the onset of sleep, the pharyngeal dilator muscles relax, causing partial or complete collapse of the pharynx, leading to obstructive hypopneas and apneas. Repeated cessation of airflow during sleep leads to repeated cycles of hypoxemia and hypercapnia, which stimulate the cardiac parasympathetic and sympathetic nervous systems. The final response depends on the balance between the parasympathetic and sympathetic nervous systems and airflow. Sympathetic activation is one of the key mechanisms involved in the genesis of resistant hypertension in OSA. Recurrent apnea episodes increase sympathetic activity during sleep and wakefulness through activation of the chemo-reflex, which plays a key role in regulating ventilation and circulatory responses to changes in arterial oxygen saturation and carbon dioxide. An activated renin-angiotensin-aldosterone system is another vital pathomechanism linking OSA to resistant hypertension. Previous studies have shown that OSA subjects have increased plasma angiotensin II and aldosterone levels compared with controls. CPAP therapy significantly reduced blood pressure, as well as plasma renin and angiotensin II levels. The decrease in blood pressure correlated with lower plasma renin and angiotensin II levels. Treatment with angiotensin II receptor blockers abolished the increase in blood pressure induced by intermittent hypoxia. These data suggest that OSA mediates hypertension at least in part through increased angiotensin II production (Wang, 2014).

Intermittent hypoxia and post-apneic reperfusion lead to the formation of free oxygen radicals, increase oxidative stress, and activate the inflammatory cascade. Reactive oxygen species and inflammation reduce nitric oxide levels and impair endothelium-dependent vasodilation, which may contribute to increased blood pressure independently of sympathetic activation. Studies have shown impaired endothelium-dependent vasodilation and decreased nitric oxide levels in OSA subjects, which improved after CPAP therapy.[6] Complaints of nasal obstruction (6% vs 3%), nasal congestion (8% vs 7%), difficulty breathing (4% vs 3%), difficulty sleeping due to nasal problems (5% vs 3%), and difficulty breathing air (6% vs 4%) were more common in the high-risk sleep disorder breathing group

(BMI >25kg/m^2) compared to the low-risk sleep disorder breathing group (BMI <25kg/m^2), respectively. The high-risk sleep disorder breathing group (BMI >25kg/m^2) also reported a higher mean NOSE SCALE score than the low-risk sleep disorder breathing group (BMI <25kg/m^2), which was 5.81 vs 3.95. It indicates that individuals with high-risk sleep disorder breathing (BMI >25kg/m^2) have higher nasal problems than individuals with low-risk sleep disorder breathing (BMI <25kg/m^2).

Magliulo G *et al*., who evaluated the olfactory function in patients with OSA found that olfactory dysfunction occurred in 22 (36.6%) patients in the study group, hyposmia occurred in 19 patients (86.4%) and anosmia in 3 patients (13.6%). The average TDI score in the study group was 30. A strong correlation was found between olfactory dysfunction and the severity of OSA as measured using the AHI. Patients with OSA appear to have a high incidence of olfactory dysfunction. The degree of olfactory dysfunction seemed to be related to the severity of the disease. However, other factors, such as nasal obstruction and reduced mucociliary clearance, play a role in the etiology of this condition (Magliulo *et al.,*2018). Another study conducted by Shin DH *et al*., who assessed the effect of sleep disorder breathing on olfactory function based on the Apnea-Hypopnea Index (AHI) scores obtained similar results that AHI was related to the odor threshold score (odor), and the average SaO2 was related to the odor discrimination score (odor). Hypoxia and low nasal airflow caused by OSAS also affect olfactory function. In addition, low mean oxygen is a major risk factor in determining olfactory function (Shin *et al*., 2017). Kaya KS *et al*., found an increase in the olfactory threshold in OSA patients who received PAP treatment thought to be able to improve olfactory dysfunction (Kaya *et al*., 2020). Siegel JK *et al*., who evaluated sleep disorder breathing against the incidence of odor identification disorders in the elderly, found that 29% of elderly adults in the US reported symptoms of sleep disorder breathing (apnea or snoring at night). Based on this number, only 32% were diagnosed with sleep apnea. Older adults with SDB (those who reported symptoms or had been diagnosed with sleep apnea) were significantly more likely to have impaired odor identification (odds ratio 2.13, 95% confidence interval 1.19–3.83, p = 0.012) in analyses that accounted for age, sex, race/ethnicity, education, cognition, comorbidities (including depression), and body mass index (Siegel *et al*., 2021).

Assessment of activated brain areas in OSA patients during the olfactory test was conducted by Invitto S *et al*., who found that OSA patients showed faster N1 latency and greater amplitude. The same trend was found in the Late Positive Component (LPC), where OSA showed decreased latency and increased amplitude during stimulation using rose flowers, in the right inferior frontal cortex and faster latency in the left centroparietal cortex. The OERP results showed a decrease in the endogenous component. These results may be a consequence of the exogenous perception difficulties highlighted in the N1 component. Increased arousal could also be associated with the respiratory activity during the olfactory task (Invitto *et al*., 2019).

In OSA patients, olfactory dysfunction is associated with various mechanisms. Several studies have reported cognitive deficits in OSA patients, including memory, attention, and sensory and olfactory functions. Decreased (poor) neurocognitive performance found to be associated with olfactory dysfunction through impaired olfactory discrimination and decreased threshold. On the other hand, decreased nasal airflow, intermittent hypoxia, chronic irritation, and upper airway mucosal damage may be additional causes associated with the mechanisms responsible for olfactory dysfunction in OSA (Kaya *et al*., 2020).

The mechanisms that affect olfactory function in OSA may be related to many factors, including oxygen saturation, disease duration, and degree of upper airway inflammation. Several studies have reported that airway inflammation in OSA patients experiencing intermittent nocturnal hypoxia increases pro-inflammatory markers such as interleukin 8 and TNF-α. Positive airway pressure (PAP) administration may contribute to olfactory function by reducing mucosal inflammation in OSA. The mechanisms that affect olfactory function in OSA may be related to many factors,

including oxygen saturation, disease duration, and degree of upper airway inflammation. Several studies have reported that airway inflammation in OSA patients experiencing intermittent nocturnal hypoxia increases pro-inflammatory markers such as interleukin 8 and TNF-α. Positive airway pressure (PAP) administration may contribute to olfactory function by reducing mucosal inflammation in OSA (Wang *et al*., 2015).

Clinical studies have shown that PAP treatment contributes to respiratory and cognitive performance in OSA (Xu *et al.,* 2017). PAP administration can improve olfactory dysfunction in OSA patients through various interactions (Boerner *et al.,* 2017). The cholinergic neurotransmitter system is involved in many cognitive functions and is sensitive to cerebral hypoxemia. PAP, by normalizing neurotransmitter synthesis can improve cognitive dysfunction in OSA patients. Increased oxygen saturation positively affect neurocognitive functions, including olfaction (Salihoğlu *et al*., 2014). Inflammation of the nasal mucosa with altered nasal mucociliary clearance is a common cause of olfactory neuroepithelial dysfunction. Typically, poor mucociliary clearance prevents the interaction between odorant molecules contained in inspired air and the olfactory epithelium. Most patients with OSAS are known to have decreased mucosal clearance even in the absence of overt sinonasal inflammatory disease. A recent clinical study of nasal mucociliary clearance in patients with obstructive sleep apnea syndrome showed that the nasal mucociliary system showed significant impairment in patients with severe OSAS (Deniz *et al*., 2014; Cai *et al*., 2020).

The underlying mechanism of the correlation between OSAS and olfactory function is thought to be that intermittent hypoxia and sleep fragmentation can cause neuronal loss in the hippocampus and prefrontal cortex, areas closely related to memory and executive function (Salihoğlu *et al.,* 2014; Peng *et al*., 2018). The impact of cognitive decline on smell can lead to decreased discrimination and identification functions. It is known that OSA is characterized by cessation of breathing (apnea) or reduced airflow (hypopnea) during sleep. Increased AHI is associated with decreased nasal airflow. Changes in nasal airflow affect olfactory function, especially the odor threshold. Therefore, the negative correlation between AHI and odor threshold is thought to indicate changes in nasal airflow in OSA patients (Fu *et al*., 2015).

Conclussions

Individuals with high-risk sleep disorder breathing (BMI >25kg/m^2) have higher nasal problems (complaints of nasal obstruction, nasal congestion, difficulty breathing, difficulty sleeping due to nasal problems, and difficulty breathing air) compared to individuals with low-risk sleep disorder breathing (BMI <25kg/m^2).

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References

Boerner, B., Tini, G.M., Fachinger, P., Graber, S.M., & Irani, S., 2017. Significant Improvement of Olfactory Performance in Sleep Apnea Patients After Three Months of Nasal CPAP Therapy – Observational Study and Randomized Trial. *PLoS One*, 12(2), pp.e0171087.

Cai, Y., Goldberg, A.N., & Chang, J.L., 2020. The Nose and Nasal Breathing in Sleep Apnea. *Otolaryngologic Clinics of North America*, *53*(3), pp.385-395.

Deniz, M., Gultekin, E., Ciftci, Z., Alp, R., Ozdemir, D.N., Isik, A., & Demirel, O.B., 2014. Nasal Mucociliary Clearance in Obstructive Sleep Apnea Syndrome Patients. *Am J Rhinol Allergy*, 28(5), pp.e178–80.

Feng, X., Zhu, J., Hua, Z., Shi, Q., Zhou, J., & Luo, P., 2023. The Prevalence and Determinant of Overweight and Obesity Among Residents Aged 40–69 Years in High-Risk Regions for Upper Gastrointestinal Cancer in Southeast China. *Sci Rep*, 13(1), pp.8172.

Foldvary-Schaefer, N.R., & Waters, T.E., 2017. Sleep-Disordered Breathing. *Continuum Lifelong Learning in* Neurology, 23(4), pp.1093–116.

Fu, D., Pinto, J.M., Wang, L., Chen, G., Zhan, X., &

Wei, Y., 2015. The Effect of Nasal Structure on Olfactory Function in Patients with OSA. *European Archives of Oto-Rhino-*Laryngology, 272(2), pp.357–62.

Invitto, S., Calcagnì, A., Piraino, G., Ciccarese, V., Balconi, M., De Tommaso, M., & Toraldo, D.M., 2019. Obstructive Sleep Apnea Syndrome and Olfactory Perception: An OERP Study. *Respir Physiol Neurobiol*, 259, pp.37–44.

Kaya, K.S., Akpınar, M., Turk, B., Seyhun, N., Cankaya, M., & Coskun, B.U., 2020. Olfactory Function in Patients with Obstructive Sleep Apnea Using Positive Airway Pressure. *Ear Nose Throat J.*, 99(4), pp.239–44.

Khabazkhoob, M., Emamian, M.H., Hashemi, H., Shariati, M., & Fotouhi, A., 2017. Prevalence of Overweight and Obesity in the Middle-age Population: A Priority for the Health System. *Iran J Public Health*, 46(6), pp.827–34.

Magliulo, G., De Vincentiis, M., Iannella, G., Ciofalo, A., Pasquariello, B., Manno, A., Angeletti, D., & Polimeni, A., 2018. Olfactory Evaluation in Obstructive Sleep Apnoea Patients. Acta *Otorhinolaryngologica Italica*, 38(4), pp.338–45.

Parati, G., Lombardi, C., Hedner, J., Bonsignore, M.R., Grote, L., Tkacova, R., Lévy, P., Riha, R., Bassetti, C., Narkiewicz, K., Mancia, G., & McNicholas, W.T., 2013. Recommendations for the Management of Patients with Obstructive Sleep Apnoea and Hypertension. *European Respiratory Journal*, 41(3), pp.523–38.

Peng, M., Chen, R., Cheng, J., Li, J., Liu, W., & Hong, C., 2018. Application Value of the NoSAS Score for Screening Sleep-Disordered Breathing. *Journal of Thoracic Disease*, *10*(8), 4774.

Punjabi, N.M., Brown, T.T., Abreu, A.R., Aurora, R.N., Patel, S.R., Stosor, V., Cho, J.H., D'Souza, G., Wallace, D., Margolick, J.B., 2023. Sleep-Disordered Breathing and Prevalent Hypertension in Men with and Without HIV. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, 94(4), pp.349–54.

Salihoğlu, M., Kendirli, M.T., Altundağ, A., Tekeli, H., Sağlam, M., Çayönü, M., Şenol, M.G., & Özdağ, F., 2014. The Effect of Obstructive Sleep Apnea on Olfactory Functions. *Laryngoscope*, 124(9), pp.2190–4.

Sawa, A., Suzuki, H., Niwa, H., Oguchi, S., Yagi, T., Iwata, Y., Makiyama, Y., Chow, C.M., & Komiyama, O., 2020. Assessment of Screening for Nasal Obstruction among Sleep Dentistry Outpatients with Obstructive Sleep Apnea. *Dent J (Basel)*, 8(4), pp.1–10.

Shin, D.H., Ahn, S.H., Yang, Y., Choi, S., Cho, J.H., Hong, S.C., & Kim, J.K., 2017. The Effect of Sleep Disordered Breathing on Olfactory Functions: Analysis by Apnea-Hypopnea Index. *Clin Exp Otorhinolaryngol*, 10(1), pp.71–6.

Siegel, J.K., Yuan, X., Wroblewski, K.E., McClintock, M.K., & Pinto, J.M., 2021. Sleep-Disordered Breathing Is Associated with Impaired Odor Identification in Older U.S. Adults. *The Journals of Gerontology*, 76(3), pp.528–33.

Wang, A.Y.M., 2014. Sleep-Disordered Breathing and Resistant Hypertension. *Semin Nephrol.*, 34(5), pp.520–31.

Wang, Y., Hu, K., Liu, K., Li, Z., Yang, J., Dong, Y., Nie, M., Chen, J., Ruan, Y., & Kang, J., 2015. Obstructive Sleep Apnea Exacerbates Airway Inflammation in Patients with Chronic Obstructive Pulmonary Disease. *Sleep Med.*, 16(9), pp.1123–30.

Xu, H., Wang, H., Guan, J., Yi, H., Qian, Y., Zou, J., Xia, Y., Fu, Y., Li, X., Jiao, X., Huang, H., Dong, P., Yu, Z., Yang, J., Xiang, M., Li, J., Chen, Y., Wang, P., Sun, Y., Li, Y., Zheng, X., Jia, W., & Yin, S., 2017. Effects of Continuous Positive Airway Pressure on Neurocognitive Architecture and Function in Patients with Obstructive Sleep Apnoea: Study Protocol for a Multicentre Randomised Controlled Trial. *BMJ Open*, 7(5), pp.e014932.

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Malaria Infection Among Pregnant Women of Abau District in Papua New Guinea

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Abstract

Malaria is a communicable disease that poses a serious problem in Papua New Guinea, with the country recording the highest incidence of malaria in the Asia-Pacific region each year. However, research on the risk factors for malaria in Papua New Guinea is still minimal, especially among pregnant women. This study aims to investigate the correlation between malaria incidence in pregnant women in Papua New Guinea. This study is an observational study with a cross-sectional approach conducted on 200 pregnant women from January to March 2024 in Abou District, Papua New Guinea. Data collection used questionnaires and Rapid Diagnostic Tests (RDT) to diagnose malaria infection in pregnant women. The independent variables in this study are healthcare-seeking behavior, prevention of malaria, knowledge of malaria, maternal age, marital status, occupation, education level, and residential location. The dependent variable in this study is the incidence of malaria in pregnant women. In this study, the data analysis used included univariate analysis, bivariate analysis with chi-square, and multivariate analysis with logistic regression. The results showed that the risk factors for malaria incidence in pregnant women in Papua New Guinea are malaria prevention (p-value 0.014; OR= 4.426) and healthcare-seeking behavior (p-value 0.033; OR= 4.033), meaning that pregnant women with poor malaria prevention behavior and poor healthcare-seeking behavior are four times more likely to suffer from malaria. It is hoped that pregnant women will increase their awareness of malaria prevention during pregnancy and make full use of healthcare facilities during pregnancy.

Introduction

This study is an analytical observational study with a cross-sectional design to determine the prevalence of malaria in pregnant women (Capili, 2021). The location of the study is in Abau District, Central Province in Papua New Guinea. The research study was conducted in three healthcare facilities that were accessible at the time, Moreguina Station Health Centre, Kupiano Station Health Centre, and Domara Aid Post. This study was carried out from January to March 2024. The research was conducted in Abau District where the healthcare facilities serving as the research sites did not require ethical approval. The research proceeded with verbal consent from the hospital head and the healthcare facility. The healthcare facility only required informed consent for the research.

The questionnaire used in this study is the Intervention on Malaria Knowledge, Motivation, and Behavioral Skill (IMB) questionnaire on malaria in pregnancy, which has been tested for validity and reliability (Balami et al., 2020). The population of pregnant

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women in Abau District is not precisely known due to poor record-keeping in health service facilities. Therefore, the sample size for the study is calculated using the Lameshow formula with a 95% confidence level and a standard error of 0.07, which is expected to represent the entire population (Pourhoseingholi et al., 2013). The calculation results in 196 respondents, which is rounded to 200 respondents. The selection of respondents was based on inclusion and exclusion criteria. The inclusion criteria in this study were pregnant women aged 15-45 years, residing in Abau district, willing to be tested for malaria with rapid diagnosis test (RDT), and willing to participate as research respondents. The exclusion criteria in this study were respondents who could not be reached during home visits. The process started at Moreguina Health Center with 70 respondents, followed by Kupiano with 100 respondents, and finally Domara Aid Post with 30 respondents. All pregnant women who meet the inclusion and exclusion criteria will then be asked to provide their consent by signing an informed consent form. For all respondents who agree, an interview and RDT will be conducted.

The dependent variable is the malaria infection status of the pregnant women with the independent variables being age, marital status, residence, occupation, education, knowledge of malaria, healthcare-seeking behavior, and prevention of malaria. The research data was collected using a questionnaire to gather data on respondent characteristics, healthcare-seeking behavior, malaria prevention, knowledge of malaria, maternal age, marital status, occupation, education level, and residential location. Malaria data among pregnant women was obtained by conducting a rapid diagnostic test on 200 pregnant women at the research location. The collected research data is then analyzed using univariate analysis to determine the frequency distribution of respondents' answers. Bivariate analysis with chi-square is used to examine the relationship between independent variables and dependent variables. Multivariate analysis with logistic regression is used to identify the variables that are risk factors for malaria incidence in pregnant women (Tukey, 1977). Data analysis is performed using SPSS version 23 (IBM, 2016).

TABLE 1. Characteristics of Respondents

Category		N	%
Age	Teenagers (15-<18 years old)	85	42.5
	Adult (>18-45 years old)	115	57.5
Marital status	Single	1	.5
	Married	199	99.5
Residence	Rural	196	98.0
	Urban	4	2.0
Occupation	Farmers	35	17.5
	Housewife	156	78.0
	Student	3	1.5
	Entrepreneur	3	1.5
	Other	3	1.5
Education	Non-formal education	9	4.5
	Primary school	117	58.5
	Secondary school	66	33.0
	Collage/University	8	4.0
	Received	38	79.2
Malaria status	Positive	14	7.0
	Negative	186	93.0

Result and Discussion

In Papua New Guinea's Central Province, the Abau District, a region rich in biodiversity with diverse landscapes, is situated about 283 kilometers from the main city, Port Moresby. The tropical climate of the area, conducive to mosquito breeding, poses significant public health implications, as mosquitoes are vectors for diseases, including malaria, which remains prevalent despite control efforts. The study covered a target population of 200 pregnant women. The respondents, predominantly adults aged between 18 and 45 years old (57.5%), were mostly married (99.5%) and lived in rural areas (98%). The majority were housewives (78%), and had primary school education (58.5%). Regarding malaria status, a small percentage (7%) tested positive for malaria which translates to 14 out of 200 surveyed individuals testing positive, or 70 cases per 1000 individuals, while the majority (93%) tested negative. The distribution of the research respondents' characteristics is presented in TABLE 1 as follows.

The bivariate analysis with the Chi-square test as shown in TABLE 2 reveals no significant association between malaria status and age, marital status, residence, education level, or occupation, as indicated by p-values greater than 0.05. However, individuals with poor knowledge of malaria, poor healthcare-seeking behavior, and poor malaria prevention practices have a significantly higher prevalence of malaria, as indicated by p-values less than 0.05. These findings suggest that interventions aimed at improving knowledge about malaria, promoting better healthcare-seeking behavior, and encouraging effective malaria prevention practices could potentially reduce malaria prevalence. However, these are observational

TABLE 2. Relationship Between Independent Variables and Dependent Variables

No	Variable	**Positive**	**Negative**	***p-value***
		n=14	n=78	
1.	Age			
	Teenagers (15-<18 years old)	7 (8.2%)	78 (91.8%)	0.758
	Adults (>18-45 years old)	7 (6.1%)	108 (93.3%)	
2.	Marital status			
	Single	0 (0%)	1 (100%)	0,783
	Married	14 (7.0%)	185 (93.0%)	
3.	Residence			
	Rural	14 (7.1%)	182 (92.9%)	0,579
	Urban	0 (0%)	4 (100%)	
4.	Education level			
	Low	10 (7.9%)	116 (92.1%)	0.783
	High	4 (5.4%)	70 (94.6%)	
5.	Occupations			
	High risk	13 (6.8%)	178 (93.2%)	0,621
	Low risk	1 (11.1%)	8 (88.9%)	
6.	Knowledge of malaria			
	Bad	9 (13.6%)	57 (86.4%)	0.010*
	Good	5 (3.7%)	129 (96.3%)	
7.	Healthcare-seeking behavior			
	Bad	11 (11.3%)	86 (88.7%)	0.040*
	Good	3 (2.9%)	100 (97.1%)	
8.	Prevention of malaria			
	Bad	8 (17.8%)	37 (82.2%)	0.001*
	Good	6 (3.9%)	149 (96.1%)	

TABLE 3. Last Model of Multivariate Analysis

No	Variables	Standard error	p-value	POR	95%CI	
					Lower	Upper
1.	Prevention of malaria	0.606	0.014	4.426	1.350	232.127
2.	Healthcare-seeking behavior	0.689	0.033	4.033	1.122	168.148
3.	Knowledge of malaria	0.616	0.097	2.778	0.831	5.598

findings, and further research is needed to establish causality.

The multivariate analysis results with logistic regression test suggest that individuals with poor malaria prevention practices are about 4.4 times (POR=4.426) more likely to have malaria, a statistically significant finding with a p-value of 0.014. Similarly, individuals with poor healthcare-seeking behavior are about 4 times (POR=4.033) more likely to have malaria, another statistically significant finding with a p-value of 0.033. However, while individuals with poor knowledge of malaria are about 2.8 times (POR=2.778) more likely to have malaria, this result is not statistically significant with a p-value of 0.097. The wide confidence intervals for these estimates indicate some uncertainty. These findings suggest potential areas for intervention, such as improving malaria prevention practices and healthcare-seeking behavior, but further research is needed to establish causality and consider potential confounding factors. The final multivariate modeling in this study is presented in TABLE 3 as follows.

In this study, malaria prevention was the most influential factor in the incidence of malaria among pregnant women in Papua New Guinea (p-value 0.014; POR= 4.426 95%CI= 1.35-232.12). This means that pregnant women with poor malaria prevention are four times more likely to suffer from malaria compared to those with good malaria prevention. Table 2 shows that the percentage of pregnant women who suffer from malaria with poor malaria prevention behavior (17.8%) is higher compared to pregnant women with good malaria prevention behavior (3.9%). Most pregnant women who suffer from malaria have poor malaria prevention; most only use bed nets when sleeping. However, the bed nets used are mostly older than four years, which may reduce their effectiveness. Additionally, women in the Abou District often go to the fields until late afternoon without using mosquito repellent or wearing long clothing. This condition increases the risk of pregnant women being bitten by mosquitoes and becoming infected with malaria.

The results of this study are consistent with research conducted in Ghana, which showed that malaria prevention affects the incidence of anemia in pregnant women (p-value 0.044 AOR= 1.57 95%CI= 1.01-2.47). This means that pregnant women who do not have the habit of sleeping under a mosquito net are 1.5 times more likely to suffer from malaria compared to those who sleep under a mosquito net (Ampofo et al., 2023). Another study conducted in Ethiopia showed that the malaria prevention variable significantly influences malaria infection in pregnant women (p-value 0.000 POR= 14.89 95%CI= 5.24-42.27). This means that pregnant women who do not have the habit of sleeping under a mosquito net are 1.5 times more likely to suffer from malaria compared to those who sleep under a mosquito net (Gontie et al., 2020). However, the results of this study are not consistent with research in the Lihir Group of Islands, Papua New Guinea, which showed no significant effect of malaria prevention, specifically sleeping under bed nets, on malaria incidence (p-value 0.675) (Millat-Martínez et al., 2023).

Healthcare-seeking behavior is also an influential factor in the incidence of malaria among pregnant women in Papua New Guinea (p-value 0.033; POR= 4.033 95%CI= 1.22-168.148). This means that pregnant women with poor healthcare-seeking behavior are four times more likely to suffer from malaria compared to those with good healthcare-seeking behavior. Table 2 shows that the percentage of pregnant women who suffer from malaria with poor healthcare-seeking behavior (11.3%) is higher compared to pregnant women

with good healthcare-seeking behavior (2.9%). The high number of pregnant women with poor healthcare-seeking behavior is due to limited access to healthcare facilities. The community in the Abou district, which lives in rural areas, has difficulty accessing healthcare facilities during pregnancy due to long distances and a lack of transportation. Additionally, inadequate road infrastructure, still consisting of dirt roads, makes it difficult for the community to travel, especially during the rainy season. Another reason is the community believed they could self-treat if they got malaria and could seek treatment themselves by buying anti-malarial drugs at the black-market sales or street market.

This study's findings are consistent with research conducted in East Nusa Tenggara Indonesia, which showed that healthcare-seeking behavior affects the incidence of anemia (p-value 0.000 POR= 1.87 95%CI= 1.19-2.96). It means that individuals who do not have good healthcare-seeking behavior are 1.87 times more likely to suffer from malaria compared to those who have good healthcare-seeking behavior (Guntur et al., 2022b). Another study conducted in the Republic of Democratic Congo showed that healthcare-seeking behavior significantly affects malaria infection in pregnant women (p-value 0.017) (Olapeju et al., 2023). However, this study's results are not in line with research in Nigeria, which showed no significant influence of healthcare-seeking behavior on the incidence of malaria in pregnant women (OR= 0.51 95%CI= 0.468-0.649) (Udenweze, 2019).

Age did not affect malaria infection in pregnant women in Papua New Guinea. The results of the data analysis showed that the majority of pregnant women were in the adult age group. The results of this study are not in line with research in Ghana which shows that age influences the incidence of malaria in pregnant women (p-value 0.000). This research shows that the older a pregnant woman is, the more she will protect herself from the risk of being infected with malaria during pregnancy(Alhassan, 2021). Age does not directly influence malaria infection in pregnant women, malaria infection is caused by various complex factors resulting from a combination of habits and environmental conditions (Andegiorgish et al., 2023).

Residence did not affect malaria infection in pregnant women in Papua New Guinea. The results of the data analysis showed that almost all pregnant women lived in rural areas. The results of this study are not in line with research in Guinea which showed residence influenced the incidence of malaria in pregnant women (p-value <0.001). This research shows that pregnant women who live in rural areas are more at risk of experiencing mosquito bites because there are many mosquito habitats in rural areas(Diallo et al., 2021). The proportion of research respondents who were almost entirely in rural areas meant that it was impossible to compare the prevalence of malaria in rural and urban residents(Yimam et al., 2021).

Marital status did not affect malaria infection in pregnant women in Papua New Guinea. The results of the data analysis showed that almost all pregnant women were married. The results of this study are not in line with research in Guinea which showed that marital status influenced the incidence of malaria in pregnant women (p-value <0.001)(Diallo et al., 2021). Marital status is indirectly related to the division of women's roles in the household, married African women spend more time at home so the risk of experiencing mosquito bites is lower (Frempong et al., 2023). Knowledge of malaria did not affect malaria infection in pregnant women in Papua New Guinea. The data analysis results showed that most pregnant women had a good knowledge of malaria. The results of this study are not in line with research in Burkina Faso which showed that knowledge influenced the incidence of malaria in pregnant women (p-value 0.033). Pregnant women with a lack of knowledge of malaria are 2.54 times more likely to be infected with malaria during pregnancy(Yaro et al., 2021). Research in Nusa Tenggara Indonesia shows that knowledge does not affect the incidence of malaria, this condition is caused by the community's customary habit of using natural ingredients to prevent mosquito bites (Guntur et al., 2022a).

In this study, occupation did not affect malaria infection in pregnant women in Papua New Guinea. The results of the data analysis showed that the majority of pregnant women worked as farmers who were susceptible to

mosquito bites. The results of this study are not in line with research in Guinea which showed that a person's job influences the incidence of malaria in pregnant women (p-value <0.001) (Diallo et al., 2021). Pregnant women with knowledge of working in gardens or fields are more at risk of being infected with malaria during pregnancy (Guntur et al., 2022b). Level of education did not affect malaria infection in pregnant women in Papua New Guinea. The results of the data analysis showed that almost all pregnant women had a low level of education. The results of this study are not in line with research in Guinea which showed that a person's job influences the incidence of malaria in pregnant women (p-value <0.001). Pregnant women with a low level of knowledge are more at risk of being infected with malaria during pregnancy because there is a possibility of continuing to carry out activities that carry a high risk of being bitten by mosquitoes that cause malaria (Diallo et al., 2021; Oyerogba et al., 2023).

Conclusion

In this study, there was a significant influence between malaria prevention and healthcare-seeking behavior on the incidence of malaria. The malaria infection was not significantly influenced by factors such as age, marital status, residence, education level, knowledge of malaria, and occupation. The findings of this research are expected to provide a strong foundation for the government of Papua New Guinea in formulating policies related to effective and efficient malaria management in pregnant women.

References

Abuallut, I., Qumayi, E.A., Mohana, A.J., Almalki, N.M.,Ghilan, M.E., Dallak, F.H., Mahzari, S.M., Makrami, A., Tawhari, A, Ajeebi, R.E., & Bakri, S.M., 2022. Prevalence of Asthenopia and Its Relationship with Electronic Screen Usage During the COVID-19 Pandemic in Jazan, Saudi Arabia: A Cross-Sectional Study. *Clinical Ophthalmology*, 16(9), pp.3165–3174.

Anbesu, E.W., & Lema, A.K., 2023. Prevalence of Computer Vision Syndrome: A Systematic Review and Meta-Analysis. *Scientific Reports (Nature Publisher Group)*, 13(1), pp.1801.

Arshad, S., Khan, A., Pal, D.K., Melwani, V., Verma, S., & Sawlani, H., 2019. Prevalence of Asthenopia Among Computer Operators in Central India and Effectiveness of Educational Intervention. *International Journal Of Community Medicine And Public Health*, 6(5), pp.2091.

Chowdhury, S., & Chakraborty, P., 2017. Universal Health Coverage - There Is More to It Than Meets The Eye. *Journal of Family Medicine and Primary Care*, 6(2), pp.169–170.

Deng, R., Zhu, Y., Zhang, J., Lin, N., Li, X., Lin, Y., Zheng, J., & Lu, F., 2019. Investigation of Asthenopia and Related Factors in the General Public in China. *Chin J Optom Ophthalmol Vis Sci.*, 21, pp.668–76.

Ferreira, K.S.L., Lucena, A.D., de Oliveira, F.N., & Lucena, H.M.A., 2024. Visual Fatigue from Occupational Environment: A Review Study. *Occupational and Environmental Safety and Health V*, 492, pp. 813–824.

Hashemi, H., Saatchi, M., Yekta, A., Ali, B., Ostadimoghaddam, H., Nabovati, P., Aghamirsalim, M., Khabazkhoob, M., 2019. High Prevalence of Asthenopia Among A Population of University Students. *Journal of Ophthalmic and Vision Research*, 14(4), pp.474–482.

Irwan., Ridha, N.R., Katili, D.I., & Una, M., 2023. Risk Factor Analysis of Occupational Diseases in Computer Users. *International Journal of Environmental, Sustainability, and Social Science*, 4(5), pp.1295–1301.

Jang, Y.S., Lee, J.H., Lee, N.R., Kim, D.W., Lee, J.H., & Lee, K.J., 2023. Association Between Receiving Work Communications Outside of Work Hours Via Telecommunication Devices and Work-Related Headaches And Eyestrain: A Cross-Sectional Analysis of the 6th Korean Working Conditions Survey. *Annals of Occupational and Environmental Medicine*, 35(1), pp.1–11.

Kim, G., Cho, S., Kim, J., Yoon, S., Kang, J., & Kim, S., 2023. Relationship Between Visual Display Terminal Working Hours and Headache/ Eyestrain in Korean Wage Workers During the COVID-19 Pandemic: the Sixth Korean Working Conditions Survey. *Annals of Occupational and Environmental Medicine*, 32, pp.1–12.

Ruliati, L.P., Maisal, F.M., Junias, M.S., & Santi, L.E.N., 2020. Ergonomic Analysis of Work Fatigue and Eyestrain Among Wig Makers at PT. SCI Indonesia Kupang City', *Proceedings of the 4th International Symposium on Health Research (ISHR 2019)*, pp. 434–439.

Long, J., Cheung, R., Duong, S., Paynter, R., & Asper, L., 2017. Viewing Distance and Eyestrain Symptoms with Prolonged Viewing of Smartphones. *Clinical & Experimental Optometry*, 100(2), pp.133–137.

López, J., Rojas, L., & Osada, J., 2020. Frecuencia de Factores Ocupacionales Asociados A Astenopía en Trabajadores Usuarios de Pantallas de Visualización de Datos de Empresas Del Rubro Construcción en Huaraz, 2019. *Rev Asoc Esp Med Trab*, 29(2), pp.1–95.

Lu, L., Megahed, F.M., Sesek, R.F., & Cavuoto, L.A., 2017. A Survey of The Prevalence of Fatigue, Its Precursors and Individual Coping Mechanisms Among U.S. Manufacturing Workers. *Applied Ergonomics*, 65, pp.139–151.

Negishi, K., Ayaki, M., Kawashima, M., & Tsubota, K., 2021. Sleep and Subjective Happiness Between The Ages 40 and 59 in Relation to Presbyopia and Dry Eye. *Plos One*, 16(4), pp.e0250087.

Oginawati, K., Nathanael, R.J., Chazanah, N., Prabandari, S.D., Basuki, M.F., Oclandhi, B., Santoso, M., Febriana, S.A., Nugrahaningsih, D.A., Suhartini, S., Prakoeswa, C.R.S., & Tanziha, I., 2023. Occupational Lead Exposure Health Risk Assessment and Heme Biosynthesis: A Study on Batik Artisans in Yogyakarta, Indonesia. *Heliyon*, 9(9), pp.e19994.

Ostrovsky, A., & Ilchenko, A., 2022. Subjective Assessment of the Severity of the Main Symptoms of Visual Asthenopia in Medical Students. *Oftalmologija. Vostochnaja Evropa*, 12(4), pp.476–481.

Prasetio, D.B., Setyaningsih, Y., Suhartono., & Suroto., 2023. Identification of Subjective Fatigue Accompanied by Hypertension in Female Workers Making Tiles in Indonesia: A Cross-Sectional Survey. *International Journal of Occupational Safety and Health*, 13(4), pp.484–493.

Prasetio, D.B., Setyaningsih, Y., Suhartono., & Suroto., 2023. Individual, Habits, and Work Environment Factors Associated With Blood Lactic Acid Levels in Roof Tile Manufacturing Workers. *Malaysian Journal of Public Health Medicine*, 23(1), pp.253–260.

Primantara, I.P., & Putere, S.P.M.L.M., 2020. Prevalence of Asthenopia in Visual Display Terminal Operators at Federal International Finance Group Bali. *The Proceedings of the 1st Seminar The Emerging of Novel Corona Virus*, pp.4–9.

Rahman, A., Amir, S.P., Novriansyah, Z.K., Maharani, R.N., & Aulia, N., 2024. Hubungan Durasi dan Lama Kerja Penjahit dengan Kejadian Kelelahan Mata. *Journal Of Social Science Research*, 4(3), pp. 2215–2227.

Ruliati, L.P., Maisal, F.M.M., Junias, M.S., & Santi, L.E.N., 2020. Ergonomic Analysis of Work Fatigue and Eyestrain Among Wig Makers at PT. SCI Indonesia Kupang City. *Proceedings of the 4th International Symposium on Health Research (ISHR 2019)*, pp.434–439.

Sharma, S., Sitaula, R.K., Mishra, S., Shrestha, G.B., & Sharma, A.K., 2021. The Ocular Health and Visual Function Status of Sewing Professionals of Garment Factories of Kathmandu Valley. *Cogent Medicine*, 8(1).

Souchet, A.D., Lourdeaux, D., Pagani, A., & Rebenitsch, L., 2023. A Narrative Review of Immersive Virtual Reality's Ergonomics and Risks at The Workplace: Cybersickness, Visual Fatigue, Muscular Fatigue, Acute Stress, and Mental Overload. *Virtual Reality*, 27, pp.19-50.

Stack, R.J., Southworth, S., Fisher, B.A., Barone, F., Buckley, C.D., Rauz, S., & Bowman, S.J., 2017. A Qualitative Exploration of Physical, Mental and Ocular Fatigue in Patients With Primary Sjögren's Syndrome. *PloS One*, 12(10), pp.e0187272.

Wang, J., Zeng, P., Deng, X., Liang, J., Liao, Y., Fan, S., & Xiao, J., 2022. Eye Habits Affect the Prevalence of Asthenopia in Patients with Myopia. *Journal of Ophthalmology*, 1.

Xu, Y., Deng, G., Wang, W., Xiong, S., & Xu, X., 2019. Correlation Between Handheld Digital Device Use and Asthenopia in Chinese College Students: A Shanghai Study. *Acta Ophthalmologica*, 97(3), pp.e442–e447.

Zafar, A., Ahmad, S., Ali, K.N., Khalid, B., & Ayyub, F., 2021. Frequency of Asthenopia Symptoms Among Tailors of Rawalpindi: A Cross-Sectional Survey. *J. Shifa Tameer-e-Millat Univ.,* 5(1).

Zhang, H., Song, T., Kang, R., Ren, F., Liu, J., & Wang, J., 2023. Plant Bioactive Compounds Alleviate Photoinduced Retinal Damage and Asthenopia: Mechanisms, Synergies, and Bioavailability. *Nutrition Research*, 120, pp.115–134.

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Red Ginger Essential Oil (Zingiber officinale var. Rubrum) as a Biolarvicide in the Control of Aedes Aegypti Mosquitoes

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Abstract

Synthetic larvicides are often used to control Aedes aegypti mosquitoes, but they are detrimental to humans, the environment, and the occurrence of resistance. The purpose of the study was to determine the influence and effectiveness of red ginger essential oil (Zingiber officinale var. Rubrum) as the biolarvicide of Ae. Aegypti and the most effective concentration (LC50). A total of 25 instar 3 larvae with concentrations of 200, 400, 600, and 800 ppm and K+(temephos), K-(aquaade), four repetitions every 30 minutes of observation for 3 HSPs. The results of the study showed that red ginger essential oil affected the death of Ae. Aegypti larvae. There was a significant difference in mortality rates between concentrations (Kruskal-Wallis test, p = 0.001). Likewise, there was a moderate but significant correlation between concentration and mortality (Spearman correlation: r = +0.503, p = 0.001). The probit analysis, LC50 was 257.89 ppm, most effectively influencing mortality in Ae. Aegypti larvae based on LC50. Red ginger essential oil (Zingiber officinale var. Rubrum) is effective and effective as a bio-larvicide to control Ae. aegypti so that it can reduce dengue fever cases.

Introduction

Mosquitoes are one of the important insects in the world of health. Based on its classification, mosquitoes are included in the phylum Arthropoda, Order Diptera, Family Culicidae, with three tribes, namely Tribus Anophelini (*Anopheles*), Culicini Tribes (*Culex, Aedes, Mansonia*), and Toxorhynchitini Tribe (*Toxorhynchites*). In humans, mosquitoes are ectoparasites that act as vectors for various diseases, including malaria, filariasis, and dengue fever (Wahyuni, Makomulamin & Sari, 2021). According to the World Health Organization (WHO), vector-borne diseases account for more than 17% of all infectious diseases and cause more than 700,000 deaths annually worldwide (WHO, 2023b). *Aedes aegypti* (L) is one of the main vectors of transmission of viral diseases to humans, such as yellow fever, Zika virus fever, chikungunya, dengue fever, and other arboviruses (Scalvenzi *et al.*, 2019; Valle *et al.*, 2019). Dengue fever is one of the viral diseases transmitted by *Ae. Aegypti,* until now, is still a global public health threat (Darriet, 2016; da Botas *et al.*, 2017; Amelia-Yap *et al.*, 2018). According to WHO, there are about 390 million cases of dengue virus infection per year, with 96 million of them showing severe clinical manifestations and about 40,000 deaths each year. WHO also estimates that around 3.9 billion people in more than 129 countries are at risk of contracting the dengue virus (WHO, 2023a).

In Indonesia, dengue hemorrhagic fever (DHF) is still an infectious disease that has become an unresolved health problem, with the incidence rate still fluctuating. In 2020, there were 103,509 cases of dengue fever, with

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a mortality rate of 725 people, with a dengue IR of 38.15 per 100,000 population (Kemenkes RI, 2020). In 2022, there was an increase of 143,000 cases, the national dengue fever IR of 52 per 100,000 population, higher than the target set in the previous period (which was 49 per 100,000 population) (Kemenkes RI, 2023). The results of these statistics show that there are still challenges in controlling this disease, so it requires a concerted effort to overcome these health problems.

As dengue vectors, mosquitoes *Aedes* consist of two species, namely *Ae. Aegypti* and *Ae. Albopictus* with the characteristics of the body and limbs covered with scales, with silvery white stripes. *Ae. Aegypti* Females bite during the day and like human blood as their food (Rojas-Pinzón *et al.*, 2018). Water reservoirs such as bathtubs, containers, buckets, clay vases, buckets, cans, used tires, and others are places to lay eggs from *Ae. Aegypti* mosquito (da Botas *et al.*, 2017). So that in the rainy season, there will be an increase in the mosquito populations of *Ae. Aegypti,* which is accompanied by dengue fever cases. (Akollo *et al.*, 2020). Until now, the problem that still occurs, the right method for population control of mosquitoes has not been found for *Ae. Aegypti* both in the adult and larval stages, which is evidenced by dengue fever cases that are always present every year (Pandiyan *et al.,* 2019).

Ae. Aegypti mosquito control that has been done so far is the modification and manipulation of the environment where the patient is located, control chemically, biologically, physically, mechanically, 3M plus, and others, but has not been effective. However, chemical (synthetic) control is still a Popular and frequently used control, both for controlling mosquito populations of *Ae. Aegypti* and larvae (Govindarajan *et al.*, 2016), such as pyrethroid-based fumigation for the mosquito stages of *Ae. Aegypti* Adults and larvicides for larval stages (Galvão *et al.*, 2019). The use of synthetic compounds is carried out because it is considered more effective, can kill large and fast insects, and have lower production costs compared to natural materials.

In the mosquito control of *Ae. Aegypti,* in particular, larvae usually use abate powder containing 1% temephos, which is sprinkled on water reservoirs in the house, such as bathtubs, drums, containers, and others. However, the use of temephos, which is used to kill larvae, can cause resistance from mosquitoes. There have been reported cases of larval resistance to *Ae. Aegypti* in several countries, including Brazil (Valley *et al.*, 2019): Mexico (Kandel *et al.*, 2019); Southeast Asia (Indonesia, Malaysia, Philippines, Thailand, Singapore, Laos, Myanmar) (Amelia-Yap *et al.*, 2018) and Indonesia (Akollo *et al.*, 2020). In addition, the sustainable use of temephos in the community will harm humans because it contains non-systemic organophosphate chemical compounds by inhibit the production of the enzyme acetylcholinesterase, which functions to change acetylcholine to its original state. When an excessive amount of acetylcholine will cause excessive stimulation of the nervous system and lead to the death of larvae of *Ae. Aegypti*. Therefore, temephos poses a significant risk if exposed to humans because organophosphate compounds can cause disorders of the nervous, respiratory, and cardiovascular systems that which can lead to death (WHO, 2005).

In connection with the above, new alternatives from plants are needed to control *Ae. Aegypti* mosquito. Biolarvicide is one of the environmentally friendly solutions to reduce the negative impact of the excessive use of synthetic chemical compounds (Rohmah *et al.,* 2020), because it is not so toxic that it is safe for humans & the environment, does not cause resistance, and decomposes naturally (Pandiyan *et al.,* 2020). From some previous studies on mosquito control of the *Ae. aegypti* It seems that they are trying to find alternatives by utilizing ingredients found in nature from plants that are safer for humans and the environment, available in large quantities, and easy to get. Based on the research, it is proven that various types of plants have the potential to be important biological resources for humans and can be used as bioinsecticides and biolarvicides.

One plant that is thought to be effective and potentially bio-larvicide is red ginger (*Zingiber officinale* Var. Rubrum) because it contains active compounds and essential oils. Red ginger is an annual plant that belongs to the Zingiberaceae family, the genus Zingiber,

that originated in India and spreads almost all over the country, including the equator. This plant is often used in traditional medicine in several countries in Asia, such as for headaches, indigestion, nausea, and vomiting (Sivasothy *et al.*, 2011). Some studies state that red ginger has a wide range of pharmacological activities (Zhang *et al.*, 2022), antioxidant and anti-cancer (Ghasemzadeh *et al.,* 2016), and antibacterial (Sivasothy *et al.*, 2011). Other scientific evidence also proves that red ginger exhibits Immunomodulatory, Antihypertensive, Antihyperlipidemic, Antihyperuricemic, Antimicrobial, and Cytotoxic activity (Zhang *et al.*, 2022).

Effectiveness and how red ginger works as a mosquito biolarvicide of the *Ae. Aegypti is* caused by the active compounds contained in it, one of which is essential oil (EO). The essential oil content of red ginger is a Sesquiterpene compound consisting of three substances, namely: (Zingiberene, Zingiberol, Farnesene), which play a role in providing aroma, and Gingerol, Shogaol, and Paradol as compounds that give a spicy taste (Stoner, 2013). Zingiberene and zingiberol as contact venoms, act as receptors that activate anti-feeding signals in the insect's central nervous system (Moon *et al.*, 2020). Gingerol, as a stomach toxin, actively works to damage the outer membrane and cytoplasmic membrane so that the lysis of the larval cell membrane results in leakage (Syukur *et al.*, 2018)). Shogaol is effective in suppressing intestinal contractions and is an antitussive (Mao *et al.*, 2019).

Essential oils (EO) are a mixture of complex compounds that are volatile and are lipophilic, flavorful and flavorful, and liquid in form (Moon *et al.,* 2018). From several previous studies, it was found that essential oils act as an insect repellent. Da Botas explained that essential oils are plant volatile compounds that function as plant chemical defenses against insects, with the main mechanism of action being by inhibiting acetylcholine (da Botas *et al.*, 2017). Essential oil compounds are also toxic and can protect plants from pests, inhibit the growth of some types of insects, and act as mosquito larvicides that are safe against greenery (Govindarajan *et al.*, 2016; AlShebly *et al.*, 2017; Rezzoug *et al.*, 2019). The content of essential oil compounds has an anti-insect effect as an alternative to chemical compounds for insect control with repellent, feeding deterrent/antifeedant, toxicant, growth inhibitor, chemosterile, and attractant (Hikal *et al.,* 2017). Based on the explanation above, the content of essential oils in plants, especially red ginger, is likely to be effective and potentially used as a biolarvicide for mosquito control of the *Ae. aegypti.*

Red ginger (*Z.Officinale*) from several previous studies, besides being used for medicinal purposes, is also used for insect control. Such as research conducted by Ghahfarokhi about the Potential of essential oils *Zingiber officinalis* and *Eucalyptus globulus*, as a flea exterminator (*Rhipicephalus bursa*). Essential Oil Manifestation *Z. officinalis* and *E. globulus* have lethal activity against fleas (Madreseh-Ghahfarokhi *et al.*, 2019). Next, Boekoesoe and Ahmad's research using *Zingiber Officinale Rosc*. as a natural insecticide against larvae of *Ae. Aegypti* by using concentrations of 60%, 70%, 80%, 90%, and 100%. From the results of his research, it was found that the *Z.officinale Rosc*. Effectively kills larvae of *Ae. Aegypti* at 100% concentration with 97% larval mortality (Boekoesoe & Ahmad, 2022). This time, the author also conducted research on red ginger (*Zingiber officinale* Var. Rubrum) as a biolarvicide against *Ae. Aegypti,* however, no longer uses red ginger extract as done by Boekoesoe and Ahmad, but uses red ginger Essential Oil (EO) compounds using much lower concentrations of 200 ppm, 400 ppm, 600 ppm, and 800 ppm (mgL^{-1}), which refers to the WHO Standards (WHO, 2005).

Research on this topic is interesting because of the essential oil compounds isolated from red ginger (*Z. Officinale* Var. Rubrum) as a biolarvicide in mosquito control of the *Ae. Aegypti* has not been explored before. The question that needs to be answered is whether red ginger essential oil can be utilized as a biolarvicide

in controlling *Ae. Aegypti* mosquito larval phase. The main objective of this study is to determine the influence and effectiveness of Red Ginger Essential Oil (*Z. Officinale* Var. Rubrum) in killing *Ae. Aegypti* larvae and know the Most Effective Concentration (LC_{50}) as a biolarvicide in *Ae. Aegypti* mosquito control.

Method

The research was conducted at the Natural Ingredients Pharmaceutical Laboratory of the Riau College of Pharmacy (STIFAR), Pekanbaru, in May–June 2022. This study examines the use of red ginger essential oil as a biolarvicide in the control of *Ae. Aegypti* mosquitoes without ignoring the factors that affect the life of *Ae. Aegypti*, namely temperature and air humidity. The research design used was the Complete Random Design Method (RAL) with four concentrations, namely 200, 400, 600, and 800 ppm, K (+)Temephos, K (-) aquatics, which were carried out four times. The ingredients used were 2500 grams of red ginger rhizome, 8 liters of Aquades, red ginger essential oil, 1 liter of N-Hexane, 50 ml of DMSO, 1 liter of Ethanol, 1 pack of Abate (Temephos) Powder, Na2SO4, Helium, 450 larvae *of Ae aegypti* instar three. Meanwhile, the tools used include analytical scales, blenders, separation funnels, micropipettes, distillation tools, stopwatches, cups, skewers, thermometers, large basins, and aquariums.

The preparation of test larvae is carried out in two ways: 1) first, by breeding *Ae. Aegypti* mosquito larvae. To get larvae by providing a medium (black basin) then fill it with clean water, and place it in a cool place and protected place from direct sunlight, as a place for mosquitoes to lay *Ae. Aegypti's* eggs. Then the eggs are left to wait for a few days so that they hatch into larvae. After becoming larvae, they are kept in an aquarium with a temperature range of 24.2-24.40C with a relative humidity of 67-70%. During the rearing period, the larvae are fed on coconut water feed (Fontana *et al.*, 2020) until it became the third instar larva used as a test larva. 2) The second method is to collect larvae in water reservoirs in residential environments. The three instar larvae used are healthy, actively moving larvae. The test larvae for each concentration consisted of 25 larvae of *Ae. Aegypti* with four (4) repetitions, plus 25 larvae for positive control and negative control, so that the total test larvae amounted to 450 acres of larvae.

The process of making essential oils begins by providing as many as 2500 grams of red ginger rhizomes, and then cleaned with running water, followed by thin slicing and drying in a place protected from direct sunlight, so that 400 g of dry powder is obtained. Then the process of making essential oils is carried out using the Water Distillation Method, using aqueducts as a solvent. The powder is stored in a distilled flask and then heated at 100°C for 6 hours. After the distillation process is complete, the essential oils are separated from the solvent using an N-Hexane solution with a separate funnel. This is done by filling a separate funnel with 500 ml of distillate product and 50 ml of N-Hexane, followed by a perfect shake and letting it sit, and then the essential oils are separated. The extracted essential oils are put in a 10 ml vial and wrapped in aluminum foil and plastic wrap. Meanwhile, the essential oil content obtained is influenced by geographical conditions, environmental factors, agroclimatic conditions of plants, and the method of manufacture used (Pandiyan *et al.,* 2019), as well as rainfall and altitude of an area (topography) (Suryati *et al.*, 2022).

The preparation of the red ginger essential oil test solution uses DMSO as a solvent. The parent solution is made by weighing 200 µg of red ginger essential oil, which is put in a 20 ml measuring cup. DMSO is added so that a parent solution with a concentration of 10000 ppm is obtained. Furthermore, the parent solution was separated into concentrations of 200 ppm, 400 ppm, 600 ppm, and 800 ppm which were achieved by pipetting 0.4 ml, 0.8 ml, 1.2 ml, and 1.6 ml of the parent solution into each test cup, followed by the addition of 20 ml of aqueduct and homogenization. The red ginger bio-larvicide test solution used for testing has met WHO standards (WHO, 2005). Next, testing of the larvae was carried out on *Ae. Aegypti* by putting 25 instar three larvae into each test cup containing their respective test solutions, namely positive control, negative

Figure 1. The Process of Separating Essential Oils from Distillation Solvents With N-Hexane Solution
Image source: Researcher (2022)

control, and concentrations of 200, 400, 600, and 800 ppm. Then it was observed every 12 hours for 3×24 observations (3 HSP) of the larval death process, and the number of larvae was calculated on died *Ae. Aegypti*. Temperature and humidity measurements were carried out that affect the life of mosquito larvae. The same procedure is repeated on the second and third repetitions. To see the death of larvae of *Ae. Aegypti,* it is done by touching it with a stick, and if the larvae do not move, they are considered dead (WHO, 2005). Data analysis was carried out with a Statistical Test of Variance Analysis with RAL, followed by an ANOVA test. The ANOVA test cannot be performed because it is not eligible. Therefore, alternative tests were carried out, namely the Non-Parametric Kruskal-Wallis Test and the Spearman Analysis Test, to determine the degree of closeness of the relationship between the free variable and the bound variable.

Results and Discussion

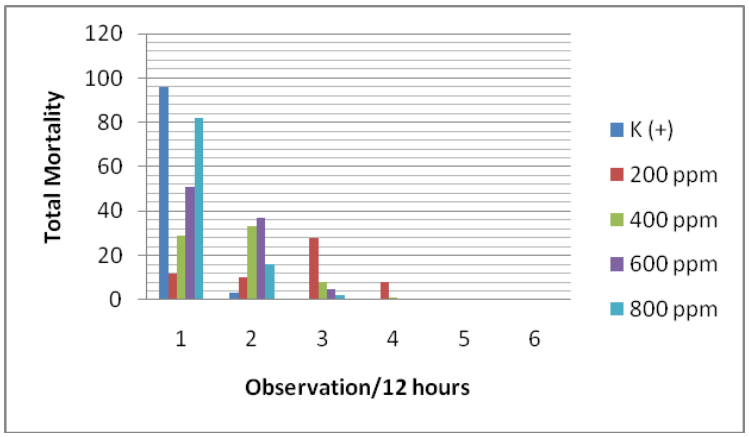
Based on the results of research that has been carried out on larvae of *Ae. Aegypti*, those which died with various concentrations of red ginger essential oil, namely 200 ppm, 400 ppm, 600 ppm, 800 ppm, and a positive control using temephos and a negative control using distilled water. Where the calculation and observation of the number of dead larvae was observed at an interval of 12 hours for 3 (three) observation days (HSP) with 4 repetitions. From the results of observation, the larvae of *Ae. Aegypti* shows a different pattern in the process of death. The first time the larvae are put in a test glass with various concentrations of red ginger essential oil, the larvae of *Ae. Aegypti* shows fluctuating active movement at concentrations of 200 ppm and 400 ppm. However, a very active movement is seen at essential oil concentrations of 600 ppm and 800 ppm and then returns to normal. At intervals of time, the larvae are seen to move stiffly, then weaken, fall to the bottom of the test glass, stand still, and die. Death is characterized by the larvae falling to the bottom of the test cup and not being able to move up and down again (WHO, 2005). The dead larvae look stiff, and the number of deaths increases as the concentration of the treatment increases. In the negative control (K-aquaades), all the larvae were still alive and active, and on two days of observation, it was seen that the larvae turned into pupae and then became mosquitoes. In the positive control (K+ temephos) in the first 12 hours of observation, there was 96% larval mortality. The larvae's movement is very rapid and active, followed by gradual weakening and death that occurs rapidly, and the larvae exhibit seizure behavior and eventually die.

Based on Table 1 below, it can be seen that after the administration of red ginger essential oil, observed for 3 observation days (HSP), indicates that each concentration of red ginger essential oil can kill larvae of *Ae. Aegypti*. The results of the tests that have been carried out on the larvae of *Ae. Aegypti.* By using red ginger essential oil at concentrations of 200, 400, 600, and 800 ppm, the total mortality was 58%, 71%, 93%, and 100%. From the total larval mortality of *Ae. Aegypti*, the lowest is at a concentration of 200 ppm, which reached 58%, and the highest total death is at a concentration of 800 ppm, which was 100%. Positive control using temephos showed total larval mortality of *Ae. Aegypti,* which reached 100%, and in the

Table 1. Total *Ae. Aegypti Larval Mortality* During 3 Observation Days (HSP)

No.	Concentration of Red Ginger Essential Oil	Total larval mortality *of Ae. Aegypti*					
		Repetition				Total Deaths (Tail)	Total Percentage of Deaths (%)
		1	2	3	4		
1	200 ppm	12	15	14	17	58	58
2	400 ppm	20	16	18	17	71	71
3.	600 ppm	25	24	22	22	93	93
4.	800 ppm	25	25	25	25	100	100
5.	(+) Controls	25	25	25	25	100	100
6.	Control (-)	0	0	0	0	0	0

Primary data for 2022



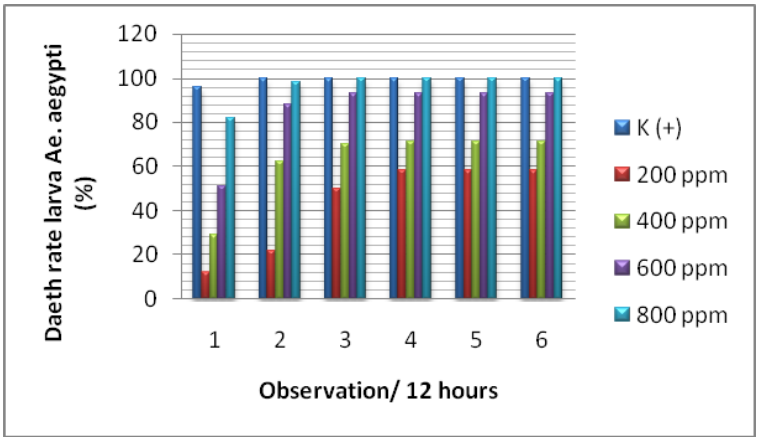
Primary data for 2022

Figure 2. Number of *Ae. Aegypti Larval Deaths* at Various Concentrations Every 12 Hours of Observation

negative control using aqueducts showed no death in the larvae of *Ae. aegypti.*

Based on Figure 2, the number of *Ae. aegypti larval deaths* at various concentrations of red ginger essential oil were observed every 12 hours of observation. In the first 12 hours of observation for each concentration, there was a high number of *Ae. Aegypti* larval deaths, as many as 12, 29, 51, and 82, respectively. At concentrations of 800 ppm and 600 ppm, the highest number of deaths, namely 82 and 51, occurred in the first 12 hours of observation. Meanwhile, at concentrations of 400 ppm and 200 ppm, the highest number of deaths of 33 and 28, occurred in 24 hours and 36 hours of observation. In the positive control (K+) of Temephos, there were 100 deaths of *Ae. Aegypti larvae* in the first 12 hours of observation. Whereas negative control (K-) distilled water did not cause larval death at all. Effective mortality at concentrations of 600 ppm and 800 ppm occurred at the first 12 hours of observation, while concentrations of 400 and 200 ppm were effective at 24 hours and 36 hours, respectively. This shows that the higher the concentration, the greater the number of larval deaths, along with the increase in the faster the death time as well.

The average mortality of larvae of *Ae. Aegypti* observed every 12 hours for 3 observation days (HSP) in Figure 3 above, at 1 HSP, the average mortality of larvae at 12



Primary data for 2022

Figure 3: Average Mortality of *Ae. Aegypti* Larvae at Each Biolarvicide Concentration Red Ginger Essential Oil Every 12 Hours of Observation

hours of observation with red ginger essential oil treatment at a concentration of 200 ppm of 12%, a concentration of 400 ppm of 29%, a concentration of 600 ppm of 51% and a concentration of 800 ppm of 82%. In 2 HSPs, at 36 hours of observation, the average mortality with red ginger essential oil treatment was 50 ppm concentration, 400 ppm concentration was 70%, 600 ppm concentration was 93%, and 800 ppm concentration was 100%. In 3 HSPs, the average mortality of larvae with red ginger essential oil treatment was 58 ppm concentration, 400 ppm concentration was 71%, 600 ppm concentration was 93%, and 800 ppm concentration was 100%. In positive cocks, the average mortality of larvae was 100%, while in negative controls, larval mortality did not occur (0%). The higher the concentration of red ginger essential oil, the higher the percentage of larval mortality of *Ae. Aegypti.*

Based on Figure 3, it shows that in the treatment of the concentration of red ginger essential oil, the concentration of 200 ppm causes mortality of *Ae. Aegypti* larvae occurred until the 2nd day of HSP at the 48th hour, with the concentration of 400 ppm, 600 ppm, and 800 ppm, the average mortality of *Ae. Aegypti* larvae occurred until the 2nd day of HSP at the 36th hour. For positive control, larval mortality has occurred since the first 12 hours of observation, while in negative control, larval mortality does not occur after 3 HSP. This shows that red ginger essential oil can work from 1 HSP and is most effective on day 1 HSP, and then decreases. From the results of observations of the phase development of *Ae. aegypti* larvae at the time of testing, some of the non-dead larvae turned into pupae, some even became mosquitoes, especially at concentrations of 200 ppm and 400 ppm. For the concentrations of 600 ppm and 800 ppm, no changes in larval development to pupa were found. Environmental conditions such as water temperature, air humidity, and water pH are the reasons for the larvae to survive when tested with red ginger essential oil. From the results of observations that have been made, the water temperature ranges from 240 °C- 250 °C, and the indoor air humidity during normal research is around 69.8% - 72.3%

From the results of the Kolmogorov-Smirnov Test Statistics, a P-value of 0.001< 0.05 was obtained, meaning that the distribution of data from each group was abnormal. The Variance test obtained a P-value of 0.001< 0.05, concluding that the data variance was unequal or abnormal. So that the ANOVA test cannot be used, even though the data transformation has been repeated several times, and the results are fixed. Therefore, the Kruskal-Wallis Non-Parametric Test is used as an alternative to the ANOVA test. From the results of the Kruskal-Wallis test, a P-value of 0.001 < 0.05 was obtained, this value showed that there was a significant difference in the mortality of *Ae. Aegypti* larvae with a difference in the concentration of red ginger essential oil. In the

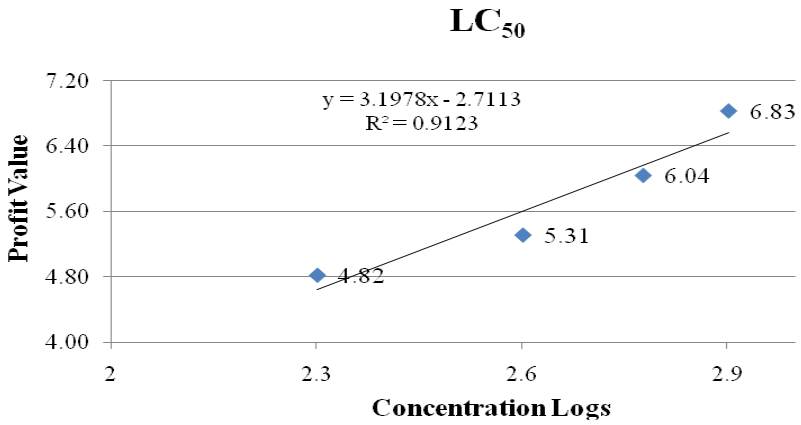


Figure 4. Deadly Concentration of 50 (LC_{50}) Biolarvicide of Red Ginger Essential Oil

Non-Parametric Analysis correlation test, a Sig Spearman (2-tailed) value of 0.001 < 0.05 was obtained, which showed an influence between the increase in the concentration of red ginger essential oil on the number of larval deaths. The strength of the correlation is shown by the interpretation of "moderate" with a value of 0.503**. This is consistent with the observed trend that higher concentrations of red ginger essential oil lead to increased larval mortality, accompanied by faster death times.

In probit analysis, adjusted to the parameters of larvicide effectiveness according to WHO in 2005, the larvicide concentration is considered effective if it can cause the death of test larvae between 10-95%, which will later be used to determine the lethal concentration (LC) value (WHO, 2005). Based on the graph of the bio-larvicide probit value of red ginger essential oil on larvae of *Ae. Aegypti,* in this study, shows an increase in larval mortality from a concentration of 200 ppm to 800 ppm, with an LC_{50} value of 257.89 ppm for 3 HSPs. This means that the bio-larvicide concentration of red ginger essential oil is 257.89 ppm and is most effective in influencing death in larvae of *Ae. Aegypti* based on LC_{50} (Figure 4)

From the results of the Kruskal-Wallis Non-Parametric test, a P-value of 0.001<0.05 was obtained. This value means that there is a significant difference in the mortality of *Ae. Aegypti* larvae between treatment groups with different mean values in soaking time for 3 HSPs. This is evidenced by the results of observation of the death of various concentrations of treatment, it can be seen that there is an increase in the mortality of *Ae. Aegypti* larvae as the concentration of red ginger essential oil increases. This is strengthened from the results of the study in Figure 2 on the number of deaths and Figure 3 on the average mortality of *Ae. Aegypti* larvae are increasing along with the increasing concentration of red ginger essential oil. This can happen because the higher the concentration, the more toxic active compounds contained in red ginger essential oil accumulate in the body of *Ae. Aegypti* larvae, so that more larvae die.

The same conclusion but different results were also obtained in Kosini's research on the effects of the extract *Gnidia kassiana* (Thymeleaceae) on *Callosobruchus maculatus,* which indicates that more and more toxic compounds are being absorbed by the larvae *C. maculatus* will slowing down the development and accelerating the death of the larvae by the melanization of the cuticle, which results in the disruption of the endocrine system due to the secondary metabolite compounds contained in the extract *Gnidia kassiana* (Kosini & Nukenine, 2017). In addition, in the research that we have done previously on bio-insecticides of cattilage extract (*Polygala paniculata*) in mosquito control of *Ae. Aegypti* with the concentrations of 10%, 15%, 20%, and 25%, the higher concentration of *P. Paniculata* extract, there will be more *Ae. Aegypti* mosquitoes died. At a concentration of 10%, it can only kill *Ae. Aegypti* mosquitoes as much as 52%, while the concentration of 25% kills more *Ae. Aegypti mosquitoes,* i.e., 100% within 60 minutes, every 5 minutes of observation (Wahyuni *et al.*, 2022). Likewise,

with research on vegetable insecticides of basil leaf extract (*Ocimum basil*) against the death of *Ae. Aegypti*, get more and more *Ae. Aegypti* mosquitoes absorbing the toxin compounds of basil leaf extract, the more mosquitoes die, and the longer the exposure, the higher the toxicity level (Wahyuni & Yulianto, 2018).

The influence of larvicides to kill insects by the soaking method depends on the shape, how it enters the insect's body, the type of substance contained, the concentration dose, and the duration of exposure (Vasantha-Srinivasan *et al.*, 2016; Pineda-Cortel *et al.*, 2019). In this study, it can be seen in Figure 2 that at 12 hours of soaking observation in a concentration of 800 ppm, 82% of the Ae. *Aegypti* larvae can be killed, and the total larvae that died during the 3 HSPs was 100%. This number is the largest and fastest number in killing *Ae. Aegypti* larvae, compared to other concentrations. Another thing that needs to be considered during the testing process in this study is water temperature and air humidity, because one of the causes of *Ae. Aegypti* larvae survive even after immersion has been carried out, which is caused by the temperature of the water and the humidity of the air where the test was carried out. From the results of observations that have been made, the average water temperature when testing red ginger essential oil on *Ae. Aegypti* larvae are around 24^0C- 25^0C and normal indoor air humidity, which is around 69.8% - 72.3%. Conditions for mosquito breeding of *Ae. Aegypti,* that is, at a conducive humidity between 60 – 80%. In this study, the temperature did not affect the death of the *Ae. Aegypti* larvae, because the temperature between 24^0C- 25^0C is the optimal temperature. It is also explained by Nikookar that water temperature and pH are environmental factors that can affect the growth of larvae, and the optimum temperature for mosquito growth is 20°C to 25°C, and pH 6–8 (Nikookar *et al.*, 2017).

Larval death process of *Ae. Aegypti* in this study is influenced by compounds contained in red ginger essential oil, namely Sesquiterpene compounds consisting of three substances, namely: (Zingiberene, Zingiberol, Farnesene), which play a role in providing aroma (smell), and Gingerol, Shogaol, and Paradol as compounds that provide flavor (Stoner, 2013). The mechanism of action of this substance enters the body of *Ae. Aegypti* larvae through the surface of the body (contact toxins), the respiratory system (respiratory toxins), and through the mouth and digestive tract (stomach toxins). This is reinforced by several opinions that state that the level of larvicide toxicity to kill larvae depends on the form of larvicide, how it enters the larva's body, the size and arrangement of the larva's body, as well as the stage and habitat. Larvicides enter the larva's body in three ways, namely through the surface of the body, through the mouth and digestive tract, and through the respiratory system (da Botas *et al.*, 2017; Husna *et al.*, 2020; Rohmah *et al.,* 2020).

From the observations, behavior, and condition of the larvae of *Ae. Aegypti* When soaking with red ginger essential oil, it looks restless and moves actively, fluctuating at concentrations of 200 ppm and 400 ppm, but moves very restlessly and is very active at a concentration of 600 ppm, especially at 800 ppm. At intervals, it can be seen that the movement of the larvae looks stiff like a seizure, followed by weakening movements, falling to the bottom of the test glass, and dying. Larval death of *Ae. Aegypti* is due to the content of red ginger, namely zingiberene, zingiberol, curcumene, and farnesene, which have a sharp taste and aroma (Stoner, 2013). Zingiberen, zingiberol, curcumene, and farnesene indirectly function as fumigants that evaporate into gases. Fumigants are volatile insecticides that become gases and enter the body of insects through the surface of the body and respiratory system, namely the trachea, and are distributed throughout the body, causing death (Husna *et al.*, 2020).

Zingiberen, which is one of the compounds in red ginger essential oil, enters the larvae of *Ae. Aegypti* through the surface of the body, which works as a contact poison. This compound plays a role in causing larvae of *Ae. Aegypti* cannot eat because they cannot recognize food. This may be due to the influence of zingiberen, which is in contact with the larva's body, which interferes with nerves, especially the olfactory organs that function to recognize food. As stated by Moon and Lee

that Zingiberen acts as a receptor that activates anti-eating signals in the insect's central nerves, which inhibits the work of the olfactory organs (olfactory), resulting in insects being unable to smell and recognize the presence of food around them. In addition, zingiberen can cause damage to the digestive tract to reduce the larvae's feeding activity, which causes the larvae to become weak and die slowly (Moon *et al.,* 2018). Zingiberen can also be released into larval cells so that it interferes with the process of absorption of food juice and the process of cell transport. With damage to the cytoplasmic membrane, it will cause the compound contained in red ginger, namely zingiberen, to easily penetrate the larva's body to cause damage to the membrane tissue and interfering with the physiological function of the larva's body (Boekoesoe & Ahmad, 2022). In addition to zingiberen, the content of essential oil compounds from red ginger plays a role in causing the death of larvae of *Ae. Aegypti* Zingiberol is also a contact poison, acting as a receptor that activates anti-feeding signals in the central nervous system of insects (Moon *et al.,* 2018; Husna *et al.*, 2020). Zingiberen and zingiberol are the most likely to cause larvae *Ae. Aegypti* The movement looks like it's stiff, then weakens and eventually dies.

In addition to zingiberen and zingiberol, red ginger essential oils also contain gingerol and shagaol. In red ginger, gingerol, shogaol, and paradol are compounds that give a spicy taste (Stoner, 2013). Shogaol is effective in suppressing intestinal contractions and is an antitussive, 6-Shogaol is a dehydrator of gingerol (Mao *et al.*, 2019). Effect of gingerol on larval mortality of *Ae. Aegypti* in this study is a stomach poison that is ingested. Gingerol actively damages the outer membrane and cytoplasmic membrane of the digestive *Ae. Aegypti* larvae cause the lysis of the larval cell membrane so that the absorption of food is disrupted, and finally, the larvae limp and die. The same opinion, according to Mao, is that the lysis of the cell membrane will result in its permeability being disrupted, so that there is a leakage of the cytoplasmic membrane because of the breakdown of phospholipid molecules due to H+ ions. This damaged cytoplasmic membrane will cause toxic compounds to freely penetrate the insect's body, so that physiological, hormonal work, and digestive system disorders occur, which eventually lead to death (Mao *et al.*, 2019). Likewise, Syukur's opinion in his research on Properties of red ginger fraction (*Zingiber officinale* Roscoe var. rubrum) as an insecticide against *Aedes aegypti* and Boekoesoe in his research on extracts of *Zingiber officinale Rosc* as a natural insecticide against larvae of *Aedes aegypti* (Syukur *et al.*, 2018; Boekoesoe & Ahmad, 2022).

Furthermore, this study also calculated the LC_{50} value, which is intended to measure the lethal concentration of red ginger essential oil against larvae of *Ae. Aegypti.* Based on the calculation using the probit analysis method, the LC_{50} value was obtained as 257.89 ppm. The test results showed that red ginger essential oil had larvicide potential against larvae of *Ae. Aegypti*, with an LC $value_{50}$ of 257.89 ppm. LC $Value_{50}$ when compared to the lowest concentration in this study, which is 200 ppm, there is a small difference of 57.89 ppm. From these results, it can be concluded that the concentration of 257.89 ppm of red ginger essential oil in this study is the most effective in killing 50% of the larvae, because it provides an effective concentration of 257.89 ppm, which can provide a death effect of 50% on the larvae of *Ae. Aegypti*. Larval death *Ae. Aegypti* is due to its inability to detoxify the essential oil compounds of red ginger that enter the body (Figure 4).

The results of this study are different from Akon's research on essential oil activities of *Ocimum basil* and *Cymbopogon citratus* in mosquito control of *Anopheles funestus,* as Antimalarial was carried out at concentrations of 250 ppm, 200 ppm, 150 ppm, 100 ppm, and 50 ppm during 24 hours of observation. The results showed that essential oils of *O. basilicum* and *C. citratus* have insecticidal and anti-plasmodial potential on Larvae of *Anopheles funestus* with LC_{50} by 35.5 ppm and 34.6 ppm (Akono Ntonga *et al.*, 2014). Furthermore, Najar reported that the larvicide potential of essential oils *S. dorisiana* and *S. sclarea* LC_{50} ranges from 71.08 to 559.77 ppm (Najar *et al.*, 2020). The results of Pandiyan's research found that the LC_{50} of *Syzygium aromaticum* essential oil is effective against *Ae. Aegypti* 66.90 mgL^{-}

[1], essential oil *Illicium verum,* shows larvicide potential against *Ae. Aegypti* at LC_{50} 41.30 mgL^{-1} and essential oils *Trachyspermum ammi* also show larvicide potential against *Ae. Aegypti* with LC_{50} by 39.48 mgL^{-1} (Pandiyan *et al.,* 2019).

From the results of this study, it can be concluded that the active substances contained in red ginger essential oil have an effect and are effective in killing the *Ae. Aegypti* larvae. The most effective concentration is 257.89 ppm in killing 50% of the larvae (LC_{50}). The positive control in this study is intended to compare the quality of the concentration of red ginger essential oil, whether it is the same as the positive control, namely, abate powder containing temephos, which has been used in the community so far. Results obtained in the first 12 hours of observation showed 100% larval mortality of *Ae. aegypti.* While negative control with aqueducts was also carried out to compare its effectiveness with red ginger essential oil, it turned out that there was no *Ae. Aegypti* larvae that died after every 12 hours of observation. Therefore, red ginger essential oil is effective and a potential biolarvicide in mosquito control of *Ae. Aegypti* because environmentally friendly, safe for other living things, not cause resistance to *Ae. Aegypti* mosquitoes, has high economic value, and easily accessible in different parts of the world, so that it can be used as an alternative to chemical larvicides (Pandiyan *et al.,* 2019). In addition to having various pharmacological activities (Zhang *et al.*, 2022), antioxidant and anti-cancer (Ghasemzadeh *et al.,* 2016), Antibacterial (Sivasothy *et al.*, 2011), Immunomodulatory activity, Antihypertensive, Antihyperlipidemic, Antihyperuricemic, Antimicrobial, and Cytotoxic (Zhang *et al.*, 2022).

Conclusion

The active substances contained in red ginger essential oil (*Zingiber officinale* Var. Rubrum) Effective and effective in killing *Ae. Aegypti* larvae. The most effective concentration is 257.89 ppm in killing 50% of the larvae (LC_{50}). Therefore, Red Ginger Essential Oil Potential to be a biolarvicide for controlling *Ae. Aegypti* because not so toxic that it is safe for humans, does not leave residue in the environment, and will not cause resistance to Aegypti mosquitoes. Red ginger essential oil (*Zingiber officinale* Var. Rubrum) is effectively used as a natural biolarvicide in mosquito control of *Ae. Aegypti.* So it is expected to reduce dengue fever cases.

References

Akollo, I.R., Pattipeluhu, L., Lameky, V.Y., & Ivakdalam, L.M., 2020. The Resistance Status of Aedes aegypti to Malathion and Gene Ace-1 Mutation in Ambon City. *Jurnal Vektor Penyakit*, 14(2), pp.119–128.

Akono Ntonga, P., Baldovini, N., Mouray, E., Mambu, L., Belong, P., & Grellier, P., 2014. Activity of Ocimum basilicum, Ocimum canum, and Cymbopogon citratus Essential Oils Against Plasmodium falciparum and Mature-Stage Larvae of Anopheles funestus s.s. *Parasite*, 21(33), pp.1–8.

AlShebly, M.M., AlQahtani, F.S., Govindarajan, M., Gopinath, K., Vijayan, P., & Benelli, G., 2017. Toxicity of ar-curcumene and epi-β-bisabolol from Hedychium larsenii (Zingiberaceae) Essential Oil on Malaria, Chikungunya and Japanese encephalitis Mosquito Vectors. *Ecotoxicology and Environmental Safety*. 137(-), pp.149–157

Amelia-Yap, Z.H., Chen, C.D., Sofian-Azirun, M., & Low, V.L., 2018.Pyrethroid Resistance in the Dengue Vector Aedes aegypti in Southeast Asia: Present Situation and Prospects for Management. *Parasites and Vectors*, 11, pp.2–17.

Boekoesoe, L., & Ahmad, Z.F., 2022. The Extraction of Zingiber Officinale Rosc as a Natural Insecticide for Aedes Aegypti Larvae. *Kemas*, 18(2), pp.250–257.

Da Botas, G.S., Cruz, R.A.S., Almeida, F.B.D., Duarte, J.L., Araújo, R.S., Souto, R.N.P., Ferreira, R., Carvalho, J.C.T., Santos, M.G., Rocha, L., Pereira, V.L.P., & Fernandes, C.P., 2017. Baccharis reticularia DC. and Limonene Nanoemulsions: Promising Larvicidal Agents for Aedes aegypti (Diptera: Culicidae) Control. *Molecules*, 22(11), pp.2–14.

Darriet, F., 2016. An Anti-Mosquito Mixture for Domestic Use, Combining a Fertiliser and a Chemical or Biological Larvicide. *Pest Manag Sci*, 72, pp.1340–1345.

Fontana, J.D., Ferreira, R.L., Zuccolotto, T., Dallagassa, C.B., Wielewski, L.P., Chalcoski,

B.M.S., da Silva, M.A.N., Richardi, V.S., Golart, J., & Rodovalho, C.M., 2020. Accelerating the Morphogenetic Cycle of the Viral Vector Aedes aegypti Larvae for Faster Larvicidal Bioassays. *BioMed Research International*, 2020, pp.1–9.

Galvão, J.G., Cerpe, P., Santos, D.A., Gonsalves, J.K., Santos, A.J., Nunes, R.K., Lira, A.A., Alves, P.B., Corte, R.L., Blank, A.F., Silva, G.F., Cavalcanti, S.C., & Nunes, R.S., 2019. *Lippia gracilis* Essential Oil in β-cyclodextrin Inclusion Complexes: An Environmentally Safe Formulation to Control *Aedes aegypti* Larvae. *Pest Management Science*, 75(2), pp.452–459.

Ghasemzadeh, A., Jaafar, H.Z.E., & Rahmat, A., 2016. Variation of the Phytochemical Constituents and Antioxidant Activities of Zingiber Officinale var. rubrum Theilade Associated with Different Drying Methods and Polyphenol Oxidase Activity. *Molecules*, 21(6).

Govindarajan, M., Rajeswary, M., Arivoli, S., Tennyson, S., & Benelli, G., 2016., Larvicidal and Repellent Potential of Zingiber nimmonii (J. Graham) Dalzell (Zingiberaceae) Essential Oil: An Eco-Friendly Tool Against Malaria, Dengue, and Lymphatic Filariasis Mosquito Vectors?. *Parasitology Research*, 115(5), pp.1807–1816.

Govindarajan, M., Rajeswary, M., Hoti, S. L., & Benelli, G., 2016. Larvicidal Potential of Carvacrol and Terpinen-4-ol from the Essential Oil of Origanum vulgare (Lamiaceae) against Anopheles stephensi, Anopheles subpictus, Culex quinquefasciatus and Culex tritaeniorhynchus (Diptera: Culicidae). *Research in Veterinary Science*, 104, pp.77–82.

Hikal, W.M., Baeshen, R.S., & Said-Al Ahl, H.A.H., 2017. Botanical Insecticide as Simple Extractives for Pest Control. *Cogent Biology*, 3(1404274), pp.3–16.

Husna, I., Setyaningrum, E., Handayani, T.T., Kurnia, Y., Palupi, E.K., Umam, R., & Andriana, B.B., 2020. Utilization of Basil Leaf Extract as Anti-Mosquito Repellent: A Case Study of Total Mosquito Mortality (Aedes aegypti 3rd Instar). *Journal of Physics: Conference Series*, 1467(1), pp.1–7.

Kandel, Y., Vulcan, J., Rodriguez, S.D., Moore, E., Chung, H.N., Mitra, S., Cordova, J.J., Martinez, K.J.L., Moon, A.S., Kulkarni, A., Ettestad, P., Melman, S., Xu, J., Buenemann, M., Hanley, K.A., & Hansen, I.A., 2019. Widespread Insecticide Resistance in Aedes aegypti L. From New Mexico, U.S.A. *PLoS ONE*, 14(2), pp.1–16.

Kemenkes RI., 2020. *Incidence Rate Per 100.000 Penduduk Demam Berdarah Dengue Tahun 2010-2018*. Jakarta.

Kemenkes RI., 2023. *Laporan Tahunan Demam Berdarah Dengue 2022*. Kemenkes RI. Jakarta,Indonesia.

Kosini, D., & Nukenine, E.N., 2017. Bioactivity of Novel Botanical Insecticide from Gnidia Kaussiana (Thymeleaceae) Against Callosobruchus maculatus (Coleoptera: Chrysomelidae) in Stored Vigna Subterranea (Fabaceae) Grains. *Journal of Insect Science*, 17(1), pp.1–7.

Madreseh-Ghahfarokhi, S., Dehghani-Samani, A., Pirali, Y., & Dehghani-Samani, A., 2019. Zingiber officinalis and Eucalyptus globulus, Potent Lethal/Repellent Agents Against Rhipicephalus bursa, Probable Carrier for Zoonosis. *Journal of Arthropod-Borne Diseases*, 13(2), pp.214–223.

Manh, H.D., Hue, D.T., Hieu, N.T.T., Tuyen, D.T.T., & Tuyet, O.T., 2020. The Mosquito Larvicidal Activity of Essential Oils From Cymbopogon and Eucalyptus Species in Vietnam. *Insects*, 11(2), pp.1–7.

Mao, Q.Q., Xu, X.Y., Cao, S.Y., Gan, R.Y., Corke, H., Beta, T., & Li, H.B., 2019. Bioactive Compounds and Bioactivities of Ginger (Zingiber Officinale roscoe). *Foods*, 8(6), pp.1–21.

Moon, Y.S., Lee, H.S., & Lee, S.E., 2018. Inhibitory Effects of Three Monoterpenes from Ginger Essential Oil on Growth and Aflatoxin Production of Aspergillus Flavus and Their Gene Regulation in Aflatoxin Biosynthesis. *Applied Biological Chemistry*, 61(2), pp.243–250.

Najar, B., Pistelli, L., Venturi, F., Ferroni, G., Giovanelli, S., Cervelli, C., Bedini, S., & Conti, B., 2020. Salvia spp. Essential Oils Against the Arboviruses Vector Aedes albopictus (Diptera: Culicidae): Bioactivity, Composition, and Sensorial Profile—Stage 1. *Biology*, 9(206), pp.1–16.

Top of Form

Nikookar, S.H., Fazeli-Dinan, M., Azari-Hamidian, S., Mousavinasab, S.N., Aarabi, M., Ziapour, S.P., Esfandyari, Y., & Enayati, A., 2017. Correlation Between Mosquito Larval Density and Their Habitat Physicochemical Characteristics in Mazandaran Province, Northern Iran. *PLoS Neglected Tropical Diseases*, 11(8), pp.1–19.

Pandiyan, G.N., Mathew, N., & Munusamy, S., 2019.

Larvicidal Activity of Selected Essential Oil in Synergized Combinations Against Aedes aegypti. *Ecotoxicology and Environmental Safety*, 174, pp.549–556.

Pineda-Cortel, M.R.B., Cabantog, R.J.R., Caasi, P.M., Ching, C.A.D., Perez, J.B.S., & Godisan, P.G.M., 2019. Larvicidal and Ovicidal Activities of Artocarpus Blancoi Extracts Against Aedes aegypti. *Pharmaceutical Biology*, 57(1), pp.120–124.

Rezzoug, M., Bakchiche, B., Gherib, A., Roberta, A., Guido, F., Kilinçarslan, O., Mammadov, R., & Bardaweel, S.K., 2019. Chemical Composition and Bioactivity of Essential Oils and Ethanolic Extracts of Ocimum basilicum L. and Thymus algeriensis Boiss. & Reut. from the Algerian Saharan Atlas. *BMC Complementary and Alternative Medicine*, 19(1), pp.1–10.

Rohmah, E.A., Subekti, S., & Rudyanto, M., 2020. Larvicidal Activity and Histopathological Effect of *Averrhoa bilimbi* Fruit Extract on *Aedes aegypti* from Surabaya, Indonesia. *Journal of Parasitology Research*, 2020, pp.1–5.

Rojas-Pinzón, P.A., Silva-Fernández, J.J., & Dussán, J., 2018. Laboratory and Simulated-Field Bioassays for Assessing Mixed Cultures of Lysinibacillus sphaericus Against Aedes aegypti (Diptera: Culicidae) Larvae Resistant to Temephos. *Aplied Entomologyand Zoologi*, 53, pp.183–191.

Scalvenzi, L., Radice, M., Toma, L., Severini, F., Boccolini, D., Bella, A., Guerrini, A., Tacchini, M., Sacchetti, G., Chiurato, M., Romi, R., & Luca, M.D., 2019. Larvicidal Activity of Ocimum campechianum, Ocotea quixos and Piper aduncum Essential Oils Against Aedes aegypti. *Parasite*, 26(23), pp.1–8.

Sivasothy, Y., Chong, W.K., Hamid, A., Eldeen, I.M., Sulaiman, S.F., & Awang, K., 2011. Essential Oils of Zingiber officinale var. rubrum Theilade and Their Antibacterial Activities. *Food Chemistry*. Elsevier, 124(2), pp.514–517.

Stoner, G.D., 2013. Ginger: Is It Ready for Prime Time?. *Cancer Prevention Research*, 6(4), pp.257–262.

Suryati., Santoni, A., Arifin, B., Ferdinal, N., Salim, E., Amelia, A.,Zein, L., Mairanti, S., & Lestari, I.P., 2022. Analysis of Chemical Content, Cytotoxic and Anti-Bacterial Activity Essential Oil of Lantana Camara Linn Leaves from Various Regions. *Molekul*, 17(2), pp.156–164.

Syukur, K.Y., Anwar, C., Dalilah., Salni., & Novrikasari., 2018. The Efficacy of Red Ginger Fraction (Zingiber officinale Roscoe var. rubrum) as Insecticidal Aedes aegypti. *Bioscientia Medicina: Journal of Biomedicine and Translational Research*, 2(2), pp.31–41.

Valle, D., Bellinato, D.F., Viana-Medeiros, P.F., Lima, J.B.P., & Junior, A.J.M., 2019. Resistance to Temephos and Deltamethrin in Aedes aegypti from Brazil between 1985 and 2017. *Memorias do Instituto Oswaldo Cruz*, 114(3), pp.1–17.

Vasantha-Srinivasan, P., Senthil-Nathan, S., Thanigaivel, A., Edwin, E., Ponsankar, A., Selin-Rani, S., Pradeepa, V., Sakthi-Bhagavathy, M., Kalaivani, Hunter, W.B., Duraipandiyan, V., & Al-Dhabi, N.A., 2016. Developmental Response of Spodoptera Litura Fab. to Treatments of Crude Volatile Oil from Piper betle L. and Evaluation of Toxicity to Earthworm, Eudrilus eugeniae Kinb. *Chemosphere*, 155, pp.336–347.

Wahyuni, D., Sari, N.P., Jasril., & Syahri, J., 2022. Bio-insecticide's Extract of Scented Root (Polygala paniculata) in Controlling the Mosquito Aedes aegypti (L.). *Makara Journal of Science*, 26(2), pp.107–113.

Wahyuni, D., Makomulamin., & Sari, N.P., 2021. *Buku Ajar Entomologi Dan Pengendalian Vektor*. Deepublish Publisher.

Wahyuni, D., & Yulianto, B., 2018. Basil leaf (Ocimmum basillum form citratum) Extract Spray in Controling Aedes aegepty. *Jurnal Kesehatan Masyarakat (KEMAS)*, 14(2), pp.147–156.

WHO., 2005. *Guidelines for Laboratory and Field Testing of Mosquito Larvicides*. World Health Organization, pp.1–41.

WHO., 2023a. *Dengue and Severe Dengue.* Switzerland: Word Health Organization.

WHO., 2023b. *Vector Born Deseases*. Word Health Organization.

Zhang, S., Kou, X., Zhao, H., Mak, K-K., Balijepalli, M.K., & Pichika, M.R., 2022. Zingiber officinale var. rubrum: Red Ginger's Medicinal Uses. *Molecules*, 27(3).

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Soy Juice Is Effective in Reducing Hot Flush Symptoms in Premenopausal Women

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Abstract

Hot flush occur in 73.3% of premenopausal women and are often accompanied by sleep disturbances and mood swings. This study aims to determine the effectiveness of soy milk in reducing hot flush symptoms in premenopausal women. The research method used a pre-experimental design with a one-group pretest-posttest design. The sample was selected using a purposive sampling technique with a total of 31 premenopausal women. Respondents' hot flush conditions were measured using the Hot Flush Range Scale (HFRS) questionnaire. The intervention given to respondents was 250 ml of soy milk. It was given twice daily, in the morning and afternoon, for 7 days. The study was conducted in Sleman Regency in July 2024. Data analysis used the Wilcoxon Signed-Ranks Test. The results showed that soy milk consumption had a significant effect on reducing hot flush symptoms with a significance value of 0.000 ($\rho<0.05$). Isoflavones in soy milk have biological activity resembling estrogen. It binds to estrogen receptors (ERs) as an agonist. This isoflavone activity stimulates the estrogen receptor Erα, influences the transcription process of neuronal cells in the central nervous system, and results in a reduction in hot flash symptoms. Thus, soy extract may be an alternative non-hormonal treatment for hot flash symptoms in premenopausal women.

Introduction

Menopause is characterized by vasomotor symptoms, including hot flashes, excessive sweating, and sometimes trembling and feeling cold, which appear suddenly and sometimes throughout the day or only at night. These symptoms are usually the most common and disturbing during menopause. Vasomotor symptoms begin to be complained of two years before the last menstrual period and peak one year after menopause occurs. Nearly 50% of women experience vasomotor symptoms for four years. The prevalence of hot flashes is highest in low-income countries (65.93%), followed by upper-middle-income countries (54.17%) and high-income countries (49.72%) (Fang *et al.*, 2024). Hot flashes are transient feelings of heat, sweating, flushing, anxiety, and shivering lasting for 1-5 minutes. This symptom is often experienced by women over 40. It is one of the most common symptoms of menopause among women, the primary cause of which is estrogen deficiency and abnormal hypothalamic thermoregulatory control problems that result in an abnormal vasodilatory response to small increases in core body temperature. Hot flashes can be managed with hormone replacement therapy, selective serotonin and norepinephrine reuptake inhibitors, in addition to lifestyle modifications (Bansal & Aggarwal, 2019).

Research reports that hot flashes impact sleep quality during the menopausal transition. This complaint often leads to insomnia and directly impacts mood and sleep disturbances, and vice versa. Anxiety and depression during the menopausal transition also potentially increase the risk of vasomotor symptoms and sleep disturbances (Zhou *et al.*, 2021). The impact of vasomotor symptoms on mood and quality of life can be significant and is often

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underestimated, leading to a decreased quality of life due to an increased risk of cardiovascular and metabolic diseases (Jones *et al.*, 2019), depression, and obesity, which exacerbates the negative effects of this condition (Llaneza, 2017).

Hormonal therapy is a conventional therapy that is effective in reducing vasomotor symptoms, including the frequency and severity of hot flashes, but increases the risk of breast cancer. Surveys show that many women prefer Complementary and Alternative Medicine (CAM) over conventional therapies. They perceive CAM as more natural and safe, has positive effects on maintaining general health, and has few or no side effects (Biglia *et al.*, 2019). Preliminary studies indicate that hot flashes occur in 73.3% of premenopausal women and are often accompanied by sleep disturbances and mood swings. Most women do not seek treatment for their symptoms due to limited knowledge of available treatment options. Based on this background, researchers are interested in analyzing the effect of soy extract on hot flash symptoms in premenopausal women.

Method

This study used a pre-experimental procedure with a one-group pretest-posttest design. The study respondents were perimenopausal women who met the inclusion criteria, namely, aged 40–49, were not allergic to soy protein, and did not have any specific health conditions that could affect the study results. The sampling technique used a purposive sampling method, with a total of 31 respondents. The intervention provided was the administration of soy milk twice a day (morning and evening) for 7 consecutive days. The soy milk was prepared without adding sugar, and 250 ml of soy milk contains 25 mg of isoflavones (Messina, 2016). Each day, the respondents received 50 mg of isoflavones. The researcher directly monitored the consumption of soy milk by the respondents to ensure compliance and consistency of treatment. Hot flush symptoms in respondents were measured using the Hot Flush Range Scale (HFRS) instrument (Hunter *et al.*, 2019). While other symptoms, such as somatic complaints, psychological complaints, and urogenital complaints, were measured using the Menopause Rating Scale (MRS) (Heinemann *et al.*, 2004). Measurements of hot flush complaints were carried out daily during the intervention period to monitor changes in symptom intensity cauTiously. Other complaints were measured before and after the intervention. The data obtained were analyzed using the Wilcoxon Signed-Ranks Test to compare the results before and after treatment. This study has received ethical approval from the Health Research Ethics Commission (KEPK) of Aisyiyah University Yogyakarta with registration number 3691/KEP-UNISA/V/2024. All research procedures were aligned with research ethics standards, including obtaining written consent from respondents before it began.

Results and Discussions

The results of the research and data analysis are presented in the following table:

Table 1. Frequency Distribution of Respondent Characteristics

No	Respondent Characteristics	Frequency (f)	Percentage (%)
1.	Mother Age		
	42	5	16,1
	43	1	3,2
	44	5	16,1
	45	3	9,7
	46	5	16,1
	47	4	12,9
	48	3	9,7
	49	5	16,1

No	Respondent Characteristics	Frequency (f)	Percentage (%)
2.	**Parity**		
	≥ 3	12	38,7
	≤ 2	19	61,3
3.	**History of Contraceptive Use**		
	None	5	16,1
	Non Hormonal	11	35,5
	Hormonal	15	48,4
4.	**Workout**		
	Yes	2	6,5
	No	29	93,5
5	Occupation		
	Not work	21	67,7
	Work	10	23,3
6	Body Mass Index (BMI)		
	Ideal	26	84%
	Overweight	5	16%
7	Age at First Marriage		
	< 20 years old	8	25,8%
	≥ 20 years old	23	74,2%

Source: Primary Data, 2024

Based on Table 1, the majority of respondents were 42, 44, 46, and 49 years old, with 5 respondents (16.1%) representing each age group. Menopause often occurs at a median age of 48 years, with an increase in the average age of menopause with increasing parity. The median age of menopause is 3 years earlier in nulliparous women compared to women with four or more births (Sun *et al.*, 2020). Hasil studi menunjukkan bahwa usia yang lebih tua meningkatkan keluhan hot flush yang dirasakan (Gallicchio *et al.*, 2015). Of the 31 respondents, the majority (61.3%) (19 respondents) had a parity of ≤ 2, and the remaining 12 respondents (38.7%) had a parity of ≥ 3. The risk of moderate and severe menopausal syndrome increases in women with ≥ 3 births; Nulliparous women have a higher risk of severe menopausal syndrome compared to those who have had 1 or 2 births (Sun *et al.*, 2020).

Based on contraceptive history, the majority of respondents used hormonal contraception, 15 respondents (48.4%). Some hormonal contraceptive users experienced milder hot flashes (Gallicchio *et al.*, 2015) especially contraceptives containing a combination of estrogen and progesterone (Grandi *et al.*, 2022). The study results showed that physical activity was not significantly associated with hot flashes (Gallicchio *et al.*, 2015). These results differ from the results of a systematic review that reported that exercise can potentially increase the severity of vasomotor symptoms in menopausal women. Although there was a significant increase in vasomotor symptom severity after exercise compared with a control group that did not receive treatment, the certainty of the evidence for this finding is very low (Liu *et al.*, 2022).

Other studies found that physical activity and exercise can reduce the risk of hot flush. Effective types of exercise include aerobics (Witkowski *et al.*, 2024) and yoga, which significantly affect the physical domain of quality of life in perimenopausal women (Marni & Husna, 2023). Physically active women have experienced fewer hot flush. Physical activity can minimize menopausal symptoms, including hot flush. It is related to a sense

Table 2. Average Hot Flush Symptoms Before and After Intervention

Hot Flush Symptoms	Mean	SD	Minimum-Maximum	N	*p value*
Before *(Pre-Test)*	7,84	1,06	6-10	31	0,000
After *(Post-Test)*	2,45	1,12	1-5	31	

Source: Primary Data, 2024

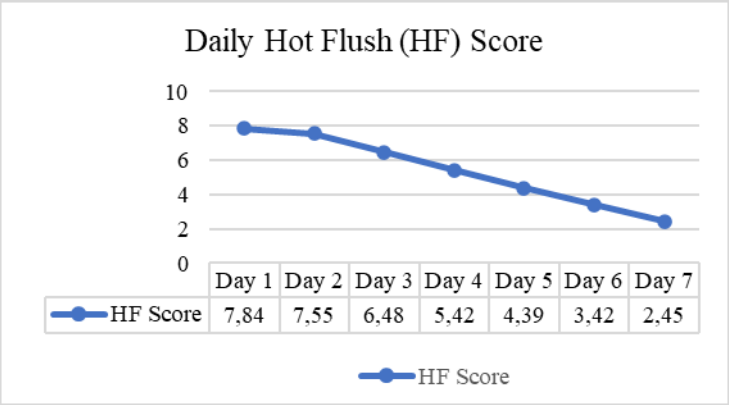

Image 1 Daily Hot Flush Score

of comfort and affects well-being. Physical activity has an indirect effect on psychosomatic factors (Asiamah *et al.*, 2024). A previous study reported that moderate physical activity effectively reduced psychosocial and physical menopause in perimenopausal women in Korea. Thereby improving quality of life by improving menopausal symptoms, although it did not directly affect vasomotor symptoms such as hot flush and sexual problems (M. J. Kim *et al.*, 2014). Perimenopausal women who exercise regularly can improve thermoregulation. It results in active vasodilation and sweating. After exercise, the body produces a more efficient heat dissipation response and increases the body's cooling capacity (Witkowski *et al.*, 2024).

Based on Table 2, before the intervention, the average hot flush symptoms were 7.84, with a minimum level of 6 and a maximum of 10. Furthermore, after the intervention, the average hot flush symptoms decreased to 2.45 with a minimum level of 1 and a maximum of 5. The results of the analysis with the Wilcoxon test showed that there was an effect of giving soy milk on reducing hot flush symptoms in premenopausal mothers with a ρ value of 0.000. So respondents experienced a decrease in hot flush symptoms after consuming soy milk. Based on the results of the Wilcoxon Signed Ranks Test statistic, a ρ value of 0.000 (ρ <0.05) was obtained, showing a significant difference in hot flush symptoms in premenopausal mothers before and after the intervention. Statistically, soy milk has been proven to decrease hot flush symptoms in premenopausal women. Hot flush can be reduced with natural hormone replacement therapy, such as consuming foods rich in phytoestrogens that can increase the production of the hormone estrogen. Foods rich in phytoestrogens include soybean products such as tofu, tempeh, tauco, and soy milk. Isoflavones, one of the important components contained in soy milk, are very helpful in alleviating various symptoms during premenopause and have positive effects on health, used as an alternative therapy for hormonal disorders such as breast and prostate cancer, cardiovascular disease, and osteoporosis (Gómez-Zorita *et al.*, 2020) Although the use of phytoestrogens has side effects on the gastrointestinal system that increase moderately, it does not increase the risk of endometrial cancer or breast cancer as does hormone therapy (Lethaby *et al.*, 2013).

Based on Figure 1, on the first day before being given soy milk, the hot flush score was 7.84, with each day's hot flush decreasing until the 7th day, reaching 2.45. During premenopause, estrogen levels reduce, while norepinephrine levels increase. This leads to increased regulation of serotonin receptors in the hypothalamus, which plays a role in temperature regulation. Decreased

estrogen can affect central alpha-2 receptors, resulting in high central norepinephrine levels. Activation of these noradrenergic and serotonin pathways narrows the upper threshold of the thermoregulatory zone, increasing the likelihood of experiencing hot flush (Morrow *et al.*, 2011). In this study, respondents received a daily intake of approximately 50 mg of phytoestrogen, and with this intake, hot flush complaints decreased daily. Women in Asia experience fewer hot flush complaints than women elsewhere. It is because they regularly consume foods containing 40-80 mg of phytoestrogen per day (Ahmadieh & Jradi, 2021).

In this study, daily soy milk contained large amounts of the isoflavones genistein and daidzein, which can produce estrogen-like effects, functioning estrogenically or anti-estrogenically in humans (Johnson *et al.*, 2019). Consuming isoflavones can help balance estrogen levels in the body and reduce premenopausal symptoms such as hot flush (Mirzavalievich & Abduxolikovich, 2023). Isoflavones are natural compounds with biological activity similar to estrogen and bind to estrogen receptors (ERs) in the cell's nuclear membrane to function as agonists or antagonists. These compounds have a high binding affinity for ERs, particularly ERα and ERβ. This interaction influences cell transcription processes, resulting in stimulation of neurons in the central nervous system and resulting in a reduction in hot flush symptoms (Kang *et al.*, 2022).

Soybeans are a plant that contains isoflavones, and they can be processed into soy milk drinks. Isoflavones are widely used to prevent and treat various women's health problems, particularly premenopausal discomfort (Chalkidou *et al.*, 2023). Soybean isoflavones may be a safer solution during premenopause. Increased health risks during premenopause can be managed by consuming soy products (Khalid, 2020). Isoflavones play a role in regulating the effects of estrogen in the body, depending on the situation. When estrogen levels are insufficient, isoflavones act as agonists and perform estrogen-like functions. Conversely, when estrogen levels are excessive, isoflavones act as antagonists. Isoflavones block estrogen receptors that bind estrogen. Specifically, estrogen antagonist activity is vital in the breast, endometrium, and prostate, suppressing the development of cancer (I.-S. Kim, 2021). A meta-analysis recommends using isoflavones as an alternative intervention that can reduce hot flush by up to

Table 3. Menopausal Symptom Scores (Somatic, Psychological and Urogenital Scales) Before and After Intervention

Menopausal Symptom	Before Intervention		Menopausal Symptom	After Intervention	
	Score	Percentage		Score	Percentage
1. Somatic Subscale			1. Somatic Subscale		
a. Medium	1	3,2%	a. No Symptom	17	54,8%
b. Severe	30	96,8%	b. Light	11	45,2%
Total	31	100%	Total	31	100%
2. Psychological Sub-scale			2. Psychological Subscale		
a. Medium	9	29%	a. No Symptom	26	83,8%
b. Severe	22	71%	b. Light	5	16,2%
Total	31	100%	Total	31	100%
3. Urogenital Subscale			3. Urogenital Subscale		
a. No Symptom	31	100%	No Symptom	31	100%
4. Total Score			4. Total Score		
a. Medium	3	9,7%	a. Very Light	23	74,2%
b. Severe	28	90,3%	b. Light	8	25,8%

Source: Primary Data Juli, 2024

50%. This therapy is easier and more affordable than hormonal therapy (Taku *et al.*, 2012).

The results of this study found that the majority of respondents experienced severe somatic problems (96.8%), and 71% experienced psychological problems. After a 7-day intervention, with a total of 14 doses of soy extract, there was a decrease in somatic symptoms, with the majority experiencing no symptoms (54.8%). A similar decrease also occurred in psychological problems, from 71% in the severe category to 83.8% experiencing no symptoms. This proves that isoflavone administration in perimenopausal women not only reduces hot flush (somatic symptoms) but also reduces psychological symptoms. This is in line with previous studies that reported that postmenopausal women experience somatic and vasomotor symptoms less frequently than perimenopausal women. This condition is influenced by the level of depression experienced. The frequency of vasomotor and somatic symptoms increases with the severity of depression. Depressive symptoms are more common in the premenopausal phase, while the decrease in symptoms in postmenopause correlates with a reduction in reports of vasomotor and somatic symptoms. However, the relationship between depressive and vasomotor symptoms remains unclear, whether they are caused by physiological, psychological, and social mechanisms. Depression is a major contributor to poorer quality of life and health-limiting conditions, such as cardiovascular disease (Borkoles *et al.*, 2015). Soy isoflavone supplementation can be used as an adjunct therapy to help alleviate depressive symptoms associated with menopause. Research (Ahsan & Mallick, 2017) reported that nearly 90% of perimenopausal women reported a 30% reduction in symptoms of severe to very severe fatigue, a decrease in hot flush, improved depressive symptoms, and an improvement in libido. However, soy isoflavones did not affect urogenital symptoms and vaginal dryness index

Conclusion

Regularly consuming soy milk can help increase phytoestrogen levels in premenopausal women. This increase in phytoestrogen levels plays a key role in reducing the hot flashes that often occur during perimenopause. Phytoestrogens, particularly the isoflavones found in soy, work by mimicking the effects of estrogen in the body, thereby helping reduce symptoms associated with the decline in natural estrogen levels in women entering menopause. This study suggests that regular soy milk consumption may be an effective alternative for managing hot flash symptoms in premenopausal women, thereby improving quality of life during perimenopause

References

Ahmadieh, H., & Jradi, N., 2021. Prevalence of Menopausal Hot Flashes in Lebanon: A Cross-Sectional Study. International Journal of Reproductive BioMedicine, 19(9), pp.789–800.

Ahsan, M., & Mallick, A.K., 2017. The Effect of Soy Isoflavones on The Menopause Rating Scale Scoring in Perimenopausal and Postmenopausal Women: A Pilot Study. Journal of Clinical and Diagnostic Research, 11(9), pp.FC13–FC16.

Asiamah, N., Aladenola, O.B., Cronin, C., Sepp, L., & O'Callaghan, K., 2024. Effects of Physical Activity on Menopausal Symptoms, Psychosomatic Factors and Well-Being Among Working Women in England: A Path Analysis. Women's Health, 20, pp.1–12.

Bansal, R., & Aggarwal, N., 2019. Menopausal Hot Flashes: A Concise Review. Journal of Mid-Life Health, 10(1), pp.6–13.

Biglia, N., Bounous, V.E., De Seta, F., Lello, S., Nappi, R.E., & Paoletti, A.M., 2019. Non-Hormonal Strategies for Managing Menopausal Symptoms in Cancer Survivors: An Update. Ecancermedicalscience, 13, pp.1–15.

Borkoles, E., Reynolds, N., Thompson, D.R., Ski, C.F., Stojanovska, L., & Remco C.J.P., 2015. The Role of Depressive Symptomatology in Peri- and Post-Menopause. Maturitas, 81(2), pp.306-310.

Chalkidou, A., Oikonomou, E., Lambrinos, D., Bothou, A., Kyriakou, D., Nikolettos, K., Iatrakis, G., Zervoudis, S., & Tsikouras, N., 2023. The Comparative Study of the Administration of the Combination Preparation of Isoflavones and Hyaluronic Acid in Menopausal Women for the Treatment of the Symptoms of Menopause, Urogenital Atrophy and Oteoporosis in Relation to Existing Hormone Replacemen. Materia Socio Medica, 35(3), pp.206.

Fang, Y., Liu, F., Zhang, X., Chen, L., Liu, Y., Yang,

L., Zheng, X., Liu, J., Li, K., & Li, Z., 2024. Mapping Global Prevalence of Menopausal Symptoms Among Middle-Aged Women: A Systematic Review and Meta-Analysis. BMC Public Health, 24(1).

Gallicchio, L., Miller, S.R., Kiefer, J., Greened, T., Zacur, H.A., & Flaws, J.A., 2015. Risk Factors For Hot Flashes Among Women Undergoing The Menopausal Transition: Baseline Results from the Midlife Women's Health Study. Menopause, 22(10), pp.1098–1107.

Gómez-Zorita, S., González-Arceo, M., Fernández-Quintela, A., Eseberri, I., Trepiana, J., & Portillo, M.P., 2020. Scientific Evidence Supporting the Beneficial Effects of Isoflavones on Human Health. Nutrients, 12(12), pp.1–25.

Grandi, G., Vinci, P. Di, Sgandurra, A., Feliciello, L., Monari, F., & Facchinetti, F., 2022. Contraception During Perimenopause : Practical Guidance. International Journal of Women's Health, 14(July), pp.913–929.

Heinemann, K., Ruebig, A., Potthoff, P., Schneider, H.P.G., Strelow, F., Heinemann, L.A.J., & Thai, D.M., 2004. The Menopause Rating Scale (MRS) Scale: A Methodological Review. Health and Quality of Life Outcomes, 2, pp.1–8.

Hunter, M.S., Nuttall, J., & Fenlon, D., 2019. A Comparison of Three Outcome Measures of The Impact of Vasomotor Symptoms on Women's Lives. Climacteric, 22(4), pp.419–423.

Johnson, A., Roberts, L., & Elkins, G., 2019. Complementary and Alternative Medicine for Menopause. 24, pp.1–14.

Jones, H., Bailey, T.G., Barr, D.A., Lucas, M.F.R.A.I., Crandall, C.G., & Craig, G.C.D.A.L., 2019. Is Core Temperature the Trigger of a Menopausal Hot Flush?. Menopause, 26(9), pp.1016–1023.

Kang, I., Rim, C.H., Yang, H.S., Choe, J.-S., Kim, J.Y., & Lee, M., 2022. Effect of Isoflavone Supplementation on Menopausal Symptoms: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Nutrition Research and Practice, 16(Suppl 1), pp.S147.

Khalid, S., 2020. Soy Reduces the Symptoms of Menopause. Biomedical Journal of Scientific & Technical Research, 32(4).

Kim, I.-S., 2021. Current Perspectives on the Beneficial Effects of Soybean Isoflavones and Their Metabolites for Humans. Antioxidants, 10(7), pp.1064.

Kim, M.J., Cho, J., Ahn, Y., Yim, G., & Park, H.Y., 2014. Association between Physical Activity and Menopausal Symptoms in Perimenopausal Women. BMC Women's Health, 14(1), pp.1–8.

Lethaby, A., Marjoribanks, J., Kronenberg, F., Roberts, H., Eden, J., & Brown, J., 2013. Phytoestrogens for Menopausal Vasomotor Symptoms. Cochrane Database of Systematic Reviews, 2013(12).

Liu, T., Chen, S., Mielke, G.I., McCarthy, A.L., & Bailey, T.G., 2022. Effects of Exercise on Vasomotor Symptoms in Menopausal Women: A Systematic Review and Meta-Analysis. Climacteric, 25(6), pp.552–561.

Llaneza, P., 2017. Clinical Symptoms and Quality of Life: Hot Flashes and Mood. Menopause, 2017, pp.69–78.

Marni, & Husna, P.H., 2023. Physical Domain of Quality of Life in Premenopause and Post Menopause Women in Central of Java. Kemas, 19(2), pp.319–332.

Messina, M., 2016. Soy and Health Update: Evaluation of The Clinical and Epidemiologic Literature. Nutrients, 8(12).

Mirzavalievich, M., & Abduxolikovich, K., 2023. Soy Protein, Isoflavones, and Cardiovascular Health. International Journal of Scientific Trends, 2(4), pp.10–18.

Morrow, P.K.H., Mattair, D.N., & Hortobagyi, G.N., 2011. Hot Flashes: A Review of Pathophysiology and Treatment Modalities. The Oncologist, 16(11), pp.1658–1664.

Sun, X., Zhang, R., Wang, L., Shen, X., Lu, Y., An, J., Wang, L., Wang, Y., Luo, X., Zhu, H., & Zhang, X., 2020. Association Between Parity and the Age at Menopause and Menopausal Syndrome in Northwest China. Sage Journals, 33(1).

Taku, K., Melby, M.K., Kronenberg, F., Kurzer, M.S., & Messina, M., 2012. Extracted or Synthesized Soybean Isoflavones Reduce Menopausal Hot Flash Frequency And Severity: Systematic Review and Meta-Analysis of Randomized Controlled Trials. Menopause: The Journal of The North American Menopause Society, 19(7), pp.776–790.

Witkowski, S., Evard, R., Rickson, J.J., & White, Q., 2024. Physical Activity and Exercise for Hot Flashes: Trigger or Treatment?. Menopause, 30(2), pp.218–224.

Zhou, Q., Wang, B., Hua, Q., Jin, Q., Xie, J., Ma, J., & Jin, F., 2021. Investigation of the Relationship between Hot Flashes, Sweating and Sleep Quality in Perimenopausal and Postmenopausal Women: The Mediating Effect of Anxiety and Depression. BMC Women's Health, 21(1), pp.1–8.

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Socioeconomic Status as a Root Cause of Child Malnutrition

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Abstract

Nutritional problems increase the prevalence of brain disorders and intellectual development disorders in underweight toddlers by 52%, severe stunting by 6.32%, and severe wasting by 1.22%. The type of qualitative research is related to problems in toddlers who experience nutritional issues. The primary informants were 9 mothers who had malnourished toddlers. Data triangulation involved nutritionists, health cadres, and health center midwives. The research location was in the working area of the Bantul Regency Health Center, Special Region of Yogyakarta. Data were taken by in-depth interviews and home observations. The instruments used were interview guidelines and Healthy Home assessment instruments. Data analysis used thematic analysis. The results obtained 5 themes, including low socio-economic status, health status, parenting style and feeding of toddlers with permissive and unresponsive parenting styles, low maternal education, and poverty resulting in low provision of quality food. Almost all malnourished toddlers experience health problems, and unhealthy housing conditions, and nutrition management carried out by the health center is good.

Introduction

The golden age (golden age in toddlers) is the most crucial period in life. At this time, there are many problems in achieving optimal toddler growth and development. The government programs various efforts in dealing with toddler malnutrition. Preventive and promotive efforts by early detection guidebooks and education on stimulation and nutrition in toddlers. While curative efforts by the Therapeutic Feeding Centers in health facilities. In several health services, these curative efforts have been implemented well by involving cross-sectors and cross-programs (Taguri *et al.,* 2015). The results of a systematic review study stated that interventions to improve good water quality, good sanitation, and maintaining personal hygiene during treatment for severe acute malnutrition can improve recovery but are unable to prevent the recurrence of malnutrition (Patlán-Hernández *et al*., 2022).

Many government programs to overcome malnutrition have not yet been able to free Indonesia from malnutrition. Based on the results of the National Riskesdas in 2018, which stated that toddlers (0-59 months) with malnutrition (BB/A <-3sd) were 3.9%, toddlers with very short (PB/A <-3sd) were 11.59%, toddlers with very thin (severe wasting) BB/PB <-3sd were 3.5% (Indonesian Ministry Of Health, 2014). Meanwhile, Bantul Regency is located in the Special Region of Yogyakarta, ranking second in the problem of toddler nutritional status. In 2018, the nutritional status of toddlers (0-59 months) with underweight (BB/A < -3sd) was 2.52%, toddlers with very short (PB/A < -3sd) were 6.32%, toddlers with very thin (severe wasting) BB/PB < -3sd were 1.22% (Indonesian Ministry Of Health, 2014).

The nutritional status of BB/TB with severe wasting criteria is one of the priorities in health development, according to the policy

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direction of the 2020-2024 RPJMN, the target for 2024 is to reduce the prevalence of wasting to 7% and stunting to 14% (Indonesian Ministry Of Health, 2014). This handling is a priority because children with nutritional problems will be highly susceptible to disorders of brain and mental development in children. The results of a systematic review study stated that children with nutritional issues, especially malnutrition, have lower scores for development. The abilities considered low include children's intelligence, the ability to distinguish colors, the ability to recognize visual images, and a short memory (Pizzol *et al*., 2021).

A child's nutritional status is greatly influenced by parenting patterns, attitudes, and practices of feeding, caring for, and giving affection. Inappropriate parenting patterns in caring for and feeding have a risk of toddlers with protein energy deficiency or experiencing primary malnutrition (Güngör *et al.,* 2023). Other factors include gender, history of low birth weight, immunization coverage, maternal characteristics (knowledge, height, maternal age, nutritional status), number of family members, birth order in the family, child birth weight (Katoch, 2022) and family characteristics (family sanitation, water quality) (Kohlmann *et al*., 2021). Other studies identified factors causing malnutrition using quantitative methods, but in this study, identification used qualitative methods.

Method

It is a qualitative study of problems in toddlers who experience nutritional issues. The location of the study was in one of the working areas of the Health Center in Daerah Bantul Daerah Istimewa Yogyakarta. The primary informants in this study were mothers who had toddlers with malnutrition, understood Indonesian, and were willing to be informants. The initial number of informants was 11 people. However, as the study progressed, 2 informants dropped out. It was because, at the time of the re-checking of the toddler's BB TB, they were no longer malnourished. The other respondents were because the parents were not cooperative, so the appropriate participants were 9 mothers who had toddlers with nutritional problems. Data were collected through in-depth interviews and healthy home observations. The data triangulation process involved 1 nutrition officer from the health center, health cadres, and health center midwives. The instruments used in this study were the researchers themselves assisted by using interview guidelines and Healthy Home assessment instruments from the Ministry of Health of the Republic of Indonesia (Indonesian Ministry Of Health, 2014). The research implementation time took 40-60 minutes. Data collection in this interview was recorded using an audio recorder in the Indonesian language, and a mixture of Javanese. During the interview, verbal and non-verbal communication was used to show appropriate feedback. For example, the researcher nodded to show understanding or motivated the informant to continue the story. The data compilation process was done anonymously to maintain confidentiality. To increase the validity and reliability of the study, the researcher will carry out a strategy to strengthen trustworthiness in the qualitative research phase (credibility, transferability, dependability, and confirmability). Data analysis in this study used thematic analysis by referring to the qualitative research protocol, which includes: transcription, statement extraction, formulating the meaning of each sentence, grouping sub-themes and themes, describing the problem phenomenon as a whole, Formulating and describing the phenomenon studied in a fundamental structure, Final validation to confirm the results of the study.

Results and Discussions

The research location is the working area of the Community Health Center, located in a rural area in the Special Region of Yogyakarta. Public health improvement carried out at the Community Health Center includes individual and community health services. Services provided by the Community Health Center to optimize growth and development are directly involved in existing integrated health service posts (19 integrated health service posts). Activities include nutritional status assessment, development monitoring, direct intervention, and referrals. Toddler nutritional status is monitored through an online application system for community-based nutritional recording

and reporting (e-PPGBM). Development monitoring activities make use of the 2012 SDIDTK manual (Stimulation, Detection, and Intervention in Growth and Development) tahun 2012.

Table 1 shows that toddlers who have poor nutritional status in all three indicators are 4 toddlers (44.44%). 66.67% have Severely Wasting nutritional status, and 66.67% are severely underweight. Toddlers who experience wasting, stunting, or being overweight can result in irreparable damage or stunted growth in later life (Indonesian Ministry Of Health, 2014). A total of 11.11% in Table 1 have Severely stunted stature. Short stature in toddlers is not hereditary, but toddlers do not reach their full linear growth potential and are related to delayed motor development (Mustakim *et al.*, 2022). If this problem is not addressed, it will potentially lead to weak cognitive capacity, which will impact their school readiness, learning ability, and health. Nutrition plays a crucial role in maintaining a person's health. It is an obligation for someone, in this case, parents, to take care of their body so that it functions properly. It is stated in the words of the Prophet Muhammad SAW: "Indeed your body has a right over you" (Almaatani *et al.*, 2017). The results of the identification of interviews and observations obtained 1) Socioeconomic status, 2) Parenting patterns, 3) Unhealthy Housing Conditions, and 4) Health service programs.

Theme 1. Low Socioeconomic Status

Socioeconomic status is defined as the level of education, income, and occupation of parents. The average education level of mothers is high school graduates or equivalent. Mothers with higher education will be more aware of health facilities and the infrastructure thus easily accept the information provided. Low maternal education increases the incidence of stunting. Stunting is one of the problems of malnutrition. Low maternal education increases the incidence of stunting. Stunting is one of the problems of malnutrition (Wijhati *et al.*, 2021). The study found that 72.7% of mothers were housewives, while one worked as a seller. 77.79% of informants were from underprivileged families with jobs in the informal sector, namely craft workers, gas agent workers, poster sellers, workshop workers, and fish sellers. The fulfillment of household needs comes from the father's income. The monthly income generated by the family is between 1-2 million rupiah. The income earned by the family is used for various needs ranging from the father's needs for work operations, payment of various monthly bills, and operational fulfillment of food for one family.

A family's income is linear with the provision of a safe environment, cleanliness, adequate clean water, and adequate sanitation. An environment consisting of clean drinking water, good sanitation, and healthy home conditions with open toilets will reduce the incidence of stunting in toddlers (Mustakim *et al.*, 2022). Poor sanitation will reduce food security and lead to increased infection risk (Taguri *et al.*, 2015). When viewed from the status of residential ownership, the majority are their own homes, but one subject family lives in a boarding house, and 2 families live with parents who do not work. Poverty is

TABLE 1. Respondents Data

Informant Code	Informants	Remarks
Informant 1-9	Mother with malnourished toddler	Key Informant
Informant 10	Health Center Nutrition Officer	Supporting informant
Informant 11	Community Health Center Midwife	Supporting informant
Informant 12	Health Cadres	Supporting informant

TABLE 2. Respondent Characteristics

Code	Gender	Weight for Height	Weight for Age	Height for age
Informant 1	Boy	Wasting	Normal	normal
Informant 2	Girl	Severely Wasting	severely underweight	stunting
Informant 3	Boy	Severely Wasting	severely underweight	Severely stunting
Informant 4	Boy	Severely Wasting	severely underweight	stunting
Informant 5	Boy	Wasting	underweight	normal
Informant 6	Girl	Severely Wasting	severely underweight	normal
Informant 7	Boy	Wasting	underweight	normal
Informant 8	P	Severely Wasting	severely underweight	Stunting
Informant 9	P	Severely Wasting	severely underweight	normal

one of the dominant factors contributing to wasting / very thin rates in toddlers because families have obstacles in providing food and nutritional services (UNICEF, 2021). Lack of family food availability in the long term can result in malnutrition even though the toddler is not sick (Taguri *et al.*, 2015). Rahma *et al.*, (2020) Their research showed that toddlers from low-income families have a 10.222 times greater risk of malnutrition. Low family income accompanied by low maternal education levels has a high risk of nutritional problems in toddlers (Owoaje *et al.*, 2014).

The majority of the attendance rate of subjects in posyandu activities is good. It is proven by the recapitulation of data owned by health cadres. However, when viewed from the data in the KIA book, there are still nutritional status graphs that have not been filled in. It is because posyandu activities have only just started since COVID-19, and there are also problems for mothers of toddlers.

"*When the mother was told about her child's condition, it was as if she couldn't accept it. So she felt that her child was fine.*" (informant 12)

"*I never bring the KIA book, because the cadres always scold me. Why isn't your child's weight increasing? I'm annoyed.*" (Informant 9).

The lack of self-confidence caused by mothers in accompanying their children to visit Posyandu is due to the lack of positive support from the community and the mothers' knowledge about the importance of monitoring the nutritional status of toddlers. Low self-confidence makes mothers unhappy and reduces the opportunity to accompany their children. Mothers' self-confidence is also highly correlated with the existence of proper feeding practices (Kohlmann *et al.*, 2021).

Pattern

The specific parenting raised in this study is related to parenting style and child feeding style. According to Harborn, the parenting style widely applied by respondent mothers is an indulgent/permissive parenting style with an unresponsive feeding style (Almaatani *et al.*, 2017). Mothers pay less attention to the diet and the food their children eat daily (Tardy *et al.*, 2020). Most mothers said they do not immediately prepare their children's food but buy fast food. Children are not used to eating according to a meal schedule.

"*Regarding breakfast, it depends on when the child wakes up. If the child wakes up at 10 am, then I serve breakfast*" (Informant 2) .

"Regarding breakfast, it's difficult. Because when waking up, the child asks for milk. If I don't give in, the child cries" (Informant 1).

"The child asks for breakfast in the morning, even though sometimes the child doesn't finish it" (Informant 2)

"The meals that are always finished are breakfast and dinner" (Informant 8)

There is no meal schedule because the child wakes up late. The child often does not want to eat because he has had milk when he wakes up and prefers to choose snacks rather than main meals. This habit makes the child feel full before the main meal. The most common habit is eating something or drinking

milk before the main meal. It makes the meal duration long (±30 minutes), and children often do not finish their main meal. Mothers have not implemented a balanced food menu on their children's serving plates. The menu commonly given to most children is rice, eggs, tempeh, vegetables, and occasionally chicken or fish. The presentation is often in the form of rice and eggs, rice and vegetables, rice and tempeh, or just rice. The food given to children does not match the child's nutritional needs. Healthy eating habits are influenced by the parents' habits. However, this habit does not always have a positive meaning and sometimes conflicts with a healthy eating menu (Almaatani *et al*., 2017).

"*Well.. sometimes the child only eats rice. He will finish eating only rice. For me, the important thing is that the child eats rice*" (Informant 1).

"*When feeding children, parents often say that the important thing is that the child fell full* " (Informant 10).

It is supported by the results of interviews with nutritionists at the Community Health Center

"*Parenting and child diet are the dominant factors in malnutrition in children here. Mothers always prefer to give organic porridge commonly sold without clearly stating any nutritional content. Toddlers here are mostly given organic porridge, even a one-day menu. The KIA book is also not utilized properly* " (Informan 10).

Improper parenting practices lead to unhealthy eating habits (e.g., overeating, eating without hunger, emotional eating, etc.). It can increase the risk of overweight and obesity (Lindsay *et al.*, 2017). The results of a systematic review showed that complementary feeding with strict supervision during meals and no activities other than eating can reduce the incidence of obesity at an early age (Bergamini *et al.*, 2022). Most informants stated that their children had comorbidities during their growth and development. There were 3 respondents with a history of being born with low birth weight. The diseases that were and are being suffered are 1 subject who had suffered from childhood pulmonary TB and underwent routine treatment (Informant 3), 1 post-epilepsy treatment (Informant 2), 1 child with Down syndrome (Informant 1), 1 child monitoring nutritional intake (Informant 6), persistent diarrhea (child has not been detected with the disease).

Infectious diseases such as TB and malnutrition have a very close relationship. Diseases interfere with the absorption of nutrients in the digestive process of toddlers. This condition will result in a decrease in the weight of toddlers. Weight loss is related to inadequate nutritional intake, causing chronic nutritional problems that will lead to stunting (Tardy *et al.*, 2020). On the other hand, malnutrition is also one of the causes of TB (Dahwan *et al.*, 2020). The association of malnutrition as a risk factor for TB in children has not been definitively established. It is because diagnostic tests for TB in children are less sensitive. So, the diagnosis is often based on clinical findings without bacteriological confirmation. The establishment of malnutrition as a causal factor for TB has been through inference and extrapolation from data from studies of adults, BCG-vaccinated children, children with latent TB infection, and animal models. Severe malnutrition is associated with decreased rates of tuberculin skin test positivity in BCG-vaccinated children, suggesting impaired cellular immune function and an increased risk for developing active disease. Thus, adults with coexisting latent TB infection and low BMI have reduced protective cytokine responses and increased production of regulatory cytokines compared with individuals with latent TB infection and normal BMI. Studies in guinea pigs challenged with M. tuberculosis (402–404) and mice suggest that protein malnutrition reduces resistance to TB through defects in innate and adaptive immune function. Compromised host defenses are associated with impaired T cell trafficking and proliferation, reduced production of protective cytokines (IFN-γ and TNF-α), impaired granuloma maturation, and reduced macrophage effector function (e.g., nitric oxide generation). Malnourished mice challenged with BCG also have reduced IFN-γ and TNF-α production and increased risk of bacterial dissemination. BCG vaccination fails to protect protein-deficient guinea pigs against M. tuberculosis challenge (Ibrahim *et al.*, 2017).

Unhealthy Housing Conditions

The assessment of 9 informants results they have unhealthy houses. 66.67% of houses do not have ceilings (Informants 1,2,4,5,8). As many as 22.22% of the walls are not permanent walls (Informants 3,8). As many as 11% of the floors are still dirt (Informant 8). The house has permanent ventilation, but the area is <10% of the house area, as many as 66.67% (Informants 1,3,4,5,8,9). The lighting in most houses is not bright enough so it required lamp light when the researcher conducted interviews (55.56%) (Informants 1,2,6,8,9). As many as 44.44% have a kitchen smoke hole but it is not sufficient (<10% of the kitchen area) (Informants 4, 5, 6, 9). Most clean water facilities are their own and meet health needs, however, there is still 1 family (Informant 8) who has clean water facilities from a well with a distance of 5-7 meters from the goat pen and septic tank. As many as 100% of subjects defecate in their respective toilets with a goose-neck toilet model. 100% of subjects dispose of garbage in closed trash cans collected by garbage officers periodically (once every 2-3 days). Environmental and house conditions at the time of the visit, five houses (55.56%) looked dusty (Informants 1, 2, 3, 8, 6), one house looked clean (Informant 7), three houses felt damp and stuffy (Informant 9, Informant 4, Informant 5).

Poor sanitation will reduce food security and can increase the risk of infection. Examples of infectious diseases caused by poor sanitation and environment are diarrhea and worms. These infections interfere with the absorption of nutrients in the toddler's digestive process. This condition will result in anemia, and in chronic conditions, the toddler's weight will decrease. Weight loss accompanied by inadequate nutritional intake will cause chronic nutritional problems, which will cause stunting (Wijhati *et al.*, 2021; Djuardi *et al.*, 2021).

Health Center Service Program

The assessment of nutritional problems among toddlers in the community begins with evaluations conducted by health cadres through Posyandu Balita (Integrated Health Service Post for Children Under Five) activities.

"As midwives, we are tasked with integrated health services (posyandu). Observing the implementation of posyandu, screening toddler development, and monitoring weight measuring. If any toddler has nutritional issues, we will refer to Puskesmas to be checked by a nutritionist" (Informant 11)

Toddlers identified as having nutritional problems are referred to the health center. The report results are followed up by nutrition officers for re-examination at the Health Center. Toddlers who are analyzed for malnutrition are re-examined for the cause of the child's nutritional problems. Toddlers who have problems due to nutritional intake will be handled directly by nutrition officers, but if there are other causes, then cross-program action will be involved. Not only reviewed by nutritionists but also identified from cross-programs (health promotion programs, environmental health, village midwives, etc.). Handling and management of malnutrition at the Health Center is by a medical team, namely midwives, nurses, nutritionists, and referrals to pediatricians for intervention. The handling carried out was counseling and education from nutrition officers and Supplementary Food Provision. It was obtained from Village Funds, Baznas, APBD (Regional Revenue and Expenditure Budget) of Bantul Regency. The Supplementary Food Provision provided was biscuits from the Health Office, milk, and multivitamins.

*"The obstacle experienced in handling malnutrition is the large number of toddlers who experience malnutrition. So the main priority in handling cross-programs is toddlers with malnutrition first, Interventions for malnutrition in the form of counseling only "(*Informant 10).

It is not explained exactly for the content of biscuits and multivitamins provided by the health center. Providing additional food appropriate to the needs of toddlers with nutritional problems is by providing micronutrients. Micronutrients help the body produce hormones and materials needed by the body to grow and develop (Tardy *et al.,* 2020). The provision of mineral micronutrient supplements such as zinc and iron has been shown in many studies to increase toddlers' appetite. Zinc supplementation increases the average frequency of eating from 4.16 to 4.8 times per day. Meanwhile, zinc and iron

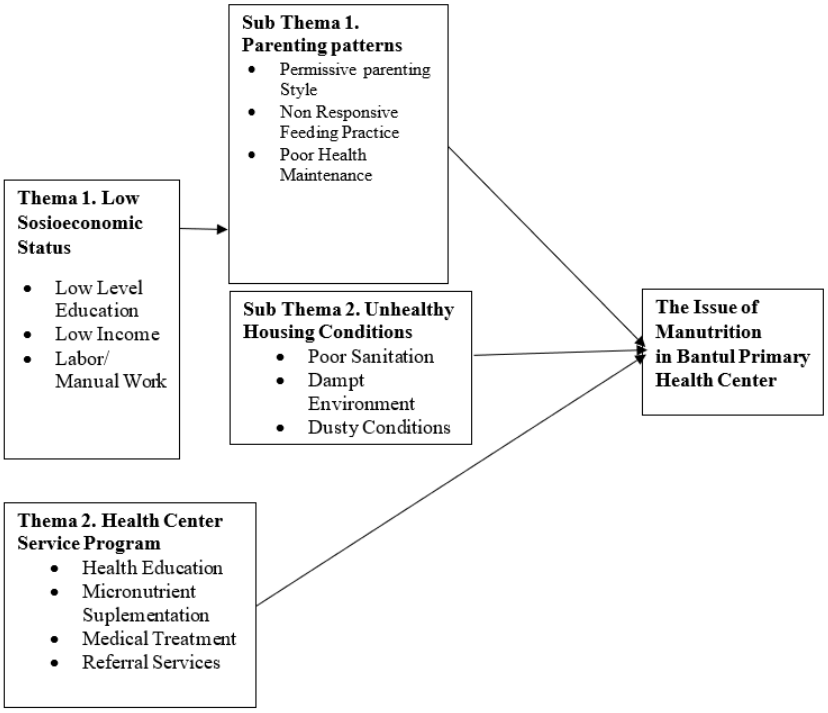

Figure 1. Research Results Chart

supplementation can increase the average frequency of eating from 4.1 to 5 times per day. This means that zinc supplementation along with iron can increase the frequency of eating more than zinc supplementation alone or iron alone. In addition to meal frequency, increased appetite can also be seen from increased energy intake. Other studies state that providing zinc and iron supplements together can increase toddlers' appetite (Candra, 2017). Zinc and iron supplementation proved to improve toddlers' nutritional status. One of the causes of weight gain is increased appetite. Zinc and iron supplementation can also help toddlers achieve optimal height. The height increase in toddlers over 2 years is slower than in toddlers under 2 years. Therefore, it takes a longer time to provide supplementation to increase height significantly. Zinc supplementation for 6 months can increase children's height and weight more than placebo (4.9 ± 1.3 vs 3.6 ± 0.9 cm, $p < 0.001$ (Candra, 2017). Other studies have stated that vitamin A supplementation can be one way to increase toddler weight, although there is not much evidence in meta-analyses (Das *et al.*, 2020). From the results obtained, it can be concluded in the chart below.

Conclussions

From the results, we concluded that toddlers experience malnutrition because of low socioeconomic status, which causes a permissive parenting style so that feeding is not responsive. Low maternal education and poverty result in low provision of quality food and unhealthy housing conditions, which cause health problems. The existing health service center program has been implemented well. Recommendations given are increasing literacy in a democratic parenting style and preventing malnutrition by routinely providing zinc and zinc supplements. This research needs to be continued with a mixed method and a different and broader research scope so that it can provide broader insights regarding malnutrition in toddlers.

References

Almaatani, D.E., Mann, L., Kelly, E., & Rossiter, M., 2017. Responsive Feeding Practices and Influences: A Qualitative Analysis of Parent Experiences With Feeding Their Young Children. *American International Journal of Contemporary Research*, 7(2), pp.56–65.

Bergamini, M., Simeone, G., Verga, M.C., Doria, M., Cuomo, B., D'antonio, G., Iacono, I.D., Mauro,

G.,D., Leonardi, L., Miniello, V.L., Palma, F., Scotese, I., Tezza, G., Caroli, M., & Vania, A., 2022. Complementary Feeding Caregivers' Practices and Growth, Risk of Overweight/Obesity, and Other Non-Communicable Diseases: A Systematic Review and Meta-Analysis. *Nutrients*, 14(13), pp.1–20.

Candra, A., 2017. Suplementasi Mikronutrien dan Penanggulangan Malnutrisi pada Anak Usai dibawah Lima Tahun (Balita). *JNH*, 5(3), pp.1–8.

Dahwan, D., Aguslina, F., & Hasan, W., 2020. The Effect of Nutrition Status and Occupancy Density Compliance with Home Contact Pulmonary TB Insidence in Specialized Hospital of Pulmonary. *Jurnal Kesehatan Masyarakat*, 16(2), pp.200–206.

Djuardi, Y., Lazarus, G., Stefanie, D., Fahmida, U., Ariawan, I., & Supali, T., 2021. Soil-Transmitted Helminth Infection, Anemia, and Malnutrition Among Preschool-Age Children In Nangapanda Subdistrict, Indonesia. *PLoS Neglected Tropical Diseases*, 15(6), pp.1–16.

Güngör, Ş., Büyükavcı, M.A., & Acıpayam, C., 2023. Effects of Parent- and Child-Related Behavioral Feeding Problems in Early Childhood on Malnutrition. *Archives de Pédiatrie*, 30(4), pp.206–211.

Ibrahim, M.K., Zambruni, M., Melby, C.L., & Melby, P.C., 2017. Impact of Childhood Malnutrition on Host Defense and Infection. *Clinical Microbiology Reviews*, 30(4), pp.919–971.

Indonesian Ministry Of Health., 2014. *Keluarga Sehat Idamanku Kota Sehat Kotaku*. Jakarta.

Katoch, O.R., 2022. Determinants of Malnutrition Among Children: A Systematic Review. *Nutrition*, 96, pp.111565.

Kohlmann, K., Sudfeld, C.R., Garba, S., Guindo, O., Grais, R.F., & Isanaka, S., 2021. Exploring the Relationships Between Wasting and Stunting Among A Cohort of Children Under Two Years of Age in Niger. *BMC Public Health*, 21(1), pp.1–9.

Lindsay, A.C., Sitthisongkram, S., Greaney, M.L., Wallington, S.F., & Ruengdej, P., 2017. Non-Responsive Feeding Practices, Unhealthy Eating Behaviors, and Risk of Child Overweight and Obesity in Southeast Asia: A Systematic Review. *International Journal of Environmental Research and Public Health*, 14(4), pp.1–18.

Das, J.K., Salam, R.A., Saeed, M., Kazmi, F.A., & Bhutta, Z.A., 2020. Effectiveness of Interventions for Managing Acute Malnutrition in Children under Five Years of Age in Low-Income and Middle-Income Countries: A Systematic Review and Meta-Analysis. *Nutrients*, 12(1), pp.116.

Mustakim, M.R.D., Irwanto., Irawan, R., Irmawati, M., & Setyoboedi, B., 2022. Impact of Stunting on Development of Children between 1-3 Years of Age. *Ethiopian Journal of Health Sciences*, 32(3), pp.569–578.

Owoaje, E., Onifade, O., & Desmennu, A., 2014. Family and Socioeconomic Risk Factors for Undernutrition Among Children Aged 6 To 23 Months in Ibadan, Nigeria. *Pan African Medical Journal*, 17, pp.1–7.

Patlán-Hernández, A.R., Stobaugh, H.C., Cumming, O., Angioletti, A., Pantchova, D., Lapègue, J., Stern, S., & N'Diaye, D.S., 2022. Water, Sanitation And Hygiene Interventions and The Prevention and Treatment of Childhood Acute Malnutrition: A Systematic Review. *Maternal and Child Nutrition*, 18(1).

Pizzol, D., Tudor, F., Racalbuto, V., Bertoldo, A., Veronese, N., & Smith, L., 2021. Systematic Review and Meta-Analysis Found That Malnutrition was Associated with Poor Cognitive Development. *Acta Paediatrica*, 110(10).

Taguri, A., El Betilmal, I., Mahmud, S.M., Ahmed, A.M., Goulet, O., Galan, P., & Hercberg, S., 2015. Risk Factors for Stunting Among Under-Fives in Libya. *Public Health Nutrition*, 12(8), pp.1141–1149.

Tardy, A.L., Pouteau, E., Marquez, D., Yilmaz, C., & Scholey, A., 2020. Vitamins and Minerals for Energy, Fatigue and Cognition: A Narrative Review of The Biochemical and Clinical Evidence. *Nutrients*, 12(1).

UNICEF., 2021. *Feed To Fail: The Crisis of Children's Diets in Early Life*. New York.

Wijhati, E.R., Nuzuliana, R., & Pratiwi, M.L.E., 2021. Analisis Status Gizi Pada Balita Stunting. *Jurnal Kebidanan*, 10(1), pp.1.

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Environmental Health Impacts and Risks of Domestic Wastewater Issues in Small Island

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Abstract

The problem of domestic wastewater on small islands poses a significant threat to the surrounding marine ecosystem. Generally, residents of small islands tend to overlook the sanitation aspects of domestic wastewater. The contents of domestic wastewater can harm environmental ecosystems and act as vectors for diseases within the community. This study aims to assess the sanitation risk index of domestic wastewater and its impact on ecological and public health. The research was conducted on Bungin Island in May 2024, using a mixed-methods approach with a Sequential Explanatory Design. The study involved 274 households as respondents and six key informants. Research instruments included questionnaires, observation sheets, and interview guides. Data collected were analyzed using Microsoft Excel 2013 and IBM SPSS version 29.0, while interview and observation data were processed using NVIVO version 14.0. The findings indicate that residents generally do not perceive domestic wastewater as a potential problem. Bungin Island falls into the high-risk category for sanitation, impacting fish ecosystems, and coral reefs, and contributing to marine pollution. Furthermore, it acts as a driving factor for diarrheal diseases and stunting in children. In conclusion, poor sanitation conditions have direct and indirect impacts on environmental ecosystems and public health. Integrated efforts are thus essential to address domestic wastewater issues on densely populated small islands.

Introduction

The problem of domestic wastewater on densely populated islands is one of the driving factors in the emergence of sanitation and environmental problems. Domestic wastewater constitutes a significant portion of the wastewater generated from human activities, with up to 90% of clean water consumption discharged as wastewater (Widyarani *et al*., 2022). Resource recovery and reuse from domestic wastewater have become crucial for the latest development of sanitation technologies and infrastructures (Firmansyah *et al*., 2021). Islands often lack land, freshwater resources, public finances, and technical personnel, leading to ineffective treatment of domestic wastewater and most pollution in surrounding sea areas (Sun *et al*., 2022).

Sanitation issues encompass solid waste management, access to clean water, proper treatment of domestic wastewater, and promotion of clean and healthy behaviors. Environmental factors have a significantly affect mortality, related to infectious diseases

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and pollution. Air pollution, unsafe water, and poor sanitation have numerous effects on human health and the environment (Liu *et al*., 2024). Domestic wastewater affects health and ecology because of its high organic concentration (Sabeen *et al*., 2018) In addition to organic matter, domestic wastewater contains bacteria and pathogens, which can directly impact human health. Many studies show that environmentally-based diseases are associated with poor hygiene and sanitation factors (Amirus *et al*., 2022).

Developing effective wastewater treatment is crucial for promoting public health and safeguarding environmental well-being. Domestic wastewater significantly affects ecological health, especially in small island ecosystems where resources are limited while the balance between human activity and nature is fragile. In small islands with limited land and water resources, releasing untreated or inadequately treated domestic wastewater can cause severe environmental damage (Silva, 2023). One of the most visible consequences is the contamination of coastal waters, where untreated wastewater from households often flows directly into the sea (Micella *et al*., 2024). It introduces high levels of organic matter, nutrients such as nitrogen and phosphorus, as well as pathogens into the marine environment (Brunetti *et al*., 2021). These pollutants can cause rapid eutrophication, leading to algal blooms that deplete oxygen levels in the water (Akinnawo, 2023). As a result, fish and other marine species struggle to survive, disrupting the local food chain and endangering biodiversity (Pfenning-Butterworth *et al*., 2024). The degradation of coral reefs, crucial to the island's marine ecosystem and economy, is also accelerated by wastewater pollution (Wear *et al*., 2021). Coral reefs are highly sensitive to changes in water quality, and the presence of excess nutrients and pathogens can lead to coral diseases and bleaching (Fattah *et al*., 2023).

Environment-based illnesses can stem from household wastewater, significantly impacting public health, particularly in regions with poor sanitation and water treatment facilities (Lin *et al*., 2022). The lack of sufficient sanitation for humans is a staggering problem (Muliana *et al*., 2021). The most prevalent illness brought on by water pollution is diarrhea, a typical indication of gastrointestinal disorders. In low-income nations, diarrhea is a primary cause of sickness and mortality among young children. In impoverished countries, diarrheal illnesses are responsible for 21% of the annual mortality of children under five (Lin *et al*., 2022). Problems related to sanitation need special attention considering the increasing population (Wulan *et al*., 2023). Thus, it is essential to research environmental health risks associated with domestic wastewater and its impact on the environment and human health. This study aimed to assess the ecological health risk index associated with household wastewater and its effect on the environment and human health.

Method

This research used mixed methods adapted from Creswell and Vicky (2018). The type of mixed methods research design used in this study is Sequential Explanatory Design. In this design, the research starts with quantitative data collection to see the sanitation risk value using the Environmental Health Risk Assessment (EHRA) method. It was followed by more in-depth qualitative data collection to find the environmental health and public health impacts of domestic wastewater problems. This research was conducted on Bungin Island, in Sumbawa Regency (shown in Fig. 1). Bungin Island is one of the most populated islands in Indonesia. This area is 8.5 ha and populated by 3.400 persons. As many as 274 households participated in the quantitative study. Questionnaires, EHRA instrument sheets, and observation sheets were employed as study tools. The impact of residential wastewater was then the subject of in-depth interviews with six key informants for the qualitative portion. A secondary data assessment was also carried out, specifically looking at disease data from the Alas Health facility in Sumbawa Regency, which serves as the Bungin Island health facility.

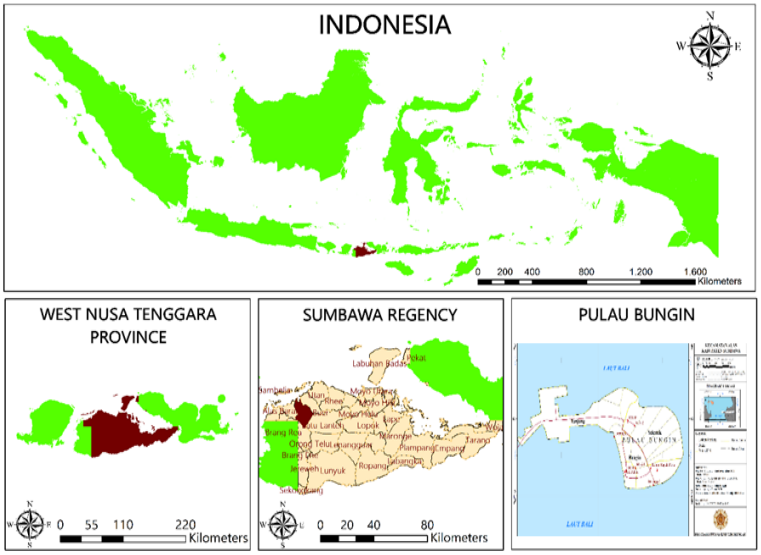

Fig. 1. Research Location

Result and Discussion

The quantitative research to find the sanitation risk index value involved 274 respondents, who had the following characteristics in Table 1,

Table 1 shows that the respondents are in the age range of 41 - 50 years old, most of whom are female. Most respondents have private home ownership status. Then, the primary type of family livelihood is as a fisherman. Most

Table 1. Characteristics of Respondents

Age Range (Years)	Frequency (n)	Precentage (%)
< 20	5	1.8
20 – 30	57	20.8
31 – 40	68	24.8
41 – 50	79	28.9
> 51	65	23.7
Gender	Frequency (n)	Precentage (%)
Man	15	5.5
Woman	259	94.5
House Ownership Status	Frequency (n)	Precentage (%)
Privately Owned	260	94.9
Family Sharing	8	2.9
Rent	6	2.2
Final Education	Frequency (n)	Precentage (%)
No School	18	6.6
Elementary	191	69.7
Junior High School	34	12.4
Senior High School	31	11.3
Occupation	Frequency (n)	Precentage (%)
Traders	24	8.7
Fisherman	195	71.2
Housewife	55	20.1

Fig. 2. Community Attitude Towards Domestic Wastewater

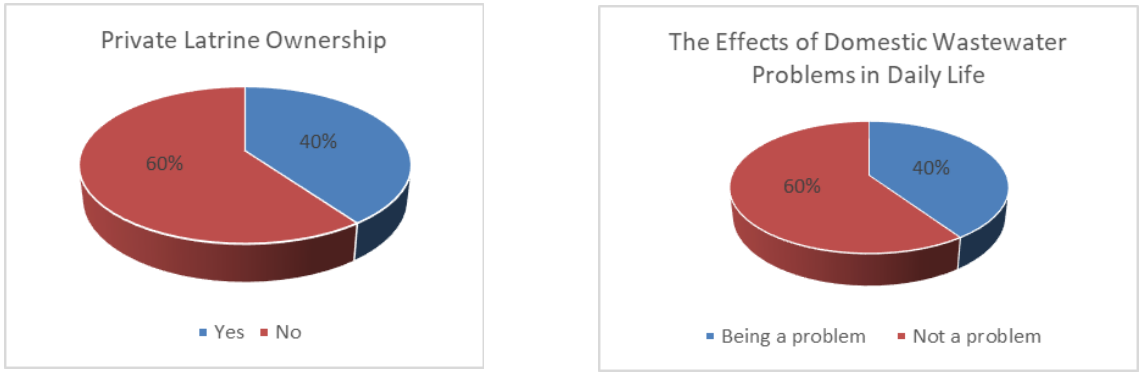

Fig. 3. Community Attitude towards Domestic Wastewater

respondents have lived on Bungin Island for more than 10 years.

The community mindset determines whether the issue of domestic wastewater affects life in the environmental and public health aspects. The results show that the community has a neutral attitude towards domestic wastewater management. In Figure 2(a), more than 50% of the community considers domestic wastewater a daily common. However, 43% of respondents agreed to domestic wastewater management. The perception evaluation on wastewater reuse was attempted to explore the level of awareness and knowledge of the beneficiary and functionary for its management (Huq *et al.*, 2024). It is essential to conduct a perception study to allow the establishment of indices and relevant elements about community water management and to match policy formulation with the conditions that already exist within the community. Because how people or groups perceive particular issues can affect planning, water management, and other matters about residential wastewater (Suksaroj *et al.*, 2024).)

Fig. 3 (a) showed that 60% of respondents have no private toilet. They rely on their neighbors' latrines and public toilets. Even still defecate directly in the sea. It is a primary challenge related to environmental sanitation issues. In urban stream systems, persistent populations of people living in open spaces have been a significant source of fecal pollution (Hinds *et al.*, 2024). In theory, this should be a problem. But for the community, it has become a habit. As many as 60% of respondents showed in Fig. 3 (b) stated that this does not lead to any problems. In addition to open defecation, a large number of anthropogenic activities specifically occur near water sources, which contributes to the contamination of their feces. Fecal pollution is related to unsanitary behaviors, including dumping waste in the waters (Okullo *et al.*, 2017). In addition to the water supply issue, the state and sufficiency of the restrooms are crucial since inadequate restrooms might promote open defecation (Odjegba *et al.*, 2024).

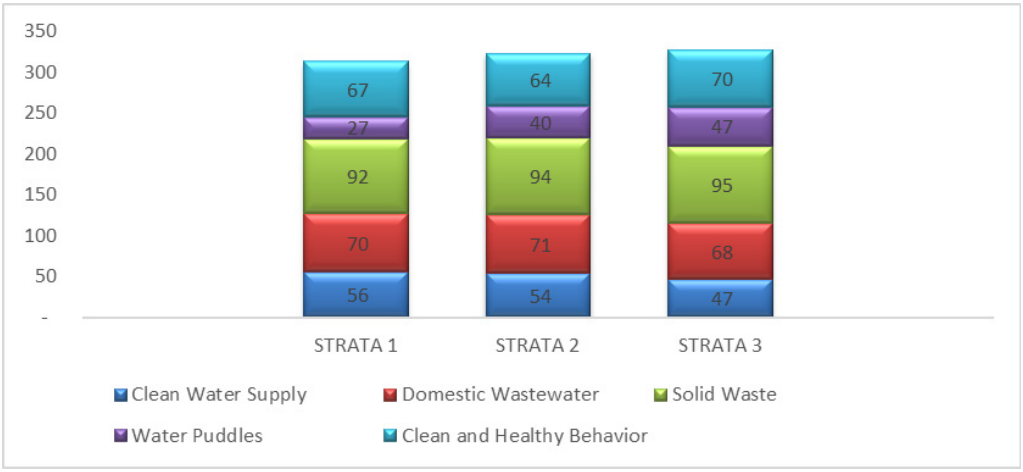

Fig. 4. Risk Sanitation Index

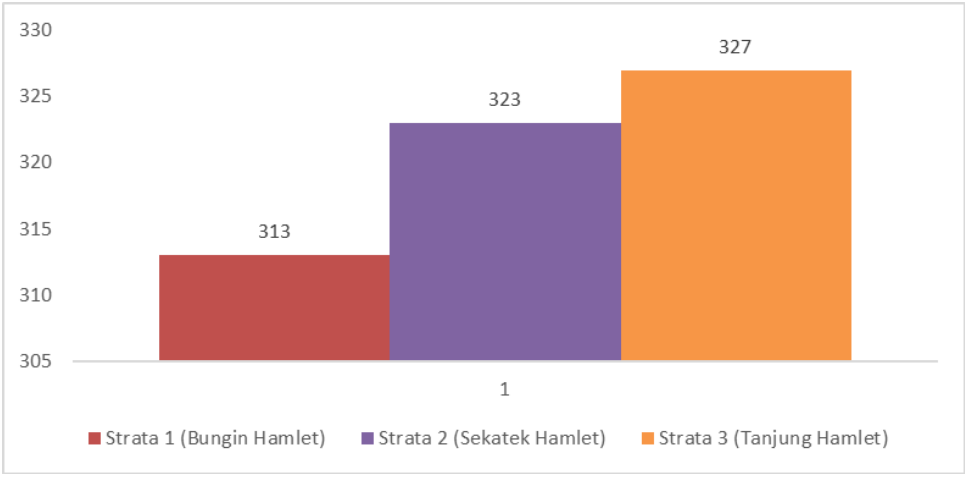

Fig. 5. Risk Sanitation Index Cumulative

In this study the sanitation risk index was measured using the EHRA method. The clustering process of the Bungin Island area is divided into 3 strata areas based on population density, poverty, tidal flooding, and drainage flow through the sea flow. Figure 4 shows that domestic wastewater is still a problem because it does not have proper management. So, it is still discharged directly into the environment. It has a very high risk after solid waste. If examined further, the sanitation indicator shows the average risk value, which results in a total value in each stratum, as shown in Figure 5.

Figure 5 shows that the cumulative sanitation risk index value in both Strata 1, 2, and 3 has a high cumulative index value. The calculation results show that the cumulative index value makes Bungin Island fall into the high-risk category. High sanitation risk in an area will affect the transmission process of environment-based disease vectors (Amirus *et al.*, 2022b). In addition, high sanitation risk will affect poor environmental ecosystems, which will ultimately have an impact on exceeding the carrying capacity of the environment (Howard *et al.*, 2016). The high risk of sanitation impacted on potential for diarrhea, trachoma, child growth, and intestinal infection (Kanda *et al.*, 2021). The projection of the results of the sanitation index calculation is followed by the creation of a sanitation risk map as in Figure 6 below,

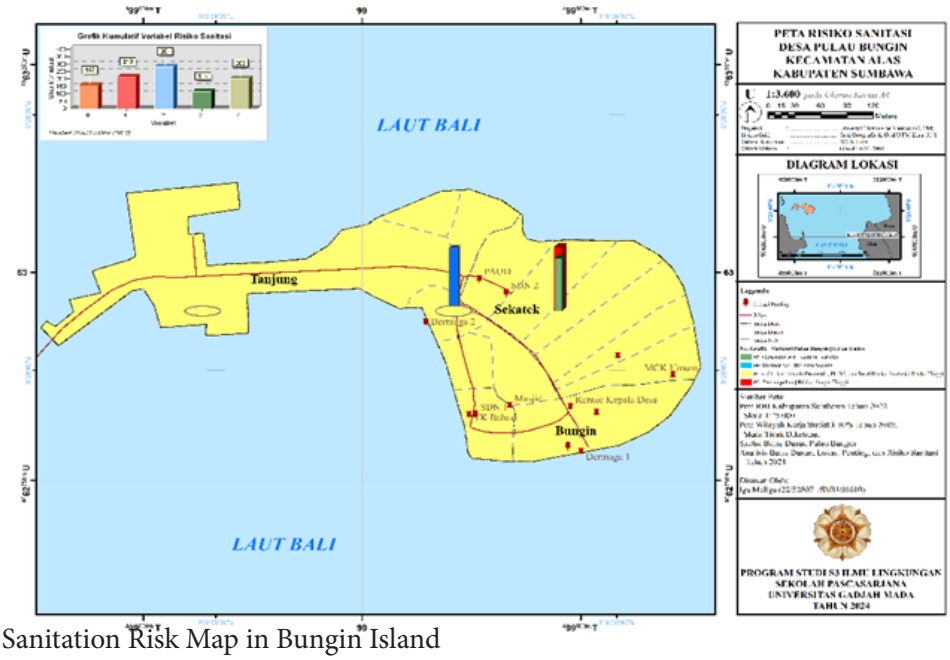

Fig. 6. Sanitation Risk Map in Bungin Island

Then, to find the impacts felt directly, in-depth interviews were conducted with residents and village policymakers related to the health and environmental impacts felt by residents due to sanitation problems and domestic wastewater in particular. Respondents and informants stated some impacts felt due to sanitation problems, as shown in Table 2.

The results of this study point to several theoretically connected effects. The longer this sanitation issue is neglected, the more detrimental effects it will have on the environment and human health in the future. It may have negative effects. Research by (Freeman *et al.*, 2017), showed that sanitation conditions impact on infectious disease and nutritional status. It is in line with the findings in the field, which show that diarrheal disease in children is high on Bungin Island. It was also validated by data from the Alas Community Health Center, which is the working area for Bungin Island. The results of the interview mentioned that stunting conditions were also suffered by having many children. Although the cause of stunting due to environmental sanitation factors cannot be known for certain. It can be a concern in the future.

Fish populations, coral reefs, and general marine health are significantly and frequently negatively impacted when untreated household wastewater is released into marine settings (Zhou *et al.*, 2022). Numerous contaminants, including nutrients, organic debris, heavy metals, and pathogens, are carried by wastewater as it flows to the ocean (Micella *et al.*, 2024). These contaminants upset the natural equilibrium of marine environments, frequently leading to detrimental effects. In fish environments, eutrophication—which encourages excessive algal growth—can

Table 2. Impact of High-Risk Sanitation in Bungin Island

Impact Category	Impact
Environmental Health	Fish ecosystem reduced
	Coral reef damage
	Potential marine pollution
Human Health	Malaria outbreaks have occurred
	High rate of diarrhea
	High rate of stunting

result from an overabundance of nutrients like phosphorus and nitrogen (Akinnawo, 2023). Hypoxic, or oxygen-depleted, zones are produced when the dead algae break down and consume dissolved oxygen (Bergland *et al*., 2019).

Wastewater pollutants can weaken coral resilience, promote the spread of coral illnesses, and induce coral bleaching (Nurdjaman *et al*., 2023). Wastewater high in nutrients encourages the growth of toxic algae on coral reefs, which suffocates these essential ecosystems by competing with corals for sunlight and space. The additional stress from wastewater pollution speeds up the destruction of coral reefs, which are already threatened by rising ocean temperatures and acidification (Pendleton *et al*., 2019). In addition to affecting biodiversity, damage to coral reefs also affects local fisheries stability and the livelihood of populations that depend on them. The effects of inadequate sanitation extend to long-term growth and development problems, particularly for young children(Ugboko *et al*., 2020). Frequent intestinal infections are caused by repeated exposure to tainted water and unsanitary settings, which hinder the absorption of nutrients. Children eventually experience stunted growth as a result of not getting the nutrients their bodies require for proper growth and development (Cumming & Cairncross, 2016). This disorder, called stunting, has long-term effects on cognitive development and physical health.

Conclusion

This research can conclude that the high sanitation risk conditions on Bungin Island impact environmental and human health conditions. The high sanitation risk that occurs is not only the result of poor domestic wastewater management but also clean water and solid waste problems. The condition of people who still do not have direct access to toilets also further increases sanitation risks due to the habits of people who do not fully care about sanitation conditions. The impacts felt by residents and the results of observations in the field show that environmental impacts such as a decrease in fish catches, coral reef problems, and potential sea water pollution also occur due to poor environmental sanitation. Sanitation and domestic wastewater problems are also driving factors for diarrhea and stunting problems in the community. Further efforts are needed to address domestic wastewater problems in Bungin

References

Akinnawo, S.O., 2023. Eutrophication: Causes, Consequences, Physical, Chemical and Biological Techniques for Mitigation Strategies. *Environmental Challenges*, 12.

Amirus, K., Sari, F.E., Dumaika, D., Perdana, A.A., & Yulyani, V., 2022. Hubungan Indeks Risiko Sanitasi dengan Kejadian Penyakit Berbasis Lingkungan di Kelurahan Pesawahan Kota Bandar Lampung. *Jurnal Kesehatan Lingkungan Indonesia*, 21(3), pp.366–372.

Bergland, H., Pedersen, P.A., & Wyller, J., 2019. Accumulated Marine Pollution and Fishery Dynamics. *Ecological Complexity*, 38, pp.56–74.

Brunetti, G., Papagrigoriou, I.A., Šimůnek, J., & Stumpp, C., 2021. Green Roofs for Domestic Wastewater Treatment: Experimental and Numerical Analysis of Nitrogen Turnover. *Journal of Hydrology*, 603(May).

Cumming, O., & Cairncross, S., 2016. Can Water, Sanitation and Hygiene Help Eliminate Stunting? Current Evidence and Policy Implications. *Maternal and Child Nutrition*, 12, pp.91–105.

Fattah, M., Intyas, C.A., Ruminar, H., & Arif, M.E., 2023. Evaluation of the Sustainability Status of the Bangsring Underwater with Indonesia'S Coral Reef Ecosystem. *Geojournal of Tourism and Geosites*, 49(3), pp.858–865.

Firmansyah, I., Carsjens, G.J., de Ruijter, F.J., Zeeman, G., & Spiller, M., 2021. An Integrated Assessment of Environmental, Economic, Social and Technological Parameters of Source Separated and Conventional Sanitation Concepts: A Contribution to Sustainability Analysis. *Journal of Environmental Management*, 295.

Freeman, M.C., Garn, J.V., Sclar, G.D., Boisson, S., Medlicott, K., Alexander, K.T., Penakalapati, G., Anderson, D., Mahtani, A.G., Grimes, J.E.T., Rehfuess, E.A., & Clasen, T.F., 2017. The Impact of Sanitation on Infectious Disease and Nutritional Status: A Systematic Review and Meta-Analysis. *International Journal of Hygiene and Environmental Health*, 220(6), pp.928–949.

Hinds, J.B., Garg, T., Hutmacher, S., Nguyen, A.,

Zheng, Z., Griffith, J., Steele, J., González Fernández, A., & Schiff, K., 2024. Assessing the Defecation Practices of Unsheltered Individuals and Their Contributions to Microbial Water Quality in An Arid, Urban Watershed. *Science of the Total Environment*, 920, pp.1–9.

Howard, G., Calow, R., Macdonald, A., & Bartram, J., 2016. Climate Change and Water and Sanitation: Likely Impacts and Emerging Trends for Action. *Annual Review of Environment and Resources*, 41, pp.253–276.

Huq, M.H., Rahman, M.M., & Hasan, G.M.J., 2024. Social Perception on Rainwater Harvesting and Wastewater Reuse: Opportunities and Challenges of a Fast-Growing Township in Dhaka. *Cleaner and Responsible Consumption*, 12, pp.1–9.

Kanda, A., Ncube, E.J., & Voyi, K., 2021. Effect of Sanitation Interventions on Health Outcomes: A Systematic Review of Cluster-Randomized Controlled Trials in Rural Communities of Low-And Middle-Income Countries. *International Journal of Environmental Research and Public Health*, 18(16), pp.1–16.

Lin, L., Yang, H., & Xu, X., 2022. Effects of Water Pollution on Human Health and Disease Heterogeneity: A Review. *Frontiers in Environmental* Science, 10.

Liu, Q., Deng, J., Yan, W., Qin, C., Du, M., Wang, Y., Zhang, S., Liu, M., & Liu, J., 2024. Burden and Trends of Infectious Disease Mortality Attributed to Air Pollution, Unsafe Water, Sanitation, and Hygiene, and Non-Optimal Temperature Globally and in Different Socio-Demographic Index Regions. *Global Health Research and Policy*, 9(1).

Micella, I., Kroeze, C., Bak, M.P., & Strokal, M., 2024. Causes of Coastal Waters Pollution with Nutrients, Chemicals and Plastics Worldwide. *Marine Pollution Bulletin*, 198.

Muliana, R., Ghozali, A., & Ariyaningsih., 2021. Factors Influencing Adequate Sanitation on Domestic Wastewater Management of Black Water Type in Margasari Village. *IOP Conference Series: Earth and Environmental Science*, 778(1).

Nurdjaman, S., Nasution, M.I., Johan, O., Napitupulu, G., & Saleh, E., 2023. Impact of Climate Change on Coral Reefs Degradation at West Lombok, Indonesia. *Jurnal Kelautan Tropis*, 26(3), pp.451–463.

Odjegba, E.E., Bankole, A.O., Sadiq, A., Layi-Adigun, B.O., Adebimpe, A.M., Kosemani, M.O., Ojo, E.B., & Adewuyi, M.A., 2024. Water, Sanitation and Hygiene (WASH) Index for Primary Healthcare Facilities: Towards Achieving WASH Security. *Heliyon*, 10(15), pp.1–16.

Okullo, J.O., Moturi, W.N., & Ogendi, G.M., 2017. Open Defaecation and Its Effects on the Bacteriological Quality of Drinking Water Sources in Isiolo County, Kenya. *Environmental Health Insights*, 11, pp.1–8.

Pendleton, L., Hoegh-Guldberg, O., Albright, R., Kaup, A., Marshall, P., Marshall, N., Fletcher, S., Haraldsson, G., & Hansson, L., 2019. The Great Barrier Reef: Vulnerabilities and solutions in the face of ocean acidification. *Regional Studies in Marine Science*, 31.

Pfenning-Butterworth, A., Buckley, L.B., Drake, J.M., Farner, J.E., Farrell, M.J., Gehman, A.-L. M., Mordecai, E.A., Stephens, P.R., Gittleman, J.L., & Davies, J., 2024. *Review Interconnecting Global Threats: Climate Change, Biodiversity Loss, and Infectious Diseases*.

Sabeen, A.H., Noor, Z.Z., Ngadi, N., Almuraisy, S., & Raheem, A.B., 2018. Quantification of Environmental Impacts of Domestic Wastewater Treatment Using Life Cycle Assessment: A Review. *Journal of Cleaner Production*, 190, pp.221–233.

Silva, J.A., 2023. Wastewater Treatment and Reuse for Sustainable Water Resources Management: A Systematic Literature Review. *Sustainability (Switzerland)*, 15(14).

Suksaroj, T.T., Jha, N.K., Chuanpongpanich, S., Siriraksophon, W., Kwanyuen, B., & Suksaroj, C., 2024. Strategy Development for Domestic Water Use Reduction in Special Economic Zone of Thailand Through Water User Perception and Factor Analysis. *Environmental and Sustainability Indicators*, 21, pp.1–14.

Sun, Y., Tang, K., Song, H., Jiang, D., Chen, S., Tu, W., Cai, L., Huang, H., & Zhang, F., 2022. The Effect of Domestic Sewage Treatment on Islands Using Ecological Treatment Processes: A Case Study of Haimen Island, Fujian Province. *International Journal of Environmental Research and Public Health*, 19(23).

Ugboko, H.U., Nwinyi, O.C., Oranusi, S.U., & Oyewale, J.O., 2020. Childhood Diarrhoeal Diseases in Developing Countries. *Heliyon*, 6(4).

Wear, S.L., Acuña, V., McDonald, R., & Font, C., 2021. Sewage Pollution, Declining Ecosystem Health, and Cross-Sector Collaboration. *Biological Conservation*, 255.

Widyarani., Wulan, D.R., Hamidah, U.,

Komarulzaman, A., Rosmalina, R.T., & Sintawardani, N., 2022. Domestic Wastewater in Indonesia: Generation, Characteristics and Treatment. *Environmental Science and Pollution Research*, 29(22), pp.32397–32414.

Wulan, D.R., Sintawardani, N., Marganingrum, D., Triyono, T., Barid, V.B., Santoso, H., & Yulianto, E., 2023. Water Sources, Consumption, and Water-Related Sanitation on Pari Island, Indonesia: A Mixed-Focus Group Discussion and Survey Study. *Aqua Water Infrastructure, Ecosystems and Society*, 72(8), pp.1359–1372.

Zhou, Q., Wang, S., Liu, J., Hu, X., Liu, Y., He, Y., He, X., & Wu, X., 2022. Geological Evolution of Offshore Pollution and Its Long-Term Potential Impacts on Marine Ecosystems. *Geoscience Frontiers*, 13(5), pp.101427.

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National Health Insurance on Household Out-of-pocket Health Expenses in Indonesia

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Abstract

BPJS Kesehatan is expected to increase access to fair and high-quality health care for all citizens and provide financial risk protection. Our study aims to examine the impact of BPJS Kesehatan's implementation as national health insurance (NHI) on household out-of-pocket expenses. Our study used a difference in differences (DID) regression model that was applied to repeated cross-section data from the National Socio-Economic Survey (Susenas) between 2013-2014 and 2019-2020. Propensity-score matching (PSM) is used to provide covariate balance in the regression model data. Illnesses that are represented by health conditions and treatment options (self-medication, outpatient, inpatient) are determining factors of out-of-pocket expenses. Our finding, the implementation of BPJS Kesehatan resulted in a 26.0% increase in out-of-pocket expenses. Its main reason is an increase in public health awareness, as indicated by the increased number of visits to health facilities. However, the increase in out-of-pocket expenses suggests that the usage of BPJS Kesehatan is not optimal. To optimize its function as financial protection, improvements must be made to the mechanism and system policies.

Introduction

Health is the right of every human being. The healthier a person is, the higher the likelihood of living longer. However, the increasing cost of health care causes people to be unable to pay their health costs. The high cost of health expenditure causes two main risks, namely the potential for poverty and a decline in household health status (Axelson *et al*., 2009). It is estimated that every year, around 150 million people suffer from financial disasters as well, and spend more than 40% of their non-food household expenditure on health (Grogger *et al*., 2015). The implications of this high health expenditure led to extreme poverty, social development, and far from affordable human rights (Okoroh *et al*., 2018).

Health insurance is one of the important health-related policies in a country because it has major health implications (Zhang *et al*., 2022) . The existence of health insurance can reduce the prevalence of diseases and increase the use of preventive health (He & Nolen, 2019; Zhang *et al*., 2022), as well as increase productivity in the economy, especially for middle-aged people (Zhang *et al*., 2022). In the absence of health insurance, when exposed to diseases that require high treatment costs, there is the potential to use savings, sell assets, go into debt, and even have implications for the interruption of children's education (Grogger *et al*., 2015) . This is especially the case in low-income societies or low-income countries. Thus, in general, health insurance benefits are associated with reduced risk of disease and reduced financial risk.

The government provides a national health management system for the entire

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community, known as universal health coverage (UHC). Several countries have established national health insurance (NHI) as a mechanism to achieve UHC, including Indonesia. Indonesia implemented NHI through the implementation of a massive universal health insurance program with the operation of BPJS Kesehatan in 2014, as a transformation of Askes through Law Number 40 of 2004 concerning the National Social Security System (SJSN) and Law Number 24 of 2011 concerning the Social Security Agency (BPJS). BPJS aims to organize the National Health Insurance Program-Healthy Indonesia Card (JKN-KIS) to ensure that all Indonesians are protected by comprehensive, fair, and equitable health insurance.

According to WHO, the success of UHC is measured in two dimensions, namely access to health care facilities and financial protection. This dimension of financial protection can be measured by the out-of-pocket expenses that a household pays for health. Out-of-pocket is defined as the total household expenditure on health-related needs, both medical expenses such as treatment, treatment, examinations, consultations, diagnoses, doctor's fees, modern and traditional medicines, as well as non-medical expenses such as transportation for patients and companions, companion lodging, food, care, accommodation, and other expenses (Axelson *et al*., 2009; Sriram & Khan, 2020; Tarigan *et al*., 2017).

Factors that affect out-of-pocket costs include a person's decision when sick, whether to seek treatment, or treatment. The existence of health insurance does not necessarily eliminate out-of-pocket expenses because not all medical expenses are covered by insurance, and other costs arise outside of medical costs. According to a study (Dey & Mishra, 2014), the decision to seek treatment is influenced by age, gender, income level, education level, and whether there is access to primary health facilities. Meanwhile, from the study (Widayanti *et al*., 2020), factors that affect a person's decision to seek treatment include the type of disease (including the involvement of the supernatural or mental illness) and who is sick (children or others). In the study (Abuduxike *et al*., 2020), it was stated that the determinants of a person's decision to seek treatment include health problems, having chronic diseases, health perception, education level, income level and insurance status, and/or ability to pay for themselves.

The out-of-pocket amount is also influenced by the form of the NHI program offered (Thuong *et al*., 2020), the type of insurance membership (Tobe *et al*., 2013); the severity of the disease, as well as the type of disease (Fong, 2019; Meraya *et al*., 2015; Tobe *et al*., 2013) , e.g., cardiovascular disease, diabetes, hypertension, and cancer, causing significantly higher expenses, age, and place of residence of the patient's location or distance from the healthcare facility (Tobe *et al*., 2013), length of hospitalization (Tobe *et al*., 2013), ownership of the hospital selected as a health facility, whether owned by the government or the private sector, as well as the level of health facilities (Grogger *et al*., 2015; Thanh *et al*., 2021; Tobe *et al*., 2013) and income from households (Al-Hanawi *et al*., 2021).

Many studies have been conducted to look at the impact of NHI on increased financial protection for its users, as measured by the decreasing medical and health care (curative) expenses that users must bear. Several studies illustrate that there has been a decrease in out-of-pocket as a result of the implementation of NHI in several countries, including studies on the impact of the implementation of NHI in Ghana since 2003, there has been a decrease in health expenditure, especially on medicines, by up to 20% (Garcia-Mandicó *et al*., 2021), other studies related to the implementation of NHI in Ghana in 2002-2016 show that households that do not have NHI have to spend out-of-pocket costs about 1.4 to 10 times higher than households with NHI (Okoroh *et al*., 2018). Similar findings were obtained in the study (Navarrete *et al*., 2019). In the implementation of IP in Vietnam, the voluntary health insurance (VHI) can also reduce out-of-pocket (Thuong *et al*., 2020). However, there are also research results that the implementation of NHI does not bring changes to out-of-pocket costs or only decreases in certain community groups. For example, in the results of the study (Karan *et al*., 2017; Ku *et al*., 2019; Sheu & Lu, 2014; Sriram & Khan, 2020) , there was a significant decrease in out-of-pocket expenses due to the

presence of NHI. In the study (Atella *et al*., 2015), the evaluation of the impact of health care reforms in China in 1998 only reduced the out-of-pocket in high-income residents with good health conditions (Atella *et al*., 2015). A similar study in Vietnam (Thanh *et al*., 2021), showed a decrease in out-of-pocket patients near poor in government health facilities. The results of the study (Al-Hanawi *et al*., 2021) even showed that health insurance provides a heterogeneous effect of income differences. In high-income/wealthy communities, health insurance leads to an increase in out-of-pocket expenses. Similarly, in the NHI impact study in Thailand, healthcare consumption outcomes increased, which was shown by the increase in hospitalization and outpatient care (Ghislandi *et al*., 2015).

In Indonesia, before the enactment of BPJS Kesehatan, a study was conducted on the impact of government-facilitated health insurance on out-of-pocket spending. The results of the study with data before the BPJS Kesehatan period showed that households that did not have health insurance had out-of-pocket expenses of 15% of total household expenditure, while those with health insurance had 13.2% (Tarigan *et al*., 2017). For the results of the study after the implementation of BPJS Kesehatan in the poor and rural communities, there was a positive influence with the existence of BPJS Kesehatan (Maulana *et al*., 2022). From the overview of various studies related to the impact of health insurance in Indonesia, research to see the impact of BPJS Kesehatan in Indonesia on the reduction of out-of-pocket expenditure on household health in general needs to be carried out, especially by using a model that not only observes the correlation between BPJS Kesehatan and out-of-pocket expenditure, But it can also find an impact. The purpose of the research is to find out the impact of the implementation of BPJS Kesehatan on household health expenditure (out-of-pocket).

Methodology

The data used in this study are data from the National Socio-Economic Survey (Susenas) Kor and the consumption module. The data taken as data before the implementation of BPJS Kesehatan is data from 2013-2014, while data after BPJS Kesehatan is enforced is taken from 2019-2020. The data was taken after 5 (five) years of the implementation of BPJS Kesehatan (since 2015), and the number of BPJS Kesehatan participants began to stabilize/tend to remain. Data was also taken in the period before the COVID pandemic to anticipate differences in outcomes due to the COVID pandemic. The unit of analysis in this study is Indonesian households.

From several previous studies, the regression model that is widely used is the difference in difference (DID) estimation model. This method is commonly used on data panels. The use of this DID estimation model aims to reduce bias due to the condition of time invariance, which is a condition that is not observed and is different in each individual but constant from time to time. However, the DID estimation model can still be done when panel data is not available, namely by using cross-sectional data. In the cross-sectional data, survey respondents before and after the program/intervention are not the same respondents. DID modeling was carried out by grouping treated and control groups, before and after the intervention/implementation of NHI in different groups, for example, in studies Ghislandi *et al*. (2015); Karan *et al*. (2017); Ku *et al*. (2019); Sheu & Lu (2014); Sriram & Khan (2020). The treated group, which is affected by NHI, is defined as a group that does not have NHI before NHI and a group that has NHI before NHI has or uses NHI. Meanwhile, the control group, which is not affected by NHI, is a group that, before NHI, already had other health insurance available, and a group that already had NHI still used available health insurance and/or owned or used NHI. The unit of analysis in the group can be in the form of households (Karan *et al*., 2017; Sheu & Lu, 2014; Sriram & Khan, 2020) or individuals (Ghislandi *et al*., 2015; Ku *et al*., 2019).

In this study, the data used is repeated cross-section data with the Treated Group approach, and affected by the implementation of BPJS Kesehatan, are household groups that, before the implementation of BPJS Kesehatan, did not have any type of health insurance, and household groups that, after the implementation of BPJS Kesehatan, are registered/have non-

PBI BPJS Kesehatan. The ownership of BPJS Kesehatan is taken non-PBI group, because the group that owns BPJS Kesehatan PBI is a change of name from Jamkesnas, Jamkesda, Jampersal, and Askeskin. This group is included in the Control Group, which is not affected by the implementation of BPJS Kesehatan. Another control group is a group of people who have any type of health insurance before the implementation of BPJS Kesehatan and continue to have health insurance after the implementation of BPJS Kesehatan. This group is considered not affected by the implementation of BPJS Kesehatan because the absence of BPJS Kesehatan does not affect their health expenses, as they are still covered by health insurance.

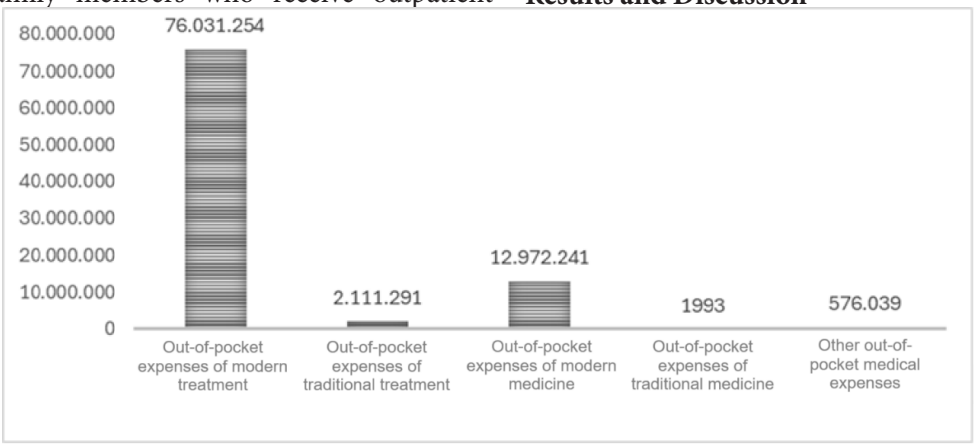
The regression model used in this study is:

$$Ln\, Y_{it} = \beta_0 + \beta_1 D_t + \beta_2 T_i + \beta_1 (D_t \, x \, T_i) + \alpha Z_{it} + \varepsilon_{it}$$

$Ln\, Y_{it}$ i.e., changes in household curative health expenditure (**Out-of-pocket**) are a dummy before and after the implementation of BPJS Kesehatan in 2015, with D_t= 0 if before 2015, i.e., 2013-2014, and D_t= 1 if in 2015 and above, namely in 2014-2015. T_i indicates the treatment group due to the implementation of BPJS Kesehatan. Z_{it} is the control variables used in this study include the health characteristics of household members (the number of household members who are sick and disrupted by work/school, the number of family members who use over-the-counter drugs (modern/traditional), the number of family members who receive outpatient treatment, the number of family members who receive treatment who are hospitalized (Karan *et al*., 2017; Thuong *et al*., 2020), the length of hospitalization, and the ownership of private insurance or company insurance (Tobe *et al*., 2013), household characteristics (age of the head of household and education of the head of household (Atella *et al*., 2015; Sheu & Lu, 2014), the level of household economy (Atella *et al*., 2015; Sheu & Lu, 2014) and characteristics of households (provincial areas, villages, cities) (Atella *et al*., 2015; Tobe *et al*., 2013; Zikidou & Hadjidema, 2020). ε_{it} is error terms and $\boldsymbol{i}$ represents households.

Because the household respondents used by the group before and after the intervention/ implementation of BPJS Kesehatan were different and there were differences in household characteristics between the treated and control groups, to balance the covariate between the treated and control groups, before the DID regression was carried out, data matching was carried out with the Propensity Scored Matching method (PSM). In this study, the variables used to obtain a covariate balance are the education of the head of household (Ku *et al*., 2019; Sriram & Khan, 2020) , the economic status of the household, namely the average annual expenditure per capita (Ku *et al*., 2019; Sriram & Khan, 2020) , the number of household members, the age of the head of the household, and the number of children under the age of 4 years in the household.

Results and Discussion



GRAPH 1. Average Composition of Health Expenditure Out-of-Pocket Household. Source: Susenas 2013-2014, 2019-2020 (Data Processed)

TABLE 1. The Results of Data Processing Using the DID Method

	DID	DID (VAR Health Control)	DID (var control RT character)	DID (var control area)	DID (all var control)
	(1)	(2)	(3)	(4)	(5)
Out-of-pocket changes per month	1,010***	0,716***	0,558***	0,919***	0,262***
	(0,00817)	(0,00696)	(0,00819)	(0,00819)	(0,00685)
Constant	9,715***	9,099***	8,710***	9,535***	8,115***
	(0,00382)	(0,00398)	(0,00849)	(0,00417)	(0,00751)
Observations	748.753	748.753	748.753	748.753	748.753
R-squared	0,031	0,309	0,125	0,043	0,398
Variable Control: Health characteristics of household members					
Number of sick and disturbed household members		0,0152***			0,0710***
		(0,00211)			(0,00196)
Number of self-medication household members		0,0270***			0,0446***
		(0,00153)			(0,00142)
Number of Outpatient household members		0,426***			0,413***
		(0,00212)			(0,00195)
Number of household members Hospitalization		1,651***			1,611***
		(0,00646)			(0,00589)
Private/corporate Insurance Ownership		-0,253***			-0,130***
		(0,00887)			(0,00782)
Length of stay (days)		0,00876***			0,00340***
		(0,00156)			(0,00131)
Household Characteristics					
Age of Head of Household			0,0108***		0,00876***
			(0,000148)		(0,000123)
Category Education Head of Household					
Pend. Basic Equivalent (reference)					
Pend. Intermediate Equivalent			0,143***		0,0881***
			(0,00423)		(0,00357)
Pend. Equivalent Height			0,242***		0,203***
			(0,00757)		(0,00628)

	DID	DID (VAR Health Control)	DID (var control RT character)	DID (var control area)	DID (all var control)
	(1)	(2)	(3)	(4)	(5)
Categories Household Expenses					
Poor (reference)					
Intermediate			0,736***		0,727***
			(0,00417)		(0,00353)
Rich			1,364***		1,349***
			(0,00645)		(0,00532)
Region Characteristics					
Province					
Provinces in Java and Bali (reference)					
Other Provinces				0,0316***	0,0851***
				(0,00428)	(0,00339)
Rural urban					
City (reference)					
				0,374***	0,0681***
Village				(0,00413)	(0,00340)

Note: Robust Standard Error *** Confidence level <0.01, ** Confidence level <0.05, * Confidence

From the data processing, it was found that the expenditure on **out-of-pocket** household health costs as depicted in Graph 1, was dominated by expenditure on modern medicine, both for treatment at government hospitals, private hospitals, health centers/ Pustu/Polindes/Posyandu, doctors/polyclinic practices and treatment at health workers' practices. The portion of traditional medicine, such as traditional medicine practices and shamans to help with childbirth, as well as the purchase of traditional medicine/herbal medicine for treatment, is relatively small compared to modern medicine.

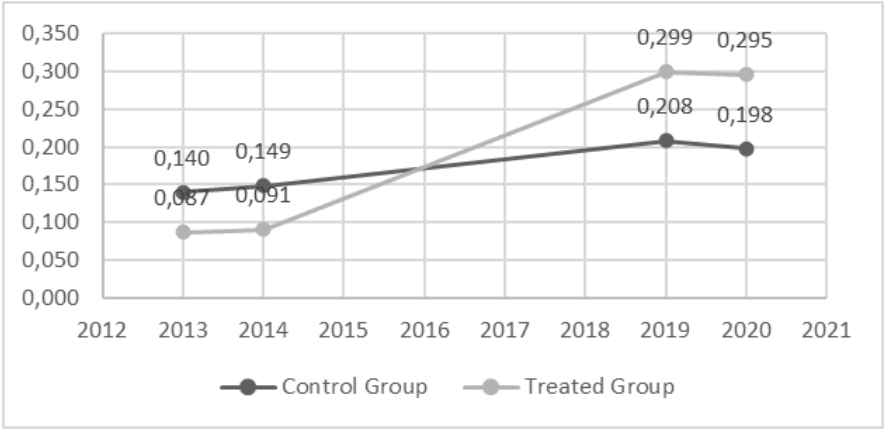
Table 1 shows the data processing results using the difference in difference (DID) estimation model to find changes in the value of out-of-pocket expenses due to BPJS Kesehatan ownership. By using various control variables that affect independent variables, it is hoped that it can further reduce the possibility of bias that arises, therefore, the estimation results in column (5) were chosen with estimation results that are not overconfident and with the highest R-squared results compared to other columns. Furthermore, data matching was carried out using the Propensity Scored Matching (PSM) method using Nearest Neighbor Matching combined with radius/caliper matching. The data that has been rematched is estimated based on the data on support using DID by adding all control variables.

Table 2 column (1) shows the estimated data of DID without PSM. Column (2) shows the DID estimate using all control variables other than household characteristics, while column (3) shows the DID estimate using all control variables, including the variables used in the PSM, after matching. The estimated results from PSM-DID are not much different from the estimates using DID, namely, the implementation of BPJS Kesehatan caused a significant **increase in out-of-pocket** per month of 26.0% at a confidence level of 0.01.

TABLE 2. Data Processing Results Using the PSM - DID Method

	DID (all var. control)	PSM - DID (var. control kec. RT characters)	PSM - DID (all var. control)
	(1)	(2)	(3)
Out-of-pocket changes per month	0,262***	0,646***	0,260***
	(0,00685)	(0,00704)	(0,00692)
Constant	8,115***	8,954***	8,130***
	(0,00751)	(0,00420)	(0,00754)
Observations	748.753	736.282	736.282
R-squared	0,398	0,316	0,397

Note: Robust Standard Error *** Confidence level <0.01, ** Confidence level <0.05, * Confidence level<0.1. Source: Susenas 2013-2014, 2019-2020 (data reprocessed)

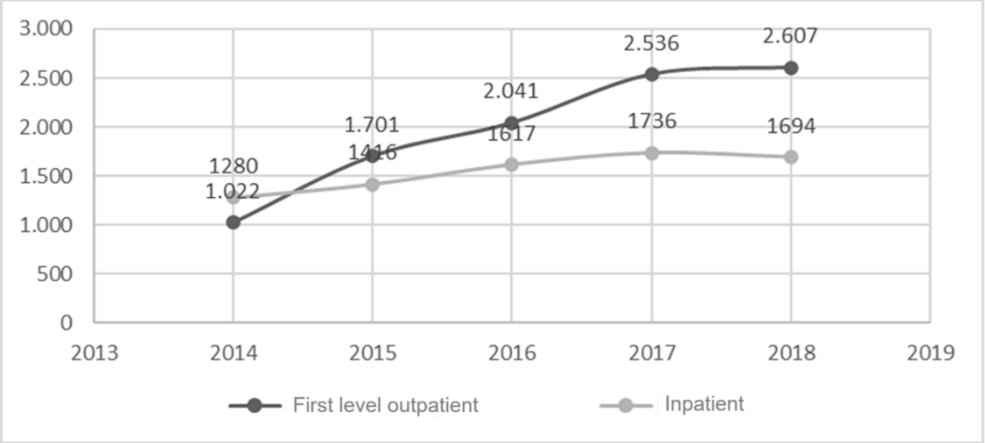


GRAPH 2. The average number of household members who are hospitalized. Source: Susenas data 2013-2014, 2019-2020 (data reprocessed)

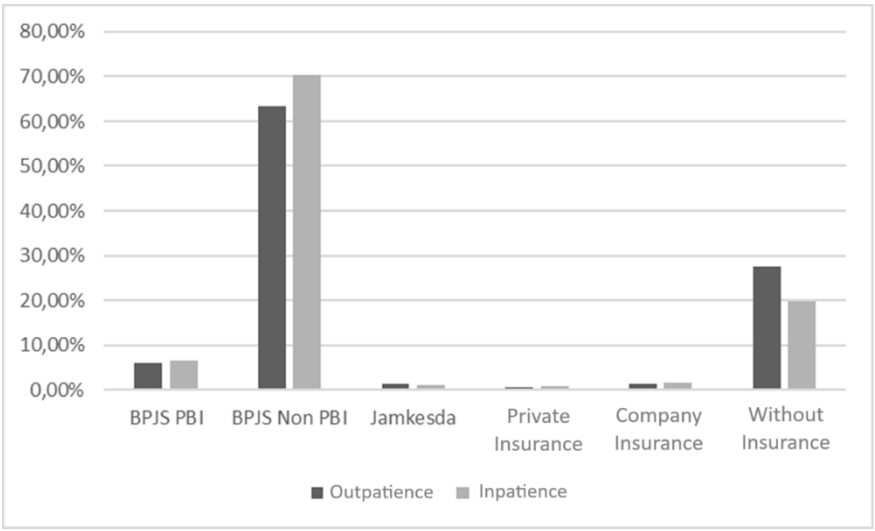
The increase in out-of-pocket expenses can be explained by the existence of BPJS Kesehatan as a national health insurance (NHI) can increase the average number of public visits to health facilities (Ghislandi *et al*., 2015; Thuong *et al*., 2020), increase the probability of being treated (Sriram & Khan, 2020), and increase the use of health facilities (Axelson *et al*., 2009).

The results of Susenas data processing in Graph 2 showed a change in behavior in the treated group, namely an increase in family members who were hospitalized in 2019-2020, which is the period after having BPJS Kesehatan. Meanwhile, in the control group that has had health insurance since 2013, family members who were hospitalized in 2019-2020 tended to remain the same compared to 2013-2014. This is reinforced by the data in Graph 3 from BPJS Kesehatan in 2014-2018, namely an increase in the number of visits per 10,000 residents at first-level outpatient health facilities and outpatient-inpatient at advanced health facilities since the implementation of BPJS Kesehatan.

Thus, having BPJS Kesehatan will improve people's behavior when conducting outpatient and inpatient medical visits. This increase has implications for an increase in out-of-pocket expenses due to the cost of medical services that are not covered and non-medical expenses such as transportation and accommodation, which BPJS Kesehatan does not cover. This condition also occurs in other



GRAPH 3. Data on the number of first-level outpatient visits and advanced-level hospitalizations per 10,000 people in 2014-2018. Source: National Social Security Board, 2019 (data reprocessed)



GRAPH 4. Choice of insurance use by BPJS Non-PBI Health Owners for Outpatient and Inpatient Care. Source: Susenas data for 2019-2020 (data reprocessed)

countries that implement NHI, where not all health-related services are covered by insurance (Karan *et al.*, 2017; Sheu & Lu, 2014; Sriram & Khan, 2020; Thanh *et al.*, 2021). The increase in visits to health facilities, if not accompanied by an increase in the quantity of health facilities and the quantity of medical personnel, will cause long queues in getting health services when using BPJS Kesehatan. BPJS Kesehatan also results in some people needing a longer time to carry out treatment until it is completed. These things can imply that BPJS Kesehatan owners do not use BPJS Kesehatan at the time of treatment, which has implications for an increase in out-of-pocket expenses.

From Susenas data in 2019-2020 on graph 4, the treated group, namely the owners of BPJS Kesehatan Non-PBI in 2019-2020 at the time of outpatient treatment, around 63% did use BPJS Kesehatan facilities, but there are still around 28% who do not use insurance, both BPJS Kesehatan and other insurance. Likewise, in hospitalization, in the treated group, namely the owners of BPJS Kesehatan Non-PBI in 2019-2020, around 70% used BPJS Kesehatan facilities, but there are still around 20% who do not use insurance, both BPJS Kesehatan and other insurance. Without the use of insurance in outpatient and inpatient treatment, there are out-of-pocket health expenses that must be borne or incurred by the household.

From Susenas data in 2019-2020, data

was also obtained that the reason for the treated group, namely the owners of BPJS Kesehatan Non-PBI in 2019-2020, did not use BPJS Kesehatan during outpatient and inpatient treatment, among others, because BPJS Kesehatan owners did not know how to use the facility, long service waiting times, inactive cards, the existence of other insurance, and the absence of transportation costs when going to do treatment. While the biggest reason is other reasons, no more detailed or detailed data or information is obtained. On the other hand, in Table 1, there is ownership of insurance other than BPJS Kesehatan, for example, private/ corporate insurance will contribute 13% lower out-of-pocket expenses than households that only have BPJS Kesehatan. Thus, the existence of additional insurance other than BPJS Kesehatan can contribute to reducing out-of-pocket expenses. From the characteristics of the provincial area, out-of-pocket expenditure in regions other than Java and Bali is 8.5% higher than provincial households in Java and Bali. This is because the number of health facilities in regions other than Java and Bali is smaller. The ratio of the number of health facilities to the first health facility in areas outside Java and Bali is higher than in the Java and Bali regions. The wider area outside Java-Bali than the Java-Bali region requires more costs to be required, for example, transportation and larger accommodation to be able to reach health facilities. Likewise, the characteristics of urban and rural areas, **out-of-pocket** spending in rural areas is 6.81% higher than that of urban households. This contrasts with the results of studies (Zikidou & Hadjidema, 2020) that urban households spend higher health costs than rural areas. Almost the same as the difference in **out-of-pocket** expenditure in regions by province, health facilities in villages are more affordable than in cities, so it requires costs, such as transportation and greater accommodation, to be able to reach health facilities.

This research is inseparable from the limitations that result in regression results being biased. First, in the health expenditure data from Susenas, it cannot be ascertained whether the respondents include or provide treatment data, including transportation and accommodation, so the out-of-pocket expenditure data issued may be higher. Second, there is a limitation of control variable data that can affect out-of-pocket expenditures, including data on the severity and type of disease, the type and level of health facilities used, and recurrent illness conditions in family members within a period, which cannot be obtained or are not available. The availability of such data allows the bias in the estimation results to be reduced. Finally, there are unobserved variables that cannot be identified, including behavior, trust in modern health, expectations of health care needs, and health-seeking behaviors, which also affect out-of-pocket spending.

Conclusion

From the regression results using PSM-DID, it was found that the implementation of BPJS Kesehatan had an impact on an increase in out-of-pocket expenses of 26%. The increase in out-of-pocket expenses was due to the increase in the number of outpatient and inpatient visits, as well as changes in behavior from the treated group to make more frequent visits, especially for inpatient visits. The increase in the number of visits is accompanied by the fact that BPJS Kesehatan is still not used during outpatient or inpatient treatment because BPJS Kesehatan owners do not know how to use the facility, long service waiting times, inactive cards, other insurance, no transportation costs when going to do treatment and other reasons. From several control variables added to strengthen the estimation model, households in the provincial area of Java-Bali have higher out-of-pocket expenditures than outside the province, as well as households in rural areas have higher out-of-pocket expenditures than in urban areas. On the other hand, the ownership of insurance other than BPJS Kesehatan, both private insurance and from companies, causes lower out-of-pocket expenses compared to households that only have BPJS Kesehatan. Thus, the existence of additional insurance other than BPJS Kesehatan can contribute to reducing out-of-pocket expenses.

References

Abuduxike, G., Aşut, Ö., Vaizoğlu, S.A., & Cali, S., 2020. Health-Seeking Behaviors and

Its Determinants: A Facility-Based Cross-Sectional Study in The Turkish Republic Of Northern Cyprus. *International Journal of Health Policy and Management*, 9(6), pp.240–249.

Al-Hanawi, M.K., Mwale, M.L., & Qattan, A.M.N., 2021. Health Insurance and Out-Of-Pocket Expenditure on Health and Medicine: Heterogeneities along Income. *Frontiers in Pharmacology*, 12.

Atella, V., Brugiavini, A., & Pace, N., 2015. The Health Care System Reform in China: Effects on Out-Of-Pocket Expenses and Saving. *China Economic Review*, 34, pp.182–195.

Axelson, H., Bales, S., Minh, P.D., Ekman, B., & Gerdtham, U.G., 2009. Health Financing for The Poor Produces Promising Short-Term Effects on Utilization and Out-of-Pocket Expenditure: Evidence from Vietnam. *International Journal for Equity in Health*, 8.

Dey, K., & Mishra, V., 2014. Determinants of Choice of Healthcare Services Utilization: Empirical Evidence from India. *Indian Journal of Community Health*, 26(4), pp.356–363.

Fong, J.H., 2019. Out-of-Pocket Health Spending Among Medicare Beneficiaries: Which Chronic Diseases are Most Costly? *PLoS ONE*, 14(9).

Garcia-Mandicó, S., Reichert, A., & Strupat, C., 2021. The Social Value of Health Insurance: Results from Ghana. *Journal of Public Economics*, 194.

Ghislandi, S., Manachotphong, W., & Perego, V.M.E., 2015. The Impact of Universal Health Coverage on Healthcare Consumption and Risky Behaviours: Evidence from Thailand. *Health Economics, Policy and Law*, 10(3), pp.251–266.

Grogger, J., Arnold, T., León, A.S., & Ome, A., 2015. Heterogeneity in the Effect of Public Health Insurance on Catastrophic Out-of-Pocket Health Expenditures: The Case of Mexico. *Health Policy and Planning*, 30(5), pp.593–599.

He, H., & Nolen, P.J., 2019. The Effect of Health Insurance Reform: Evidence from China. *China Economic Review*, 53, pp.168–179.

Karan, A., Yip, W., & Mahal, A., 2017. Extending Health Insurance to The Poor In India: an Impact Evaluation of Rashtriya Swasthya Bima Yojana on Out of Pocket Spending for Healthcare. *Social Science and Medicine*, 181, pp.83–92.

Ku, Y.C., Chou, Y.J., Lee, M.C., & Pu, C., 2019. Effects of National Health Insurance on Household Out-of-Pocket Expenditure Structure. *Social Science and Medicine*, 222, pp.1–10.

Maulana, N., Soewondo, P., Adani, N., Limasalle, P., & Pattnaik, A., 2022. How Jaminan Kesehatan Nasional (JKN) Coverage Influences Out-of-Pocket (OOP) Payments by Vulnerable Populations in Indonesia. *PLOS Global Public Health*, 2(7), pp.e0000203.

Meraya, A.M., Raval, A.D., & Sambamoorthi, U., 2015. Chronic Condition Combinations and Health Care Expenditures and Out-of-Pocket Spending Burden Among Adults, Medical Expenditure Panel Survey, 2009 and 2011. *Preventing Chronic Disease*, 12(1).

Navarrete, L., Ghislandi, S., Stuckler, D., & Tediosi, F., 2019. Inequalities in the Benefits of National Health Insurance on Financial Protection From Out-of-Pocket Payments and Access to Health Services: Cross-Sectional Evidence from Ghana. *Health Policy and Planning*, 34(9), pp.694–705.

Okoroh, J., Essoun, S., Seddoh, A., Harris, H., Weissman, J.S., Dsane-Selby, L., & Riviello, R., 2018. Evaluating the Impact of The National Health Insurance Scheme of Ghana on Out of Pocket Expenditures: A Systematic Review. *BMC Health Services Research*, 18(1).

Sheu, J.T., & Lu, J.F.R., 2014. The Spillover Effect of National Health Insurance on Household Consumption Patterns: Evidence From A Natural Experiment in Taiwan. *Social Science and Medicine*, 111, pp.41–49.

Sriram, S., & Khan, M.M., 2020. Effect of Health Insurance Program for The Poor on Out-of-Pocket Inpatient Care Cost In India: Evidence From A Nationally Representative Cross-Sectional Survey. *BMC Health Services Research*, 20(1).

Tarigan, I., Suryati, D.T., Penelitian, P., Pengembangan, D., Daya, S., & Kesehatan, P., 2017. Gambaran Out of Pocket pada Awal Era JKN di Indonesia Description Out of Pocket in the Early Era JKN at Indonesia. *Jurnal Penelitian dan Pengembangan Pelayanan Kesehatan*, 1(2).

Thanh, N.D., Anh, B.T.M., Thanh Hung, P., Quynh Anh, P., & Huyen Xiem, C., 2021. Impact of Public Health Insurance on Out-of-Pocket Health Expenditures of the Near-Poor in Vietnam. *Health Services Insights*, 14.

Thuong, N.T.T., Huy, T.Q., Tai, D.A., & Kien, T.N., 2020. Impact of Health Insurance on Health Care Utilisation and Out-of-Pocket Health Expenditure in Vietnam. *BioMed Research International*, 2020.

Tobe, M., Stickley, A., Del Rosario, R.B., & Shibuya, K., 2013. Out-of-Pocket Medical Expenses

for Inpatient Care Among Beneficiaries of the National Health Insurance Program in the Philippines. *Health Policy and Planning*, 28(5), pp.536–548.

Widayanti, A.W., Green, J.A., Heydon, S., & Norris, P., 2020. Health-Seeking Behavior of People in Indonesia: A Narrative Review. *Journal of Epidemiology and Global Health*, 10(1), pp.6–15.

Zhang, Y., Zhao, G., & Gu, H., 2022. Investing in Health Capital: Does Medical Insurance Matter?. *Research in International Business and Finance*, 61.

Zikidou, S., & Hadjidema, S., 2020. *Munich Personal RePEc Archive Household Health Expenditure in Greece and the Impact of Financial Crisis*.

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Sociodemographics, Knowledge, Attitudes, and COVID-19 Prevention Measures in Indonesia

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Abstract

The COVID-19 pandemic provides many lessons for all countries to prepare the health system and society when an outbreak of a disease occurs. From COVID-19, we learn that community participation in preventing COVID-19 is mandatory. This study aims to determine the relationship between sociodemographics, knowledge, and attitudes toward prevention measures for COVID-19. A cross-sectional study was conducted in the Mergangsan subdistrict, Yogyakarta City, Indonesia, in February-April 2022. A structured questionnaire was used to collect information from 350 participants. Univariate and bivariate analysis was performed to analyze the data. Our study found that age, gender, level of education, and attitude were significantly associated with COVID-19 prevention measures. Men-employed people and people with low knowledge and attitudes had a higher possibility of having poor prevention measures towards COVID-19. Considering the result of this study, increasing community participation in COVID-19 prevention measures requires interventions and programs tailored to specific layers by targeting men, working groups, and insufficient knowledge and behavior towards COVID-19.

Introduction

Assessing association is essential in COVID-19 because this disease spreads relatively quickly. At the same time, more than the knowledge base is needed as evidence to formulate programs and decisions that are effective and efficient. Prevention campaign programs held sporadically without being preceded by sufficient studies are feared not to be on target and are a waste of resources. COVID-19, caused by the coronavirus (SARS-CoV-2), is easily transmitted by air from person to person through droplets that flow from the nose or mouth when someone with this virus coughs or exhales. A person can become infected with a person with COVID-19 if they accidentally inhale droplets from an infected person (World Health Organization, 2020b). Therefore, in situations where the virus cannot kill, changes in human behavior are essential to avoid transmission, such as social distancing and maintaining personal hygiene (West *et al.*, 2020).

Since the start of the outbreak, the global pandemic has exceeded 97.8 million cases worldwide, with over two million deaths as of January 21, 2021 (Gebretsadik, Gebremichael and Belete, 2021)(Tu *et al.*, 2022). In Indonesia, COVID-19 cases were first reported on March 02, 2020; as of June 23, 2020, 47,897 confirmed positive cases. The Special Region of Yogyakarta (DIY) recorded its first case on March 15, 2020. As of June 10, 2020, 250 people have been reported to have contracted COVID-19. Furthermore, the Government DIY determined the emergency period from March 20 to May 31, 2020. However, considering the circumstances, the emergency policy was extended until June 30. Entering the first week of June, positive confirmed cases

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in the Special Region of Yogyakarta have not decreased. Meanwhile, in June, it was noticed that the development of cases in the world and Indonesia was the highest case period. At that time, the development of cases in the DIY was still challenging to predict regarding how and when the direction could be seen. One of the districts in Yogyakarta that reached the high case in DIY during that period was Yogyakarta City, which consists of 14 subdistricts.

Among the 14 subdistricts, the Mergangsan subdistrict was categorized as having a high incidence of COVID-19. Based on data from the Mergangsan Health Center for January- July 2021, the total number of cases for that period was more than 1,500. This district is divided into three villages: Brontokusuman, Keparakan, and Wirogunan. The Indonesian government has released some policies and efforts to break the chain of COVID-19 transmission called Large-Scale Social Restrictions (PSBB), or partial lockdown and social distancing movements (Herdiana, 2020)(Andriani, 2020). This policy implies that all residents should follow the daily health protocol. The level of compliance with this policy is influenced by intrinsic knowledge, attitude, and other characteristics. Still, of all the things that affect it, knowledge becomes the foundation for changing one's behavior. This knowledge can increase the perception of risk against COVID-19, which leads to preventive actions (Harper C *et al.*, 2020) (Pakpour and Griffiths, 2020). People with good knowledge are expected to implement good practices and precautions (Sulistyawati *et al.*, 2021). However, some researchers found that someone knowledgeable will automatically have good prevention practices. Considering the background, this research aimed to assess the relationship between sociodemographics, knowledge, and attitudes with prevention measures toward COVID-19. This research h is essential as a lesson learned during the pandemic to develop a proper intervention and program as part of preparedness.

Method

The theory adopted in this study is the relationship between individual characteristics, knowledge, and attitude toward practice, which has been used previously in studies about mental health (Rodriguez-Soto, Bernal, and Cumba-Avilés, 2015) and the relationship between knowledge and attitudes toward dengue prevention (Sulistyawati *et al.*, 2019). This research hypothesizes whether there is a relationship between sociodemographics, knowledge, and attitude toward the practice of preventing COVID-19. This analytic observational study used a cross-sectional approach and was conducted in the Mergangsan subdistrict from February to April 2022. The population of this study was all residents of Mergangsan District, Yogyakarta City, aged 18 to 65. According to the Mergangsan subdistrict office, the population was 21,483, distributed in 3 villages. We recruited the respondents by randomly sampling people who met our criteria. The sample was calculated using a cross-sectional formula, resulting in 350 respondents being included in this study.

This research has two variables: 1) dependent variable: COVID-19 prevention measures, and 2) independent variable: sociodemographics, level of knowledge, and attitudes. To collect all the information needed, we used a pre-tested questionnaire that is divided into some parts: sociodemographic characteristics (age, gender, education, and occupation), knowledge (10 questions), attitudes (3 questions), and prevention measures (13 questions). The knowledge question was scored 1 for a correct answer and 0 for an incorrect answer; for attitude, an agree response was scored 1, and a disagree was scored 0. For preventive measures, the question was scored 2,1 and 0 for always, seldom, and never response, respectively. All questionnaire was set up in Google form; for respondents who needed help to fill them in, the researcher helped to input their answers. Data were analyzed using the chi-square test, considering a 95% confidence level or a significant level (α) of 5%. Respondents received information about the research and were informed that participation was voluntary and that they had the right to quit time without penalty. People who agreed to join this research were asked to sign the informed consent. The study was approved by the Ethical Review Board of Ahmad Dahlan University, Yogyakarta, Indonesia (ethical approval code:

Table 1. Distribution of Research Respondents

Characteristic	Frequency (n)	Percentage (%)
Age Group (Years)		
18-29	125	35.71
30-49	153	43.71
≥50	72	20.57
Gender		
Male	163	46.57
Female	187	53.43
Level of education		
Basic education (primary and junior high school)	104	29.7
Secondary education (senior high school)	139	39.7
Higher education (university)	107	30.6
Occupation status		
Employed	266	76.00
Unemployed	84	24.00
Knowledge towards COVID-19		
Poor	127	36.29
Good	223	63.71
Attitudes towards COVID-19		
Poor	62	17.71
Good	288	82.29
Prevention measures for COVID-19		
Poor	154	44.00
Good	196	56.00

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Result and Discussion

Table 1 shows our respondent characteristics. A total of 350 respondents participated in our study, the majority (43.71%) aged 30-49. More than half (53.43%) of the respondents were female. Among the participants, the majority (39.70%) hold a middle education. Most of our respondents were employed (76%). Regarding knowledge, attitude, and prevention measures towards COVID-19, most of our respondents (63.71%) were classified as good, with 63.71%, 82.29%, and 56%, respectively.

Knowledge of this research was assessed through (True/False) questions. Table 2 shows the percentage of each respondent's responses by question. Among the 10 knowledge questions, we found outliers in the response question about "Children and youth do not need to take precautions against COVID-19," in which the majority (68.3%) of the respondents reported this question false.

Table 3 summarizes respondents' attitudes toward COVID-19. More than half (74.3%) of respondents agreed that it could be controlled. The majority (76%) agreed that Indonesia could control it. Lastly, most respondents (73.1%) agreed that the Indonesian government could handle it well.

Thirteen questions were posed to the respondents to measure the prevention of COVID-19. All questions were favorable – the "always" answer received the higher score. The complete response is presented in Table 4. Most respondents (52.3%) reported consistently washing their hands with soap using running water many times daily. Regarding wearing masks, 65.1% of respondents said they always

Table 2. Respondent Response to COVID-19 Knowledge Question

Knowledge questions	Response			
	True		False	
	n	%	n	%
The main clinical symptoms of people infected with COVID-19 are fever, tiredness, dry cough, and muscle aches (True)	263	75.1	87	24.9
There is currently no effective cure for COVID-19, but early detection and treatment can help most people who are infected recover (True)	235	67.1	115	32.9
Not everyone infected with COVID-19 becomes serious; only children, the elderly, and people with chronic illnesses (True)	191	54.6	159	45.4
People with COVID-19 cannot transmit the virus to others if they do not have a fever (False)	190	54.3	160	45.7
The COVID-19 virus spreads through the respiratory droplets of an infected person (True)	235	67.1	115	32.9
Using a mask can prevent transmission of the COVID-19 virus (True)	307	87.7	43	12.3
One way to avoid COVID-19 is to use a hand sanitizer or wash your hands with soap using running water (True)	297	84.9	53	15.1
Children and youth do not need to take precautions against COVID-19 (False)	111	31.7	239	68.3
To prevent transmission of COVID-19, one must avoid crowds and avoid using public transportation (True)	277	79.1	73	20.9

Table 3. The Respondent's Response Related to Attitude Toward COVID-19

Attitude questions	Response			
	Agree		Disagree	
	n	%	n	%
I agree that COVID-19 can be controlled (Favorably)	260	74.3	90	25.7
I believe Indonesia can control COVID-19 (Favorably)	266	76.0	84	24.0
The Indonesian government is handling COVID-19 well (Favorably)	256	73.1	94	26.9

Data Source: Primary data, 2022

Table 4. Percentage of Response to the Prevention Measure COVID-19

Prevention measure question	Response					
	Always		Seldom		Never	
	n	%	n	%	n	%
I wash my hands with soap using running water many times a day	183	52.3	162	46.3	5	1.4
I always monitor my temperature when I feel unwell	114	32.6	174	49.7	62	17.7
I maintain a nutritional balance by eating more vitamins and fruit	135	38.6	148	42.3	67	19.1
I exercise regularly	99	28.3	183	52.3	68	19.4
I use hand sanitizer	146	41.7	178	50.9	26	7.4
I wear a mask when I leave the house	228	65.1	109	31.1	13	3.7
I am traveling by private vehicle	149	42.6	158	45.1	43	12.3
I choose to stay at home during this pandemic	102	29.1	175	50.0	73	20.9
I avoid touching my eyes, nose, and mouth when my hands are dirty	147	42.0	156	44.6	47	13.4
I try to avoid crowds	125	35.7	174	49.7	51	14.6
I avoid shaking hands	113	32.3	183	52.3	54	15.4
I'm always looking for the latest information regarding COVID-19	94	26.9	170	48.6	86	24.6
I visit health facilities when I feel unwell during the COVID-19 pandemic	96	27.4	155	44.3	99	28.3

Data Source: Primary data, 2022

Table 5. Relationship between Sociodemographic, Knowledge, and Attitudes with COVID-19 Prevention Measures

Variable	**COVID-19 prevention measure**				**Total**		**PR 95% CI**	
	Poor		**Good**					
	n	**%**	**n**	%	n	%		
Age								
18-29 years	49	39.2	76	60.8	125	100	-	0.01
30-49 years	62	40.5	91	59.5	153	100		
≥50 years	43	59.7	29	40.3	72	100		
Gender								
Male	82	50.3	81	49.7	163	100	1.307 (1.031-1.656)	0.035
Female	72	38.5	115	61.5	187	100		
Level of education								
Basic	68	65.4	36	34.6	104	100	-	<0.001
Secondary	67	48.2	72	51.8	139	100		
Higher	19	17.8	88	82.8	107	100		
Occupation status								

Employed	106	39.8	160	60.2	266	100	0.697 (0.550-0.884)	0.008
Unemployed	48	57.1	36	42.9	84	100		
Knowledge category								
Poor	79	62.2	48	37.8	127	100	1,850 (1.471-2.325)	<0.001
Good	75	33.6	148	66.4	223	100		
Attitude category								
Poor	46	74.2	16	25.8	62	100	1.978 (1.605-2.439)	<0.001
Good	108	37.5	180	62.5	288	100		

Data Source: Primary data, 2022

wear masks, mainly when leaving their houses.

Table 5 summarizes the association between sociodemographics, knowledge, and attitudes with COVID-19 prevention measures. We found that our variables (age, gender, education, occupation, knowledge, and attitude toward COVID-19) are significantly associated with prevention measures for COVID-19. We found that males have a chance to have poor prevention measures towards COVID-19 (1.307 times higher) compared to females (P=0.01). For occupation, employed people have an opportunity to have inadequate prevention measures for COVID-19, 0.697 times higher than unemployed people (P=0.008). People with poor knowledge have a chance of having insufficient prevention measures related to COVID-19 1.850 times higher than people with good knowledge (P<0.001). A poor attitude can potentially have a more likely poor COVID-19 prevention measure 1.978 times higher than people with a good attitude (P<0.001).

COVID-19 spread rapidly across the globe, raising concern and awareness on preventing transmission. Many approaches are taken to promote the prevention of these diseases, such as COVID-19 immunization and changes in behavior. However, because of the rapid transmission speed, many residents are shocked and unprepared for the action of the COVID-19 program. Accordingly, this study aims to assess the relationship between sociodemographics, level of knowledge, and attitudes with COVID-19 prevention measures in Mergangsan District, Yogyakarta City. The mentioned variables are necessary as input for decision-makers in preparing appropriate campaigns and programs that should be effective and efficient in reaching the target.

This research found a relationship between age and COVID-19 prevention measures (*P-value* = 0.01). The age 36-45 years are categorized as mature age, considering that people at this age will have good patterns of understanding and thinking so that their knowledge will also be better for making decisions. This finding is in line with the previous studies, which prove that there is a relationship (Sulistyawati *et al.*, 2021),(Wolfe, Sirota, and Clarke, 2021)(Al-Hanawi *et al.*, 2020).

Regarding gender, our research indicated a significant relationship between gender and COVID-19 prevention measures, in which males have a 1.307 times chance of having poor COVID-19 prevention measures compared to females. Previous research reported that women tend to better understand preventing COVID-19 than men (Pietrangelo, 2020). It could be because women have more time to read or discuss the prevention of COVID-19 with their environment, and, during the pandemic, COVID-19 women are at the center of the fight against this disease, for example, as health workers (The Organization for Economic Cooperation and Development (OECD), 2020). Previous research said females tend to pay more attention to environmental conditions and health (Norgaard and York, 2005). During the implementation of PSBB in Indonesia, earlier research reported a relationship between gender and public compliance with the Large-Scale Social Restrictions (PSBB) policy in Jakarta, Indonesia (Rosha *et al.*, 2021). The policy about women's engagement in COVID-19 prevention was also based on previous research that stated that females have a better reaction to COVID-19 than males (Paramita *et al.*, 2021),(Ciarambino,

Para, and Giordano, 2021).

Education is developing character and expertise inside and outside school (Ratnasari, 2019). Apart from formal education, it is also available through other people or the mass media, including magazines, television, newspapers, radio, etc. People with a low education do not necessarily have low knowledge either. However, another opinion explains that higher education makes a person more likely to receive information quickly, increasing his knowledge. This study shows a relationship between education level and COVID-19 prevention measures (*P-value* <0.001). This study differed from earlier studies in finding no association between education level and COVID-19 preventive behavior (Amelia *et al.*, 2020). In China, it was confirmed that health education contributes to the student's knowledge and behavior of infectious diseases (Wang *et al.*, 2018).

Working is an activity carried out by respondents to earn income to fulfill their needs, which is why occupation is an essential factor and one of the best indicators of a person's way of life, including health (Fujishiro, Xu and Gong, 2010). The results of the study show that there was a significant relationship between occupation and the precautions against COVID-19. Working people have a 69.7% chance of poor COVID-19 prevention measures compared to those who do not. Our finding is in line with previous research, which found a relationship between occupation and the prevention of transmission of COVID-19 (Sarailoo *et al.*, 2021). According to a study in Iran, many reasons for people working in high-risk jobs to not comply with health protocol include a lack of a supportive environment, misconceptions about health, and difficulty accessing health supplies (SoleimanvandiAzar *et al.*, 2021).

The results of this study indicate a significant relationship between knowledge and precautions against COVID-19; people with poor knowledge will also have the opportunity to take poor prevention measures. Knowledge and behavior are two interconnected things; people with good knowledge will positively affect their behavior and attitude. Public knowledge about the coronavirus can be explained as a way of prevention, treatment, and complications (Mona, 2020). Some other research found similar findings, showing a significant relationship between knowledge and behavior in preventing COVID-19. During the COVID-19 pandemic, the spread of information in the mass media influenced disease prevention (Rachmawati, Suryadi and Diajeng, 2021). The mass media plays a vital role in positive and negative COVID-19 propaganda. The spread of hoaxes can impede preventive behavior, but the media also provides a wealth of information to counteract this misinformation. This teaches that, in the digital age, social media plays a role in public health for health promotion, health interventions, health campaigns, medical education, and disease outbreak surveillance (Kanchan and Gaidhane, 2023),(Chen and Wang, 2021).

Attitudes are usually always associated with behavior within normal limits, which are responses to environmental stimuli. This study's results indicate a significant relationship between attitudes and precautions against COVID-19. People with poor attitudes are 1.978 times more likely to take poor COVID-19 precautions than those with good attitudes. Belief is a supporting factor that develops an attitude and encourages people to comply with regulations such as the Large-Scale Social Restrictions policy (Rosha *et al.*, 2021). Our research follows previous research that found a relationship between attitude and the prevention of transmission of COVID-19 and a relationship between attitude and the COVID-19 health protocol (Wassif and El Din, 2022),(Retnaningsih *et al.*, 2020).

Our additional finding was related to most of our respondent's incorrect responses about the importance of children and youth not needing to take precautions against COVID-19. Most of them should have acknowledged that this group must comply with prevention measures. This is dangerous; indeed, the WHO says that people aged 80 years or older with comorbidities have a higher risk of getting COVID-19 (WHO, 2020a). However, those outside the group can still be exposed to COVID-19. So, if this group meets high-risk groups, it will pose a risk of unmaintained exposure. In addition, it is essential to maintain

health protocols for children and adolescents because this group can potentially be the asymptomatic case though they are exposed to COVID-19 (Götzinger and Strenger, 2022), (Garagiola et al., 2022). We must consider this study's limitations in interpreting the results presented here. Among other things, the respondents self-reported data, so we cannot measure the actual implementation of this behavior, which is mainly for prevention measures. However, this research is still relevant in describing the general situation that occurs in society.

Conclusion

The study's results showed a significant relationship between sociodemographic knowledge and attitudes toward COVID-19 prevention. Increasing community participation in COVID-19 prevention measures requires interventions and programs tailored to specific layers, targeting men, working groups, and insufficient knowledge and behavior toward COVID-19.

References

Al-Hanawi, M.K., Angawi, K., Alshareef, N., Qattan, A.M.N., Helmy, H.Z., Abudawood, Y., Alqurashi, M., Kattan, W.M., Kadasah, N.A., Chirwa, G.C., & Alsharqi, O., 2020. Knowledge, Attitude and Practice Toward COVID-19 Among the Public in the Kingdom of Saudi Arabia: A Cross-Sectional Study. *Frontiers in Public Health*, 8(May), pp.1–10.

Amelia, R., Harahap, J., Wahyuni, A.S., Fujiati, I.I., Yunanda, Y., Eyanoer, P.C., Wijaya, H., & Ariga, R.A., 2020. Analysis of Community Behavior in Coronavirus Disease-19 Prevention in Medan. *Open Access Macedonian Journal of Medical Sciences*, 8, pp.382–386.

Andriani, H., 2020. Effectiveness of Large-Scale Social Restrictions (PSBB) toward the New Normal Era during COVID-19 Outbreak: a Mini Policy Review. *Journal of Indonesian Health Policy and Administration*, 5(2), pp.61–65.

Chen, J., & Wang, Y., 2021. Social Media Use for Health Purposes: Systematic Review. *Journal of Medical Internet Research*, 23(5).

Ciarambino, T., Para, O., & Giordano, M., 2021. Immune System and COVID-19 by Sex Differences and Age. *Women's Health*, 17.

Fujishiro, K., Xu, J., & Gong, F., 2010. What Does "Occupation" Represent as an Indicator of Socioeconomic Status?: Exploring Occupational Prestige and Health. *Social Science & Medicine*, 71(12), pp.2100–2107.

Garagiola, E.R., Lam, Q., Wachsmuth, L.S., Tan, T.Y., Ghali, S., Asafo, S., & Swarna, M., 2022. Adolescent Resilience During the COVID-19 Pandemic: A Review of the Impact of the Pandemic on Developmental Milestones. *Behavioral Sciences,* 12(7).

Gebretsadik, D., Gebremichael, S., & Belete, M.A., 2021. Knowledge, Attitude and Practice Toward Covid-19 Pandemic Among Population Visiting Dessie Health Center for Covid-19 Screening, Northeast Ethiopia. *Infection and Drug Resistance*, 14, pp.905–915.

Götzinger, F., & Strenger, V., 2022. The Role of Children and Young People in the Transmission of SARS-CoV-2. *Pediatric Infectious Disease Journal*, 41(4), pp.E172–E174.

Harper, C., Satchell, L.P., Fido, D., Latzman, R.D., 2020. Functional Fear Predicts Public Health Compliance in the COVID-19 Pandemic. *International Journal of Mental Health and Addiction*, 27(1), pp.1-14.

Herdiana, D., 2020. Social Distancing: Indonesian Policy Response to the Corono Virus Disease 2019 (COVID-19). *Jurnal Ilmu Administrasi*, 16(1), pp.93–110.

Kanchan, S., & Gaidhane, A., 2023. Social Media Role and Its Impact on Public Health: A Narrative Review. *Cureus*, 2023.

Mona, N., 2020. Konsep Isolasi Dalam Jaringan Sosial Untuk Meminimalisasi Efek Contagious (Kasus Penyebaran Virus Corona Di Indonesia). *Jurnal Sosial Humaniora Terapan*, 2(2), pp.117–125.

Norgaard, K., & York, R., 2005. Gender Equality and State Environmentalism. *JSTOR*, 19(4), pp.506–522.

The Organization for Economic Cooperation and Development (OECD)., 2020. *Women at the Core of the Fight Against COVID-19 Crisis*.

Pakpour, A., & Griffiths, M., 2020. The Fear of COVID-19 and Its Role in Preventive Behaviors. *Journal of Concurrent Disorders*, 2, pp. 58–63.

Paramita, W., Rostiani, R., Winahjoe, S., Wibowo, A., Virgosita, R., & Audita, H., 2021. Explaining the Voluntary Compliance to COVID-19 Measures: An Extrapolation on the Gender Perspective. *Global Journal of*

Flexible Systems Management, 22.

Pietrangelo, A., 2020. *Women Are Taking the COVID-19 Pandemic More Seriously Than Men*, *Healthline*.

Rachmawati, S., Suryadi, I., & Diajeng, R., 2021. Receiving COVID-19 Messages on Social Media to the People of Semarang City. *Kesehatan Masyarakat KEMAS*, 17(2), pp.625–634.

Ratnasari, W., 2019. Character Building in Education: A Proposed Theory for STAI's Economic Syari'ah Program. *AL-MUQAYYAD: Jurnal Ekonomi Syariah*, 1(1), pp.25–39.

Retnaningsih, E., Nuryanto., Oktarina, R., Komalasari, O., & Maryani, S., 2020. The Effect of Knowledge and Attitude Toward Coronavirus Disease-19 Transmission Prevention Practice in South Sumatera Province, Indonesia. *Open Access Macedonian Journal of Medical Sciences*, 8(T1), pp.198–202

Rodriguez-Soto, N., del C., Bernal, G., & Cumba-Avilés, E., 2015. The Role of Individual Characteristics, Knowledge, And Attitudes Toward the Use of Evidence-Based Practices Among Mental Health Providers in Puerto Rico. *Revista Puertorriqueña de Psicología*, 26(1), pp.122–134.

Rosha, B.C., Suryaputri, I.Y., Irawan, I.R., Arfines, P.P., & Triwinarto, A., 2021. Factors Affecting Public Non-Compliance with Large-Scale Social Restrictions to Control COVID-19 Transmission in Greater Jakarta, Indonesia. *Journal of Preventive Medicine and Public Health*, 54(4), pp.221–229.

Sarailoo, M., Matin, S., Vosoughi, M., Dargahi, A., Gholizadeh, H., Damavandi, M.R., Abbasi-Ghahramanloo, A., & Kamran, A., 2021. Investigating the Relationship Between Occupation and SARS-CoV2. *Work*, 68(1), pp.27–32.

SoleimanvandiAzar, N., Irandoost, S.F., Ahmadi, S., Xosravi, T., Ranjbar, H., Mansourian, M., & Lebni, J.Y., 2021. Explaining the Reasons for Not Maintaining The Health Guidelines to Prevent COVID-19 in High-Risk Jobs: A Qualitative Study in Iran. *BMC Public Health*, 21(1), pp.1–15.

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Mapping the Landscape of Affirmative Healthcare for Transgender Communities through Bibliometric Analysis

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Abstract

Gender-affirmative healthcare provides a supportive and safe space for individuals irrespective of their gender identity. Despite this, transgender individuals encounter discrimination when seeking equitable healthcare. Consequently, this research aims to examine the current state of transgender healthcare research and identify areas requiring further investigation. Employing the Preferred Reporting Item for Systematic Reviews and Meta-Analyses (PRISMA), the study initially identified 278 articles, with 42 meeting the inclusion criteria for analysis. Bibliometric analysis was conducted using Biblioshiny and Vos-viewer software. The review underscores the growing academic interest in gender affirmative care and emphasizes the necessity for increased scholarly focus. Analysis of document production by various countries reveals an uneven geographical distribution of research in this area. Additionally, the study identifies a trend towards a greater emphasis on the adoption of affirmative approaches in addressing health disparities through term co-occurrence analysis. This research holds potential in informing the development of inclusive policies and comprehensive strategies to improve the health outcomes of transgender populations, thus advancing health equity and contributing to the achievement of Sustainable Development Goals.

Introduction

During the medicalization phase of the early 18th Century, transgender individuals faced disregard primarily due to the rigid binary classification of sex. The prevailing heteronormative perspectives in the education system overlooked the diversity of gender and sexuality, instead pathologizing deviations such as homosexuality and prescribing medical intervention (Teagarden, 2021). This was exemplified by the introduction of the diagnosis of "transsexualism" in the Diagnostic and Statistical Manual-III (1980), which characterized transgender individuals as having a mental disorder necessitating a desire to change their sex (Lim *et al*., 2019). Such diagnoses and interventions were rooted in a cis-heteronormative medical gaze, assuming that any deviation from the male-female alignment was pathological and required correction. Practices like conversion therapy emerged as attempts to enforce conformity to societal norms, leading to significant psychological distress among transgender individuals (Ashley, 2020a).

Over time, research began to acknowledge the spectrum of gender and sexuality, prompting revisions in the classification of gender identity disorder (GID) in the Diagnostic and Statistical Manual of Mental Disorders (DSM). The DSM-V, released in 2013, renamed GID as "Gender Dysphoria," reflecting a shift towards inclusivity and comprehensive clinical awareness (Gessner *et*

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al., 2020). These changes aimed to prioritize the well-being of non-binary individuals and foster a culture of inclusivity within medical spaces. The concept of queering medical spaces emerged as a framework challenging traditional binary categories of sex and gender, celebrating diversity, and empowering transgender individuals to make informed decisions about their bodies and identities (Eckstrand *et al*., 2016). Gender affirmative healthcare is a critical component of queering medical spaces, providing transgender individuals with healthcare that supports their well-being and self-determination. It is a personalized and holistic approach considering various aspects of the gender journey, beneficial not only for transgender individuals but also for their families, communities, and society at large (Eckstrand *et al*., 2016).

The research underscores the ongoing insufficient adoption of gender-affirming practices. In today's climate, transgender individuals continue to encounter health disparities at multiple levels. Studies indicate that transgender individuals face increased risks of discrimination and adverse mental health effects such as depression, anxiety, trauma-related stress, and suicidal tendencies. Moreover, even mental health professionals who specialize in working with transgender individuals lack adequate training and understanding to support nonbinary individuals effectively (Rider *et al*., 2019). This issue affects the well-being of transgender individuals when it comes to accessing safe healthcare services. Therefore, these obstacles underscore the pressing need for comprehensive and inclusive measures aimed at ensuring equitable access to healthcare and enhancing the health and well-being of the transgender community. Hence, the study aims to synthesize academic knowledge through a systematic literature review using bibliometric tools, shedding light on gender-affirmative healthcare and pinpointing avenues for future investigation. By embracing a culture of inclusivity and diversity through gender-affirming care for transgender individuals, it is possible to mitigate health disparities and attain gender justice for all.

Methodology

The study employed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure the accuracy of the sample database (Page *et al*., 2021). Bibliometric analysis was chosen due to its ability to provide a comprehensive analysis of accumulated knowledge over time. Initially, a search strategy was devised to systematically search for relevant literature on gender-affirmative healthcare across Scopus, PubMed, and Web of Science databases. Scopus was selected as the primary database due to its comprehensive coverage across various disciplines. It is suitable for conducting a thorough bibliometric analysis. The search

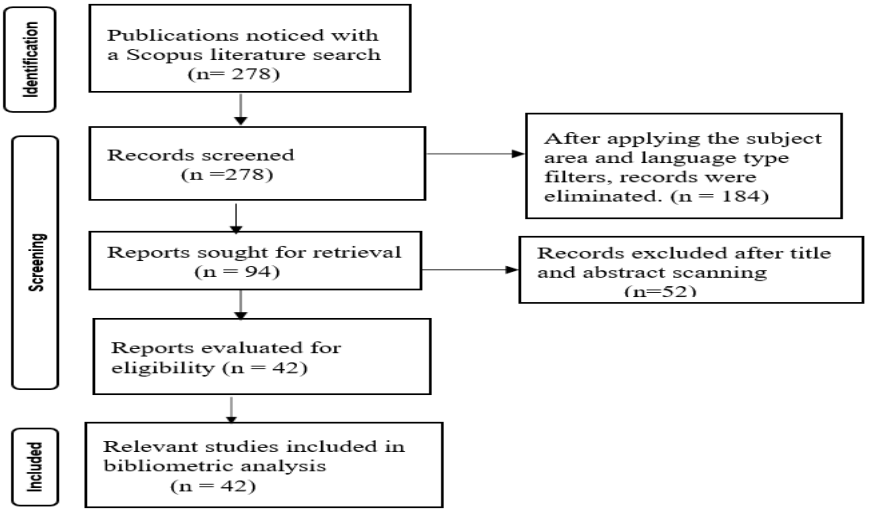

Figure 1. The Flow Diagram of Articles Selection (www.prisma-statement.org)

was conducted, including the word "Gender affirmative care" in the title, abstract, and keyword fields of the database, resulting in the identification of 278 articles in the preliminary phase. Subsequently, filtering criteria were applied to narrow down the scope. Given the limited prior literature on gender affirmative care in the social sciences domain before 2002, the search period was restricted from 2002 to 2022, with 2002 serving as the baseline year.

Further, the focus of the paper was on understanding transgender healthcare from the social science perspective. Thus, Inclusion criteria specified articles published in the English language and within the field of social sciences. After filtering, only 94 articles met these inclusion criteria for further analysis. To ensure the quality and relevance of the academic literature, further abstracts were scrutinized, resulting in the exclusion of 52 articles. Only articles addressing transgender issues and health practices were retained. After applying the inclusion and exclusion criteria, 42 articles were deemed eligible for analysis. Figure 1 illustrates the literature inclusion and exclusion process at each stage. Biblioshiny, a software package within R Studio, and Vos-viewer were employed for the analysis in this study.

Results and Discussion

The study examined 42 articles spanning from 2002 to 2022. Figure 2 displays publications from 2016 onwards to ensure publication continuity. Initially, there was minimal publication, with only one article each in 2002, 2007, 2013, and 2014. However, starting in 2016, there has been steady growth in publications, and the year 2021 recorded the highest number of articles, with eleven publications indicating a notable surge in scholarly interest in gender-affirmative healthcare. This trend highlights the increasing significance of this topic in academic discussions. Consequently, there is a distinct necessity for additional exploration and research to enhance our comprehension of this field.

Figure 3 depicts the production of documents by countries, and highlights the global research efforts in gender-affirmative healthcare. Globally, the United States leads with 86, followed by Canada with 16, indicating their significant contributions. The United Kingdom (12), New Zealand (11), Argentina (9), Australia (8), Italy and Ireland (5 each), Brazil (4), Norway (3), China, and India (3, 2 respectively) also contribute, though to a lesser extent. This distribution points to varying research intensities across countries, with a general scarcity noted outside the leading nations. The analysis calls for broader integration of gender-affirmative healthcare research to foster inclusivity for transgender individuals globally.

The research themes were illustrated by analyzing the term co-occurrence of 383 terms, with a co-occurrence threshold set at two. Subsequently, 107 terms were visualized, with the size of nodes reflecting the frequency of term co-occurrence. Clusters of related terms were represented by distinct colors, indicating groups of terms with strong relationships. Four themes were identified from these clusters based on the interconnected nodes (Figure 4) and discussed below. The field of transgender healthcare has evolved in response to medicalization and industrialization, which shaped healthcare settings based on medical science and clinical practices. Initially, transsexualism was classified as a psychological abnormality, viewed through a narrow lens of the medical gaze, and treated to

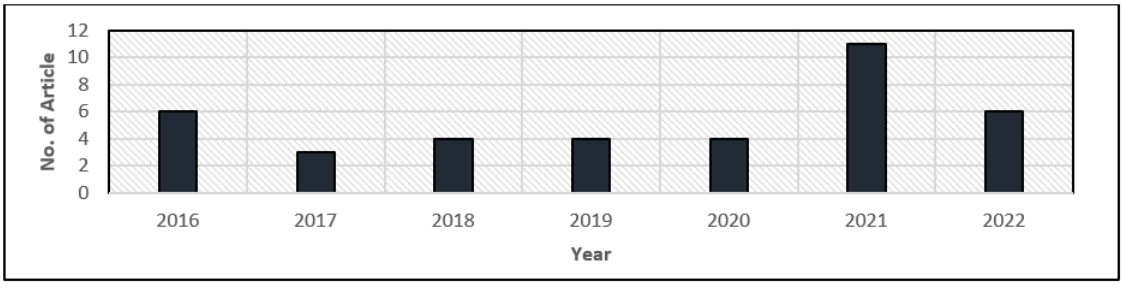

Figure 2. The Trend in Publication (Generated by the Authors Through Biblioshiny)

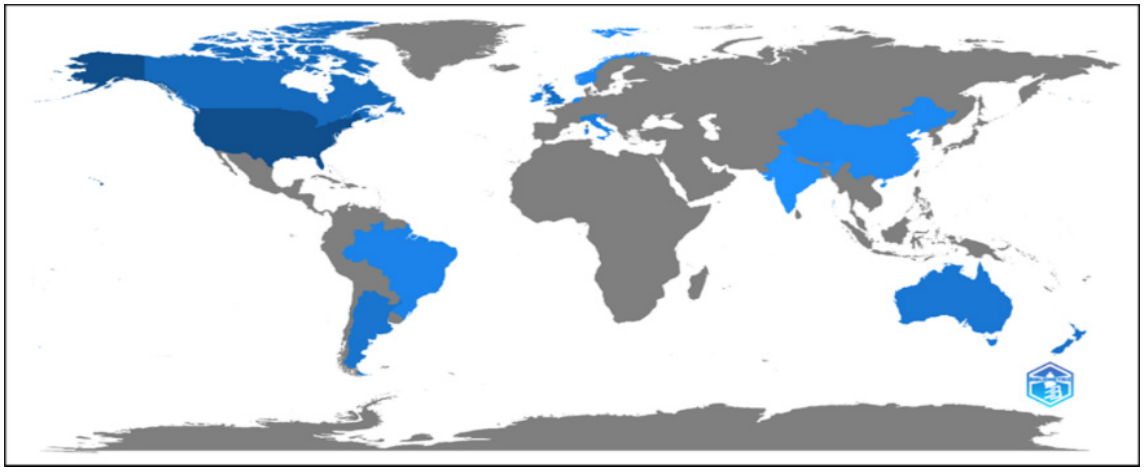

Figure 3. Production of Documents by Countries (Generated by Authors Through Biblioshiny)

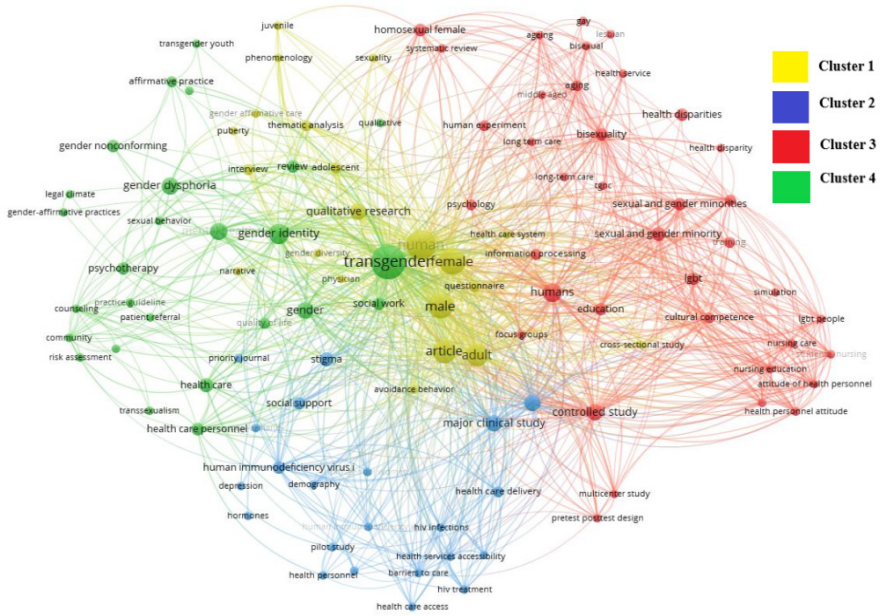

Figure 4. Thematic Clustering (Generated by Authors Through Biblioshiny)

convert individuals to binary gender categories (Teagarden, 2021). According to Benson 2013, mental health research and practice have historically taken a limited approach to addressing the needs of transgender individuals, often revolving around the diagnosis of gender identity disorder, which has restricted the understanding and support available to this population. These traditional care models have been found to have detrimental effects on the well-being of individuals (Ashley, 2020).

Cluster 1: Medical Approach

Over time, there have been significant changes in the classification of gender identity disorder (GID). The revised diagnostic criteria focused on the incongruence between an individual's gender and their secondary sex characteristics rather than pathologizing their gender identity. These changes aimed to depart from biased perspectives and foster a more comprehensive understanding of transgender experiences. Additionally, the World Professional Association for Transgender Health (WPATH) issued updated Standards of Care (SOC) as principal guidelines for

healthcare professionals serving transgender individuals (Coleman *et al*., 2022). These standards emphasize ethical principles and best practices to promote the well-being of transgender individuals (Benson, 2013). There is a need to adopt this sensitive healthcare framework globally.

Cluster 2: Social Approach

Societal perceptions of transgender individuals are shaped by a binary gender framework, resulting in marginalization and discrimination (Radusky *et al*., 2020). These individuals face significant legal and social challenges due to traditional gender norms and biases (Boza & Nicholson Perry, 2014). Minority stress, stemming from ongoing societal stress and discrimination, leads to poorer health outcomes and reduced quality of life for transgender individuals (Toomey, 2021). This stress creates barriers to healthcare access (Gessner *et al*., 2020), while societal stigma and discrimination pose challenges for transgender youth and their parents (Lorusso & Albanesi, 2021). Victimization related to gender identity is strongly linked to negative mental health outcomes, including depression, although social support can mitigate these effects (Boza & Nicholson Perry, 2014). Reducing stigma through education, advocacy, and policy changes is crucial for improving health outcomes and fostering a supportive environment for transgender individuals (Radusky *et al*., 2020).

Cluster 3: Approach to Educating Healthcare Providers

The reclassification of "gender identity disorder" to "gender incongruence" in the International Classification of Disease (ICD-11) has not significantly reduced the stigma and discrimination faced by sexual minorities in healthcare, with many providers' attitudes still negative (Gessner *et al*., 2020). Prejudices influenced by religious and cultural beliefs are common (Higgins *et al*., 2019), and the lack of sexual minority health education in healthcare curricula contributes to persistent discrimination (Lacombe-Duncan *et al*., 2021). Healthcare providers often exhibit discriminatory and unempathetic behaviors, leading to access barriers like financial hardship, long wait times, and judgmental treatment (Austin & Goodman, 2018).

Healthcare providers can play a vital role in ensuring respectful and inclusive care for transgender patients, which includes addressing specific needs, providing sexual health education, and cultural competence (Gessner *et al*., 2020; Puckett *et al*., 2022). A person-centered approach is critical, regardless of gender identity (Neri *et al*., 2022). Training programs should prioritize to adopt gender-affirming healthcare and inclusive policies (Walker *et al*., 2022). Including LGBT content in nursing education is key to increasing competency, with interactive teaching methods like role-playing enhancing critical thinking (Lelutiu-Weinberger *et al*., 2016; Díaz *et al*., 2017; Maruca *et al*., 2018; Wang *et al*., 2022). Frameworks from programs like Transgender Education for Affirmative and Competent HIV and Healthcare (TEACHH) and Gender Affirmative Lifespan Approach (GALA) need to be adopted to support mental health professionals (Rider *et al*., 2019; Lacombe-Duncan *et al*., 2021), and reflective practice in trans-affirmative healthcare is beneficial for well-being (Fraser *et al*., 2021; Raju, 2022). In the digital age, it's crucial to create inclusive online environments for mental healthcare, as a gender-affirmative approach positively affects the health and well-being of transgender individuals (Holt *et al*., 2019; Sevelius *et al*., 2019; Achuthan, 2021).

Cluster 4: Gender Affirmative Care

Transgender individuals grappling with gender dysphoria face significant mental health challenges, including isolation and depression, often exacerbated by healthcare discrimination and cultural misunderstandings (Austin *et al*., 2021; Applegarth & Nuttall, 2016; Mizock & Lundquist, 2016). Supportive healthcare and familial environments are essential, demanding clinical and cultural sensitivity to affirm transgender identities and combat systemic biases (Carlile *et al*., 2021; Holt *et al*., 2021). Affirmative care, which is multidisciplinary in nature, provides gender-affirming interventions and collaborates with families and other stakeholders to create secure healthcare settings (Kcomt *et al*., 2020; Whyatt-

Sames, 2017; Ehrensaft, 2018). Care protocols consider each individual's gender identity, family situation, and psychological state (Chen *et al*., 2016; Edwards-Leeper *et al*., 2016). Initiating affirmative practices in primary care promotes health-seeking behavior and minimizes stigma, contrasting with specialized clinics (Ker *et al*., 2021). Healthcare teams should follow WPATH and Endocrine Society guidelines (Chen *et al*., 2016). The journey towards gender-affirmative care begins with the first patient-staff interaction, underlining the importance of training for inclusive practice (Noyola *et al*., 2021). This approach has been shown to enhance the well-being and proactive health behaviors of transgender individuals (Austin & Goodman, 2018; Strauss *et al*., 2022). Implementing policy and practice changes is vital for establishing a long-term healthcare environment that is inclusive and affirming (Willis *et al*., 2017; Putney *et al*., 2018).

Conclusion

The paper argues that bibliometric analysis can effectively complement traditional review methods by qualitatively synthesizing data, providing in-depth insights into academic research on topics like gender-affirmative healthcare. Bibliometric findings reveal that this field is expanding and warrants increased academic attention. However, there is a notable lack of geographical diversity in the articles studied. The thematic analysis highlights the necessity of educating healthcare professionals, initiating social endeavors to promote acceptance of transgender individuals, and implementing gender-affirmative healthcare practices. The study suggests further exploration into legal considerations to ensure health equity. Nevertheless, it acknowledges limitations, such as reliance on the Scopus database due to software constraints and excluding publications beyond 2022. Expanding to additional databases could offer broader insights beyond the study's current scope.

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References

Achuthan, A., 2021. Gender-Affirmative Technologies and The Contemporary Making of Gender in India. *Economy and Society*, 50(3), pp.423–447.

Applegarth, G., & Nuttall, J., 2016. The Lived Experience of Transgender People of Talking Therapies. *International Journal of Transgenderism*, 17(2), pp.66–75.

Ashley, F., 2020. Homophobia, Conversion Therapy, and Care Models for Trans Youth: Defending the Gender-Affirmative Approach. *Journal of LGBT Youth*, 17(4), pp.361–383.

Austin, A., & Goodman, R., 2018. Perceptions of Transition-Related Health and Mental Health Services Among Transgender Adults. *Journal of Gay and Lesbian Social Services*, 30(1), pp.17–32.

Austin, A., Holzworth, J., & Papciak, R., 2021. Beyond Diagnosis: Gender Dysphoria Feels Like a Living Hell, a Nightmare One Cannot Ever Wake Up From. *Psychology of Sexual Orientation and Gender Diversity*, 9(1), pp.12–20.

Benson, K.E., 2013. Seeking Support: Transgender Client Experiences with Mental Health Services. *Journal of Feminist Family Therapy*, 25(1), pp.17–40.

Bockting, W.O., Knudsen, G., & Goldberg, J.M., 2007. Counseling and Mental Health Care for Transgender Adults and Loved Ones. *International Journal of Transgenderism*, 9(3–4), pp.35–82.

Boza, C., & Nicholson Perry, K., 2014. Gender-Related Victimization, Perceived Social Support, and Predictors of Depression Among Transgender Australians. *International Journal of Transgenderism*, 15(1), pp.35–52.

Carlile, A., Butteriss, E., & Sansfaçon, A.P., 2021. It's Like My Kid Came Back Overnight: Experiences of Trans and Non-Binary Young People and Their Families Seeking, Finding and Engaging With Clinical Care in England. *International Journal of Transgender Health*, 22(4), pp.412–424.

Chen, D., Hidalgo, M.A., Leibowitz, S., Leininger, J., Simons, L., Finlayson, C., & Garofalo, R., 2016. Multidisciplinary Care for Gender-Diverse Youth: A Narrative Review and Unique Model of Gender-Affirming Care. *Transgender Health*, 1(1), pp.117–123.

Díaz, D.A., Maruca, A., Gonzalez, L., Stockmann, C., & Hoyt, E., 2017. Using Simulation to Address Care of the Transgender Patient in Nursing Curricula. *BMJ Simulation and*

Technology Enhanced Learning, 3(2), pp.65–69.

Eckstrand, K.L., Ng, H., & Potter, J., 2016. Affirmative and Responsible Health Care For People with Nonconforming Gender Identities and Expressions. *AMA Journal of Ethics*, 18(11), pp.1107–1118.

Edwards-Leeper, L., Leibowitz, S., & Sangganjanavanich, V.F., 2016. Affirmative Practice with Transgender and Gender Nonconforming Youth: Expanding the Model. *Psychology of Sexual Orientation and Gender Diversity*, 3(2), pp.165–172.

Ehrensaft, D., 2018. Realities and Myths: The Gender Affirmative Model of Care for Children and Youth. *Current Critical Debates in the Field of Transsexual Stud.: In Transit,* pp.102–114.

Fraser, G., Brady, A., & Wilson, M.S., 2021. What if I'm Not Trans Enough? What if I'm Not Man Enough?": Transgender Young Adults' Experiences of Gender-Affirming Healthcare Readiness Assessments in Aotearoa New Zealand. *International Journal of Transgender Health*, 22(4), pp.454–467.

Gessner, M.K., Bishop, M.D., Martos, A., Wilson, B.D.M., & Russell, S.T., 2020. Sexual Minority People's Perspectives of Sexual Health Care: Understanding Minority Stress in Sexual Health Settings. *Sexuality Research and Social Policy*, 17(4), pp.607–618.

Higgins, A., Downes, C., Sheaf, G., Bus, E., Connell, S., Hafford-Letchfield, T., Jurček, A., Pezzella, A., Rabelink, I., Robotham, G., Urek, M., van der Vaart, N., & Keogh, B., 2019. Pedagogical Principles and Methods Underpinning Education of Health and Social Care Practitioners on Experiences and Needs of Older LGBT+ People: Findings from a Systematic Review. *Nurse Education in Practice*, 40.

Holt, N.R., Hope, D.A., Mocarski, R., & Woodruff, N., 2019. First Impressions Online: The Inclusion of Transgender and Gender Nonconforming Identities and Services in Mental Healthcare Providers' Online Materials in the USA. *International Journal of Transgenderism*, 20(1), pp.49–62.

Holt, N.R., King, R.E., Mocarski, R., Woodruff, N., & Hope, D.A., 2021. Specialists in Name or Practice? The Inclusion of Transgender and Gender Diverse Identities in Online Materials of Gender Specialists. *Journal of Gay and Lesbian Social Services*, 33(1), pp.1–15.

Jessen, R.S., Haraldsen, I.R.H., & Stänicke, E., 2021. Navigating in the Dark: Meta-Synthesis of Subjective Experiences of Gender Dysphoria Amongst Transgender and Gender Non-Conforming Youth. *Social Science and Medicine*, 281.

Kcomt, L., Gorey, K.M., Barrett, B.J., & McCabe, S.E., 2020. Healthcare Avoidance Due to Anticipated Discrimination Among Transgender People: A Call to Create Trans-Affirmative Environments. *SSM-Population Health*, *11*.

Ker, A., Fraser, G., Fleming, T., Stephenson, C., da Silva Freitas, A., Carroll, R., Hamilton, T.K., & Lyons, A.C., 2021. 'A Little Bubble of Utopia': Constructions of a Primary Care-Based Pilot Clinic Providing Gender Affirming Hormone Therapy. *Health Sociology Review*, 30(1), pp.25–40.

Lacombe-Duncan, A., Logie, C.H., Persad, Y., Leblanc, G., Nation, K., Kia, H., Scheim, A.I., Lyons, T., Horemans, C., Olawale, R., & Loutfy, M., 2021. Implementation and Evaluation of the 'Transgender Education for Affirmative and Competent HIV and Healthcare (TEACHH)' Provider Education Pilot. *BMC Medical Education*, 21(1).

Lelutiu-Weinberger, C., Pollard-Thomas, P., Pagano, W., Levitt, N., Lopez, E.I., Golub, S.A., & Radix, A.E., 2016. Implementation and Evaluation of a Pilot Training to Improve Transgender Competency among Medical Staff in an Urban Clinic. *Transgender Health*, 1(1), pp.45–53.

Lim, H.H., Jang, Y.H., Choi, G.Y., Lee, J.J., & Lee, E.S., 2019. Gender Affirmative Care of Transgender People: A Single Center's Experience in Korea. *Obstetrics and Gynecology Science*, 62(1), pp.46–55.

Lorusso, M., & Albanesi, C., 2021. When the Context Rows Against. Voicing Parents of Transgender Children and Teenagers in Italy: A Qualitative Study. *Journal of Community and Applied Social Psychology*, 31(6), pp.732–748.

Maruca, A.T., Diaz, D.A., Stockmann, C., & Gonzalez, L., 2018. Using Simulation with Nursing Students to Promote Affirmative Practice Toward the Lesbian, Gay, Bisexual, and Transgender Population: A Multisite Study. *Nursing Education Perspectives*, 39(4), pp.225–229.

Mizock, L., & Lundquist, C., 2016. Missteps in Psychotherapy with Transgender Clients: Promoting Gender Sensitivity in Counseling and Psychological Practice. *Psychology of Sexual Orientation and Gender Diversity*, 3(2), pp.148–155.

Neri, J., Iudici, A., & Faccio, E., 2022. Mental Health Practitioners' Narratives About Gender Transition and the Role of Diagnosis: A Qualitative Study in the Italian Context. *Health and Social Care in the Community*, 30(5), pp.e2678–e2689.

Noyola, N., Sierra, M.J., Allen, D.E., & Ahnallen, C.G., 2021. Incorporating Administrative Staff in Trans-Affirmative Care Training: A Cognitive-Behavioral Learning Approach. *Transgender Health*, 6(4), pp.224–228.

Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., Shamseer, L., Tetzlaff, J.M., Akl, E.A., Brennan, S.E., Chou, R., Glanville, J., Grimshaw, J.M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E.W., Mayo-Wilson, E., McDonald, S., McGuinness, L.A., Stewart, L.A., Thomas, J., Tricco, A.C., Welch, V.A., Whiting, P., & Moher, D., 2021. The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews. *BMJ*, 372.

Puckett, J., Giffel, R., Brown, F., Gallik, C., Kimball, D., Chu, H., Mustanski, B.S., & Newcomb, M.E., 2022. Suggestions for Improving Healthcare for Transgender and Gender Diverse People in the United States. *International Journal of Transgender Health*, 2022.

Putney, J.M., Keary, S., Hebert, N., Krinsky, L., & Halmo, R., 2018. "Fear Runs Deep:" The Anticipated Needs of LGBT Older Adults in Long-Term Care. *Journal of Gerontological Social Work*, 61(8), pp.887–907.

Radusky, P.D., Zalazar, V., Cardozo, N., Fabian, S., Duarte, M., Frola, C., Cahn, P., Sued, O., & Aristegui, I., 2020. Reduction of Gender Identity Stigma and Improvements in Mental Health among Transgender Women Initiating HIV Treatment in a Trans-Sensitive Clinic in Argentina. *Transgender Health*, 5(4), pp.216–224.

Raj, R., 2002. Towards a Transpositive Therapeutic Model: Developing Clinical Sensitivity and Cultural Competence in the Effective Support of Transsexual and Transgendered Clients. *International Journal of Transgenderism*, 6(2).

Raju, M.S., 2022. Reflective Practice in Trans Affirmative Care. *Indian Journal of Social Work*, 83(2), pp.193–212.

Rider, G.N., Vencill, J.A., Berg, D.R., Becker-Warner, R., Candelario-Pérez, L., & Spencer, K.G., 2019. The Gender Affirmative Lifespan Approach (GALA): A Framework for Competent Clinical Care with Nonbinary Clients. *International Journal of Transgenderism*, 20(2–3), pp.275–288.

Sevelius, J., Murray, L.R., Martinez Fernandes, N., Veras, M.A., Grinsztejn, B., & Lippman, S.A., 2019. Optimising HIV Programming for Transgender Women in Brazil. *Culture, Health and Sexuality*, 21(5), pp.543–558.

Strauss, P., Winter, S., Waters, Z., Wright Toussaint, D., Watson, V., & Lin, A., 2022. Perspectives of Trans and Gender Diverse Young People Accessing Primary Care and Gender-Affirming Medical Services: Findings from Trans Pathways. *International Journal of Transgender Health*, 23(3), pp.295–307.

Teagarden, J.R., 2021. *Reading Foucault's The Birth of the Clinic in 2021: Does the Gaze Still Dominate its Masters? – Literature Arts & Medicine Magazine*.

Toomey, R.B., 2021. Advancing Research on Minority Stress and Resilience in Trans Children and Adolescents in the 21st Century. *Child Development Perspectives*, 15(2), pp.96–102.

Walker, R.V., Powers, S.M., & Witten, T.M., 2022. Transgender and Gender Diverse People's Fear of Seeking and Receiving Care in Later Life: A Multiple Method Analysis. *Journal of Homosexuality*, 2022.

Wang, Y.-C., Miao, N.-F., & You, M.-H., 2022. Attitudes Toward, Knowledge of, and Beliefs Regarding Providing Care to LGBT Patients Among Student Nurses, Nurses, and Nursing Educators: A Cross-Sectional Survey. *Nurse Education Today*, 116.

Whyatt-Sames, J., 2017. Being Brave: Negotiating the Path of Social Transition with a Transgender Child in Foster Care. *Journal of GLBT Family Studies*, 13(4), pp.309–332.

Willis, P., Raithby, M., Maegusuku-Hewett, T., & Miles, P., 2017. "Everyday advocates" for Inclusive Care? Perspectives On Enhancing the Provision of Long-Term Care Services for Older Lesbian, Gay and Bisexual Adults in Wales. *British Journal of Social Work*, 47(2), pp.409–426.

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Role Of Health Programs Utilization and Social Factors On Adolescent Anemia Status

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Abstract

Adolescent-friendly Health Services (PKPR's Nutrition service) are intended to eliminate adolescent malnutrition, including anemia. However, the effect of health program utilization on adolescent friendly anemia has rarely been studied. This study intends to examine the prevalence of anemia, the relation of social and behavioral factors, and the use of PKPR's nutrition service with the anemia status of adolescent girls in Surakarta. A school-based cross-sectional design was conducted at a senior high school in Surakarta in 2024. The sample was 275 female students in grades 10 and 11 who had experienced menstruation. Multiple logistic regression analysis is deployed to model the factors associated with anemia. The prevalence of anemia in female students was 37.82%. The employment status of the father (p = 0.036, OR=1.79) and mother (p =0.014, OR=2.15) is associated with the anemia status of adolescents. Other factors, such as parent education, family affluence scale, behavior factors, parent support, knowledge, attitude, perception, and selfefficacy, were not associated with anemia status. PKPR's nutrition service utilization did not correlate with adolescents' anemia status. PKPR's nutrition service has not yet had an impactful outcome in reducing the frequency of anemia. Further research is needed to evaluate its implementation and impact on adolescent health outcomes.

Introduction

Anemia is a significant public health issue worldwide. According to World Health Organization (WHO) data, the worldwide prevalence of anemia in 2019 was 29.9%. The population at risk of acquiring anemia includes women in the reproductive age group (15-49 years old). The incidence of anemia in non-pregnant women of reproductive age is 29.6%(WHO, 2023). The 2018 Basic Health Research Data (Riskesdas) indicates that 32% of individuals aged 15-24 in Indonesia have anemia (Kemenkes RI, 2018). Adolescent anemia can negatively affect cognitive and physical development and increase susceptibility to illnesses. Consequently, it can have a detrimental impact on productivity in adulthood. Anemia can persist throughout adulthood during pregnancy, particularly among adolescent girls. This can lead to higher rates of morbidity and mortality during pregnancy and childbirth (Basnet *et al*., 2022). Given the widespread occurrence of anemia and its significant consequences on adolescents and their future development, it is crucial to prioritize addressing anemia in this age group.

Anemia is mainly caused by biological reasons, such as infections and genetic diseases affecting the blood (Zutphen *et al*., 2021). Biological factors, including age and gender, affect the incidence of anemia. Girls are more susceptible to getting anemia due to the occurrence of menstruation. Additional biological aspects encompass nutritional inadequacies, such as insufficient consumption of essential nutrients (macronutrients and

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micronutrients) and inadequate absorption of nutrients (Habib *et al*., 2020). Iron deficiency is responsible for 50% of the cases of anemia among these nutritional variables(Chaparro & Suchdev, 2019). Additional factors that contribute to the occurrence of anemia include infections, especially recurring infections, and genetic illnesses associated with blood abnormalities, causing anemia (Chaparro & Suchdev, 2019; Zutphen *et al*., 2021)

The World Health Organization (World Health Organization, 2023) developed a conceptual framework to categorize the causes of anemia. These causes are classified as direct causes, intermediate risk factors, and underlying risk factors. Social and behavioral factors are intermediate factors that indirectly contribute to the risk of anemia in teenagers. However, prior studies have mainly focused on biological factors such as illness, dietary intake, and nutritional status of anemia (Agustina *et al*., 2020; Gonete *et al*., 2018; Mengistu *et al*., 2019; Sari, Judistiani, *et al*., 2022). Limited research on the investigation of indirect factors, such as social factors and behaviors, and the potential advantages of health programs for adolescents, such as Adolescent-Friendly Health Services known as PKPR in Indonesia, specifically concerning anemia in adolescents.

Low access to health and nutrition services is one of the risk factors for anemia. The Indonesian Ministry of Health conducted the PKPR, intending to implement a comprehensive approach to adolescent health (Kementrian Kesehatan RI, 2014). One of the PKPR programs was an adolescent nutrition service that involved education, nutritional counseling, health screening, and Fe tablet supplementation. Previous studies have indicated that the execution of PKPR has not been optimal (Alimin Bin Alias *et al*., 2023; Barida *et al*., 2019; Nooteboom *et al*., 2021; Pham *et al*., 2023). Thus far, no research has been conducted in Indonesia to investigate the impact of school health programs or PKPR on the prevalence of anemia. Hence, it is imperative to research the PKPR program's benefits in reducing anemia in Indonesia.

The selection of the study location was determined by the findings of a preliminary study, which indicated a significant occurrence of anemia among adolescents in Surakarta (Central Java Province). According to data from the Surakarta City Health Office in 2023, the prevalence of anemia in adolescents is 34.96%. Nevertheless, there are 7 Primary Healthcare Centers (Puskesmas in Indonesia) where adolescent anemia exceeds 40%. There is a lack of data regarding the overall prevalence of anemia across the entire adolescent population. Extensive research on anemia and associated risk factors has been conducted in several towns and districts, such as Purwakarta, Bandung, and Kediri, in West Java and East Java in Indonesia. However, no such research has been carried out in Surakarta.(Agustina *et al*., 2020; Andriastuti *et al*., 2020; Sari, Herawati, *et al*., 2022a) Therefore, this study intended to investigate 1) the prevalence of anemia in the study area; 2) descriptive data of the implementation of PKPR's nutrition service(education, nutritional counseling, health screening and Fe tablet supplementation); 3) the relation of social determinants, behavior, and health program (PKPR) effect to the prevalence of anemia in Surakarta City.

Method

Using a school-based cross-sectional approach, the study was conducted in Banjarsari District, Surakarta Regency, from January to June 2024. The multistage cluster random sampling approach is implemented through a series of sequential processes. The researcher selected a single district, Banjarsari District, with the highest anemia prevalence among female students and the highest anemia screening coverage. The study included 7156 female students at the high school level in the area, comprising 14 high schools and 21 vocational schools. The researcher then selected the Puskesmas area, a sub-cluster, and randomly selected two schools within the designated area. The cluster's unit was a class, and all students in the selected classes were eligible respondents. The research sample criteria included female students in grades 10 and 11 who had experienced menstruation and were willing to participate. The sample size was calculated using a 95% confidence level and 80% research power, with a minimum of 214 students required. Those who refused to

participate, did not complete questionnaires, or refused a blood examination were excluded from the study. Despite this, 275 respondents were included in the study.

Data collection was carried out using a self-administered questionnaire. The questionnaires consist of several parts to assess social determinant factors (Father's job, Mother's work, Father's education level, Mother's education level, Family Affluence Scale (FAS)), behavior factors (Fe Tablets consumption, consumption of iron-rich food, consumption of iron absorption inhibitors), Utilization of the PKPR's nutrition services (nutrition counseling, nutrition education, receiving Fe Tablets or hemoglobin level screening), knowledge about anemia, attitude about anemia prevention's behavior. All the questionnaires were developed according to the literature review and were tested for validity and reliability. All the questionnaires were valid and had a Cronbach's alpha score of more than 0.6, indicating good internal consistency.

The Family Affluence Scale, which consists of six questions, was used as a proxy for the adolescent's family welfare using the FAS III (FAS-III) questionnaire (Hobza *et al*., 2017). The Indonesian version of the questionnaire had five valid questions. The study also assessed nutrition services utilization, including counseling, education, iron tablets, and hemoglobin screening. Students were classified as utilizing if they utilized all four components of nutrition services. The frequency of using iron tablets was assessed, with routine usage being 4 times a week. The consumption of iron absorption inhibitors was evaluated using a five-point Likert scale. The consumption of iron-rich food was assessed by evaluating the frequency of consuming iron-rich foods like red meat, fish, eggs, tofu or tempeh, green leafy vegetables, and fruit.

The dependent variable was anemia. The anemia status of the respondents was measured using the internationally accepted cyanmethemoglobin methods. A 10 μL sample of venous blood, previously treated with an anticoagulant, was mixed with 2.5 mL of Drabkin's diluting solution. The absorbance of the combination was quantified at a wavelength of 540 nm using a Microlab 300 Semi-Automated Chemistry Analyzer spectrophotometer after 5 minutes. A sole certified laboratory technician conducted the laboratory procedures, including dilution preparation and absorbance reading. The laboratory measured the hemoglobin levels in grams per deciliter (g/dL) with a precision of three decimal places. Univariate analysis and a bivariate logistic regression were conducted, and statistical significance was established if the p-value was below 0.05. Using purposeful selection modeling, multiple logistic regressions were conducted to identify major deciding factors of anemia. The ultimate model selection was made based on the AIC and BIC values and the Pseudo R2 values. The Hosmer-Lemeshow goodness of fit test assesses the quality of a multivariate model.

Result And Discussion

Table 1 shows a concise overview of the respondents' demographics and socioeconomic features of the parents, as well as the family affluence scale. Based on the table, it is evident that most responders were sixteen years old. More than half of the respondents came from families with highly educated parents. About 25% of the respondents had unemployed mothers, whereas nearly all fathers were employed. Most of the participants were unaware of the parents' income and expenditures. Therefore, we utilized the Family Affluence Scale (FAS) to measure the wealth of the participants' families. The findings revealed that a majority of the respondents, precisely 68.98%, were from families with low levels of affluence.

TABLE 1. Respondents' Characteristics

Characteristics	n	%
Class		
Ten grade	155	56.36%
Eleven grade	120	43.64%
Age		
13	1	0.36%
15	45	16.36%
16	143	52.00%
17	83	30.18%
18	3	1.09%
Fathers' education		
Elementary	16	5.82
Junior High School	17	6.18
Senior High School	109	39.64
College	133	48.36
Mothers' education		
Elementary	13	4.73
Junior High School	19	6.91
Senior High School	111	40.36
College	132	48.00
Fathers' Job		
Unemployed	7	2.55
Civil Servants	37	13.45
Entrepreneur	89	32.36
Permanent Employee	40	14.55
Farmer	2	0.73
Others	100	36.36
Mothers' Job		
Unemployed	69	25.09
Civil Servants	28	10.18
Entrepreneur	62	22.55
Permanent Employee	31	11.27
Farmer	2	0.73
Others	83	30.18
Father's income		
unaware	154	56.00
< Rp. 2.000.000	44	16.00
Rp.2.000.000- Rp.5.000.000	50	18.18
>Rp.5.000.000	27	9.82
Mother's income		
Unaware	189	68.73
< Rp. 2.000.000	37	13.45

Characteristics	n	%
Rp.2.000.000- Rp.5.000.000	37	13.45
>Rp.5.000.000	12	4.36
Expenses		
Unaware	215	78.18
< Rp. 2.000.000	23	8.36
Rp.2.000.000- Rp.5.000.000	27	9.82
>Rp.5.000.000	10	3.64
Family Affluence Scale (FAS)		
Low	189	68.98
Middle High	85	31.02
Fe Tablets Consumption		
0 tablet	148	53.82
1 – 2 tablets	96	34.91
3 tablets	20	7.27
4 tablets	11	4
Consumption of iron-rich food		
Insufficient	228	82.91
Sufficient	47	17.09
Consumption of Fe inhibitors		
High	115	41.82
Low	160	58.18
Parents' support		
Not supportive	136	49.45
Supportive	139	50.55
Knowledge		
Low	131	47.64
High	144	52.36
Anemia Status		
Normal	171	62.18
Anemia	104	37.82

Source: Primary Data, 2024

Table 2 shows that most respondents had utilized one of the four components of the PKPR nutrition service. The Fe Tablet program was the most widely used nutrition service provided by PKPR, as almost all respondents received Fe Tablets from the program. Only 60% of the responders obtained anemia screening or a Hemoglobin examination. Data showed that most respondents received all the nutrition services provided by teachers or health professionals in the school setting. Based on the PKPR's nutrition service utilization data, only 39,27% of respondents received all components of the nutrition service altogether.

The female students' mean and median Hemoglobin concentrations (n = 275) were 12.122 (SD = 1.72) and 12.43 g/dL, respectively. The study found that the prevalence of anemia was 37.82%. Of the female students with anemia, 5.09% had mild anemia, and 32.73% had moderate anemia. Compared to the national data, this current study's prevalence is higher than the national data, which was 32% (Kemenkes RI, 2018). This could indicate regional disparities in the frequency of anemia

TABLE 2. Description of Respondents' PKPR's Nutrition Service Utilization

Characteristics	n	%
Received Fe Tablets from the PKPR service		
No	13	4.73
Yes	262	95.27
School[a]	256	97.70
Puskesmas[a]	30	11.45
Received Nutrition Counselling from the PKPR service		
No	104	37.82
Yes	171	62.18
School[a]	162	94.18
Teacher[*]	13	8.03
Health worker[*]	149	91.97
Puskesmas[a]	35	20.48
Received Anemia Screening from the PKPR service		
No	110	40.00
Yes	165	60.00
School[a]	157	98.12
Puskesmas[a]	37	22.42
Received Nutrition Education from the PKPR service		
No	79	28.73
Yes	196	71.27
School[a]	189	96.42
Teacher[*]	26	13.76
Health worker[*4]	163	86.24
Puskesmas[a]	37	18.87
PKPR Nutrition service utilization		
No	167	60.73
Yes	108	39.27

Note: [a]=place of student received the service; [*]=by whom the service is delivered
Source: Primary Data, 2024

among adolescents throughout various areas of the country. Research conducted in multiple locations in Indonesia has found that the prevalence of anemia among adolescent girls ranges from 19% to 45% (Agustina *et al*., 2020, 2021; Knijff *et al*., 2021; Sari, Judistiani, *et al*., 2022). Compared to the prevalence of anemia in other countries, this study's prevalence was similar to a previous study in rural areas of Saudi Arabia, which found 39.1% (Madani *et al*., 2022), and lower than that found in other developing countries, Tanzania and India, with a prevalence of 53.3% and 71.7%, respectively (Subramanian *et al*., 2022; Yusufu *et al*., 2023). However, the prevalence of anemia in the range of 20% to 39.9% is considered a moderate public health problem that needs to be addressed.

Table 3 provides a bivariate analysis of factors associated with the anemia status of female students. Mothers' employment status was the only factor statistically significant with anemia. Other variables, such as socioeconomic factors, behavioral factors, knowledge, attitude, and utilization of the PKPR nutrition service, were not significantly associated with anemia. In multivariable analysis, Table 3 shows a higher prevalence of anemia related to fathers with permanent jobs, with an OR value of 1.813 95% CI 1.049-3.133. A higher prevalence of anemia was also associated with working mothers, with an OR value of 2.174 and 95% CI (1.176-4.020).

TABLE 3. Bivariate Analysis of Factors Associated with Anemia in Adolescents.

Variables	n(%)	Anemia Status		COR	P-value
		Non-Anemia	Anemia		
Fathers' Job					
Permanent job	77 (28)	41 (53.25)	36 (46.75)	1.678 (0.982-2.866)	0.058
Impermanent job	198 (72)	130 (65.66)	68 (34.34)		
Mothers' employment status					
Working	206 (74.9)	120 (58.25)	86 (41.75)	2.030 (1.109-3.716)	0.022
Not working	69 (25.1)	51 (73.91)	18 (26.09)		
Fathers' education					
High	242 (88)	147 (60.74)	95 (39.26)	1.723 (0.767-3.867)	0.187
Low	33 (12)	24 (72.73)	9 (27.27)		
Mothers' education					
High	243 (88.3)	149 (61.32)	94 (38.68)	1.387 (0.629-3.060)	0.417
Low	32 (11.7)	22 (68.75)	10 (31.25)		
FAS					
Middle High	85 (30.9)	47 (55.29)	38 (44.71)	1.506 (0.894-2.538)	0.124
Low	189 (69.1)	123 (65.08)	66 (34.92)		
Parents' Support					
Supportive	139 (50.54)	86 (61.87)	53 (38.13)	1.027 (0.630-1.672)	0.914
Not supportive	136 (49.46)	85 (62.50)	51 (37.50)		
Knowledge					
High	144 (52.4)	88 (61.11)	56 (38.89)	1.100 (0.675-1.793)	0.701
Low	131 (47.6)	83 (63.36)	48 (36.64)		
Attitude					
Positive	167 (60.72)	107 (64.07)	60 (35.93)	0.815 (0.496-1.341)	0.422
Negative	108 (39.28)	64 (59.26)	44 (40.74)		
PKPR Nutrition service utilization					
Yes	108 (39.27)	63 (58.33)	45 (41.67)	1.307 (0.795-2.149)	0.290
No	167 (60.73)	108 (64.67)	59 (35.33)		
Received Fe Tablets from the PKPR service					
Yes	262 (95.27)	162 (61.83)	100 (38.17)	1.388 (0.416-4.629)	0.593
No	13 (4.73)	9 (69.23)	4 (30.77)		
Received Nutrition Counselling from the PKPR service					
Yes	171 (62.18)	104 (60.82)	67 (60.82)	1.166 (0.703-1.933)	0.550
No	104 (82)	67 (64.42)	37 (35.58)		

Variables	n(%)	Anemia Status		COR	P-value
		Non-Anemia	Anemia		
Received Nutrition Education from the PKPR service					
Yes	196 (71.27)	118 (60.20)	78 (39.80)	1.347 (0.777-2.334)	0.288
No	79 (28.73)	53 (67.09)	26 (32.91)		
Received Anemia Screening from the PKPR service					
Yes	165 (60)	96 (58.18)	69 (41.82)	1.540 (0.928-2.556)	0.095
No	110 (40)	75 (68.18)	35 (31.82)		
Fe Tablets Consumption					
Regularly	61 (22.18)	38 (62.30)	23 (37.70)	0.993 (0.552-1.787)	0.984
Irregularly	214 (77.82)	133 (62.15)	81 (37.85)		
Consumption of iron-rich food					
Sufficient	160 (58.18)	98 (61.25)	62 (38.75)	1.099 (0.670-1.804)	0.707
Insufficient	115 (41.82)	73(63.48)	42 (36.52)		

Source: Primary Data, 2024

Table 4 shows the multivariable analysis of factors associated with anemia in adolescents. Respondents whose father had a permanent job and the mother was a working mother had a higher chance of getting anemia with an OR value of 1.795 with a 95% CI of 1.037-3.103, and an OR value of 2.15 with a 95% CI of 1.16-3.98, respectively. Another factor, PKPR Nutrition services' utilization, was not related to the anemia status of adolescents.

This study suggests that the factor associated with anemia was the father's job. Anemia was more frequent in families where the father had a permanent job. This result is similar to a previous study that found the social determinant of the parent was related to the adolescent's anemia status (Ekasanti *et al*., 2020; Gedefaw *et al*., 2015; Mulianingsih *et al*., 2021). A prior study in Indonesia found the same results of factors correlated to adolescent iron intake, which found that adolescents who had fathers who worked in the informal sector had higher iron intake. Father's employment in the informal sector is beneficial in choosing and determining iron intake. It is hypothesized that the role of fathers in controlling the quantity, type, and quality of foods for households will be more significant due to having more time to communicate and interact with mothers (Aji *et al*., 2021).

The mother's employment status, which was working, is associated with anemia as well. This finding is similar to previous studies that found that a mother's socioeconomic factors related to adolescent anemia status(Agustina *et al*., 2021; Subramanian *et al*., 2022). A previous study found that mothers who work in private services and are self-employed were at higher risk of anemia (Habib *et al*., 2020). This is probably due to the long working hours, which could lead to less time to practice choosing ingredients, buying and cooking nutritious foods, and paying attention to their child's eating pattern and daily food intake. The previous qualitative studies found that adolescents had poor meal regularity and preferred food purchased in the street rather than traditional home-cooked meals. Working makes less time for a mother to supervise her children's daily dietary intake(Gillespie *et al*., 2023). Future research should explore how fathers' employment sector influences household nutrition choices and how mothers' work schedules impact their ability to support

TABLE 4. Multiple Logistic Regression Model of Factors Associated with Anemia in Adolescents

Variables	SE	P	OR (95% CI)
Father's job (permanent job)	0.503	0.036*	1.795 (1.037-3.103)
Mother's employment status (working)	0.675	0.014*	2.15 (1.16-3.98)
PKPR Nutrition service utilization (Yes)	0.329	0.350	1.27(0.76- 2.11)

Note: *=p-value <0.05, Quality of the model= Pseudo R2:3%, Goodness of fit test value=0.300. AIC=361.73, BIC=376.19

Source: Primary Data, 2024

adolescents' diets. Health services could use these insights to create targeted educational programs for fathers and practical resources for working mothers to help families prevent anemia.

Interestingly, behavior factors, including iron-rich food and Fe tablet consumption, were not associated with anemia status. This study's results were different from the previous studies, which found that frequent consumption of animal-based iron-rich foods, protein intake, and Fe tablet consumption were significantly associated with a lower risk of anemia (Knijff *et al*., 2021; Mulianingsih *et al*., 2021; Sari, Judistiani, *et al*., 2022). This is probably due to the etiology of the anemia, not only because of iron deficiency. A prior systematic review of Indonesian adolescent anemia found that, on average, 53% to 58% of anemia cases could be explained by iron deficiency, whereas 42% to 47% could not and are caused by other underlying causes (Zutphen *et al*., 2021). Although iron deficiency seems to be a significant cause of anemia in Indonesian adolescents, a similar proportion of anemia cases are due to other causes and are unlikely to be resolved with iron supplementation only(Muwakhidah *et al*., 2024; Zutphen *et al*., 2021). Therefore, future studies should include measures of more than one etiology of anemia and measure its determinant factors (Shaban *et al*., 2020).

An interesting finding of this study was that PKPR nutrition service utilization did not correlate with adolescents' anemia status. One of the services provided through PKPR was the Fe tablet distribution. Almost all the female students received the Fe tablet distribution. Surprisingly, this study found about half of the respondents (53.8% (Table 1)) never consumed the Fe tablet that they got. This could explain why the utilization of the service did not affect the anemia status, since this distribution of Fe tablets did not guarantee the consumption of Fe tablets. If adolescents consume iron (Fe) tablets routinely, it can increase hemoglobin levels, thereby reducing the risk of anemia, as indicated by previous studies (Muwakhidah *et al*., 2024). A prior qualitative study in India found that most adolescents rarely consume the given Fe tablets; adolescents take the tablet, hide it, or throw it away (Gillespie *et al*., 2023). Moreover, a previous qualitative study in Indonesia stated that health workers only entrusted Fe tablet distribution to teachers, and often, no further monitoring was carried out to determine whether the tablets were distributed evenly or whether the adolescents were consuming the tablets (Sari, Herawati, *et al*., 2022b). A previous study found that the direct observed consumption of Fe tablets by teachers improves adherence and increases haemoglobin (Meilani & Setiyawati, 2023). Therefore, adding monitoring for consuming the tablet would be beneficial in improving the effectiveness of Fe distribution programs. Nevertheless, this Fe tablet distribution needs to be evaluated since compliance with taking Fe tablets is still low, discontinuation program during school holidays, and the nature of the program was a "blanket approach," meaning that all adolescents are given iron supplements without first undertaking a hemoglobin test (Sungkar *et al*., 2022). This Fe tablet distribution needs further evaluation to increase the efficiency of PKPR's nutrition service delivery.

This study also found that most students utilized PKPR counseling and education services in schools, 94.18% and 96.4%, respectively. In schools, the health worker conducts PKPR's health education and counseling services annually. Most female students utilized counseling and education services by health workers, even though the service was

conducted in schools. A prior qualitative study in Indonesia found that PKPR service delivery is still lacking in many aspects, including limited facilities and infrastructure. PKPR's counseling service often could not be conducted due to the unavailability of the counseling room in Puskemas or schools, or inappropriate rooms, such as outside the classroom. Besides, the quality of the counseling and education services provided was also lacking due to the lack of communication skills of health workers (Sari, Herawati, *et al*., 2022b). The previous study found that counseling and education about nutrition improve adolescents' behavior (Firmansyah *et al*., 2020). The inadequate implementation of the program probably affects the fact that PKPR's nutrition service does not yet have an impactful outcome, which is to reduce the frequency of anemia. This could indicate that the PKPR nutrition service needs a thorough evaluation following an improvement to achieve its target of reducing the prevalence of anemia in adolescents. A qualitative study about the review of the implementation of PKPR in Surakarta needs to be conducted before improving the implementation of PKPR's nutrition service.

This is the first study in Indonesia that investigated the outcome of PKPR's nutrition service, which was the anemia status of adolescents. Since the evaluation uses a quantitative descriptive evaluation, exploring any implementation aspect is inadequate. Besides, since the assessment uses a cross-sectional design, the causality of the program and the outcome are unclear. An improved outcome evaluation of PKPR's nutrition service is needed, using a longitudinal design to define the causalities. A qualitative study is also required to explore more aspects of program implementation. Another limitation is the use of frequency questionnaires on food consumption, which could lead to recall bias. The use of 7-day food frequency questionnaires or 24-hour food recalls provided a better estimate of food consumption than the recall of frequency, as this study provided. Therefore, further study should improve the measurement of iron-rich and Fe-enhancer food consumption.

Conclusion

All in all, this suggests that the father's and mother's employment status is associated with adolescents' anemia status. Other factors, such as parent education, family affluence scale, behavior factors, parent support, knowledge, attitude, perception, and self-efficacy, were not associated with anemia status. Moreover, health program factors, namely PKPR's nutrition service utilization, did not correlate with adolescents' anemia status. Further research is needed to evaluate the implementation of the PKPR's nutrition service and investigate the impact of the PKPR's nutrition service on adolescent health outcomes. Future research should examine how fathers' job sectors and mothers' work hours impact adolescent nutrition. Health services can use these insights to develop targeted support for families to help prevent anemia in adolescents.

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References

Agustina, R., Nadiya, K., El Andini, A., Setianingsih, A.A., Sadariskar, A.A., Prafiantini, E., Wirawan, F., Karyadi, E., & Raut, M.K., 2020. Associations of Meal Patterning, Dietary Quality and Diversity With Anemia and Overweight-Obesity Among Indonesian Schoolgoing Adolescent Girls in West Java. *PLoS ONE*, 15(4), pp.1–19.

Agustina, R., Wirawan, F., Sadariskar, A.A., Setianingsing, A.A., Nadiya, K., Prafiantini, E., Asri, E.K., Purwanti, T.S., Kusyuniati, S., Karyadi, E., & Raut, M.K., 2021. Associations of Knowledge, Attitude, and Practices toward Anemia with Anemia Prevalence and Height-for-Age Z-Score among Indonesian Adolescent Girls. *Food and Nutrition Bulletin*, 42(1_suppl), pp.S92–S108.

Aji, G.K., Laily, N., & Susanti, I., 2021. Iron Intake Among Adolescent Girls Based on Family Socio-Economic, Frequent High-Iron Foods Consumed and Knowledge About Anemia in Pandeglang District. *Media Gizi Indonesia*, 16(1), pp.17.

Alimin Bin Alias., Dewanti, L., & Qorib, M.F., 2023. The Comparison of Factors That Can

Influence Utility of Primary Health Care Among Youth Community in Indonesia and Malaysia. *World Journal of Advanced Research and Reviews*, 17(1), pp.111–118.

Andriastuti, M., Ilmana, G., Nawangwulan, S.A., & Kosasih, K.A., 2020. Prevalence of Anemia and Iron Profile Among Children and Adolescent With Low Socio-Economic Status. *International Journal of Pediatrics and Adolescent Medicine*, 7(2), pp.88–92.

Barida, I., Nurmansyah, M.I., & Sabilla, M., 2019. An Evaluation of Youth Care Health Program (PKPR) in Public Health Center in Jakarta, Indonesia. *ICSDH 2018*, pp.56–60.

Basnet, T., Sitaula, S., Sah, M.K., & Yadav, P., 2022. Analysis of Causes and Contributory Factors for Maternal Mortality during Covid-19 Lockdown. *International Research Journal of Multidisciplinary Scope*, 3(2), pp.22–28.

Chaparro, C.M., & Suchdev, P.S., 2019. Anemia Epidemiology, Pathophysiology, and Etiology in Low- and Middle-Income Countries. *Ann N Y Acad Sci.*, 1450(1), pp.15–31.

Ekasanti, I., Adi, A.C., Yono, M., Nirmala G,F., & Isfandiari, M.A., 2020. Determinants of Anemia among Early Adolescent Girls in Kendari City. *Amerta Nutrition*, 4(4), pp.271.

Firmansyah, F., Tamtomo, D.G., & Cilmiaty, R., 2020. Comparing the Effect of Nutritional Booklets and Social Media on Knowledge and Consumption of Fattening Foods among Adolescents in Surakarta, Indonesia. *International Journal of Nutrition Sciences*, 5(2), pp.84–89.

Gedefaw, L., Tesfaye, M., Yemane, T., Adisu, W., & Asres, Y., 2015. Anemia and Iron Deficiency Among School Adolescents: Burden, Severity, and Determinant Factors in Southwest Ethiopia. *Adolescent Health, Medicine and Therapeutics*, 189.

Gillespie, B., Katageri, G., Salam, S., Ramadurg, U., Patil, S., Mhetri, J., Charantimath, U., Goudar, S., Dandappanavar, A., Karadiguddi, C., Mallapur, A., Vastrad, P., Roy, S., Peerapur, B., & Anumba, D., 2023. Attention for and Awareness of Anemia in Adolescents in Karnataka, India: A Qualitative Study. *PLoS ONE*, 18(4), pp.1–15.

Gonete, K.A., Tariku, A., Wami, S.D., & Derso, T., 2018. Prevalence and Associated Factors of Thinness Among Adolescent Girls Attending Governmental Schools in Aksum Town, Northern Ethiopia. *Archives of Public Health*, 2018, pp.158–164.

Habib, N., Abbasi, S.U.R.S., & Aziz, W., 2020. An Analysis of Societal Determinant of Anemia among Adolescent Girls in Azad Jammu and Kashmir, Pakistan. *Anemia*, 2020.

Hobza, V., Hamrik, Z., Bucksch, J., & De Clercq, B., 2017. The Family Affluence Scale as an Indicator for Socioeconomic Status: Validation on Regional Income Differences in the Czech Republic. *International Journal of Environmental Research and Public Health*, 14(12).

Kemenkes RI., 2018. *Laporan Hasil Riset Kesehatan Dasar tahun 2018*. Badan Penelitian dan Pengembangan Kesehatan Kemenkes RI.

Kementrian Kesehatan RI., 2014. *Pedoman Standar Nasional Pelayanan Kesehatan Peduli Remaja (PKPR)*.

Knijff, M., Roshita, A., Suryantan, J., Izwardy, D., & Rah, J.H., 2021. Frequent Consumption of Micronutrient-Rich Foods Is Associated With Reduced Risk of Anemia Among Adolescent Girls and Boys in Indonesia: A Cross-Sectional Study. *Food and Nutrition Bulletin*, 42(1_suppl), pp.S59–S71.

Madani, B.M., Alsulami, A.M., Abu alola, I.A., Alasmari, S.M., Khoujah, F.M., Andijani, O.M., Alhomrani, M.A., Alhomrani, S.S., Alquhaibi, S.S., Alsulami, F.S., Ibrahim, W.A., Abu alola, B.A., & Alqarni, A.H., 2022. Prevalence of Anemia Among Children and Adolescents in Rural Area of Khulais in Saudi Arabia. *Cureus*, 14(2), pp.14–18.

Meilani, N., & Setiyawati, N., 2023. Directly Observed Treatment for Iron Tablet Supplements Consumption Among Female Senior High School Students. *Kemas*, *18*(3), pp.375–382.

Mengistu, G., Azage, M., & Gutema, H., 2019. Iron Deficiency Anemia among In-School Adolescent Girls in Rural Area of Bahir Dar City Administration, North West Ethiopia. *Anemia*, 2019, pp.1–9.

Mulianingsih, M., Nurmayani, W., Oktaviani, E., Pertiwi, A.N., & Info, A., 2021. Factors Affecting Anemia Status in Adolescent Girls Misroh. *Journal of Health Education*, 6(1), pp.27–33.

Muwakhidah, M., Rahmawaty, S., Rakhma, L.R., Widiyaningsih, E.N., Hidayati, L., & Rusdanurmaala, S., 2024. Pil-Pintar Intervention Reduce Anemia among Young Teen Girls: A Pilot Study. *Current Nutrition & Food Science*, 20(8), pp.1000–1005.

Nooteboom, L.A., Mulder, E.A., Kuiper, C.H.Z., Colins, O.F., & Vermeiren, R.R.J.M., 2021. Towards Integrated Youth Care: A Systematic Review of Facilitators and Barriers for Professionals. *Administration and Policy in*

Mental Health and Mental Health Services Research, 48(1), pp.88–105.

Pham, M.D., Sawyer, S.M., Agius, P.A., Kennedy, E.C., Ansariadi, A., Kagilis, F., Wiguna, T., Wulan, N.R., Devaera, Y., Medise, B.E., Riyanti, A., Wiweko, B., Cini, K.I., Tran, T., Fisher, J., Luchters, S., & Azzopardi, P.S., 2023. Foregone Health Care in Adolescents From School and Community Settings in Indonesia: A Cross-Sectional Study. *The Lancet Regional Health - Southeast Asia*, 13(April), pp.100187.

Sari, P., Herawati, D.M.D., Dhamayanti, M., & Hilmanto, D., 2022a. Anemia among Adolescent Girls in West Java, Indonesia: Related Factors and Consequences on the Quality of Life. *Nutrients*, 14(18), pp.1–13.

Sari, P., Herawati, D.M.D., Dhamayanti, M., & Hilmanto, D., 2022b. Aspectos Fundamentales del Desarrollo de un Modelo de Sistema Integrado de Atención a la Salud para la Prevención de la Anemia Ferropénica en Adolescentes: Un estudio cualitativo. *International Journal of Environmental Research and Public Health*, 19(21).

Sari, P., Judistiani, R.T.D., Hilmanto, D., Herawati, D.M.D., & Dhamayanti, M., 2022. Iron Deficiency Anemia and Associated Factors Among Adolescent Girls and Women in a Rural Area of Jatinangor, Indonesia. *International Journal of Women's Health*, 14, pp.1137–1147.

Shaban, L., Al-Taiar, A., Rahman, A., Al-Sabah, R., & Mojiminiyi, O., 2020. Anemia and Its Associated Factors Among Adolescents in Kuwait. *Scientific Reports*, 10(1), pp.1–9.

Subramanian, M., Malhotra, S., Kant, S., Goswami, K., Perumal, V., & Kaloiya, G., 2022. Prevalence of Anemia Among Adolescent Girls Residing in Rural Haryana: A Community-Based Cross-Sectional Study. *Cureus*, 14(1), pp.1–9.

Sungkar, A., Bardosono, S., Irwinda, R., Manikam, N.R.M., Sekartini, R., Medise, B.E., Nasar, S.S., Helmyati, S., Ariani, A.S., Nurihsan, J., Nurjasmi, E., Khoe, L.C., Dilantika, C., Basrowi, R.W., & Vandenplas, Y., 2022. A Life Course Approach to the Prevention of Iron Deficiency Anemia in Indonesia. *Nutrients*, 14(2), pp.1–8.

WHO., 2023. *Anaemia in Women and Children*. The Global Health Observatory.

World Health Organization., 2023. *Accelerating Anaemia Reduction*. World Health Organization.

Yusufu, I., Cliffer, I.R., Yussuf, M.H., Anthony, C., Mapendo, F., Abdulla, S., Masanja, M., Tinkasimile, A., Ali, A.S., Mwanyika-Sando, M., & Fawzi, W., 2023. Factors Associated with Anemia Among School-Going Adolescents Aged 10–17 Years in Zanzibar, Tanzania: A Cross Sectional Study. *BMC Public Health*, 23(1), pp.1–17.

Zutphen, K.G., van Kraemer, K., & Melse-Boonstra, A., 2021. Knowledge Gaps in Understanding the Etiology of Anemia in Indonesian Adolescents. *Food and Nutrition Bulletin*, 42(1_suppl), pp.S39–S58.

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The Evolution in The Field of Anticorruption in The Health Sector in Italy

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Abstract

The fight against corruption within the healthcare sector in Italy has undergone significant transformation following the introduction of Law n. 190/2012. This legislation marked a pivotal step towards establishing a comprehensive system aimed at preventing corruption through a blend of preventive measures, transparency, and administrative reorganization. Central to these efforts is the Italian National Anti-Corruption Authority (ANAC) and the National Anti-Corruption Plan (PNA), which provide structured guidelines and strategies for public administrations, including healthcare entities. This study examines the evolution and impact of anti-corruption measures in the Italian healthcare sector, focusing on key legislative and regulatory frameworks, particularly the roles played by ANAC and the PNA. The commentary explores the implementation of these measures, highlighting the innovative approaches and the challenges encountered. Significant milestones include the legislative updates, such as the Legislative Decree n. 231/2001, which introduced administrative liability for corporate crimes, and the more recent resolution n. 605/2023, which reinforces digital procurement processes, real-time data analytics, and enhanced transparency in healthcare administration. These updates align with broader national recovery efforts post-COVID-19 and aim to foster a culture of integrity and accountability within the sector. Key findings reveal that while there has been considerable progress in enhancing transparency and reducing corruption risks, challenges remain. These include resource constraints, complexity of integrating new measures with existing systems, stakeholder engagement, and ensuring rigorous monitoring and enforcement. Addressing these challenges is critical for sustaining the progress achieved and further improving the effectiveness of anti-corruption strategies. The continuous refinement of the PNA and its application within the healthcare sector illustrates a robust commitment by Italian authorities to uphold public trust and prevent corruption.

Introduction

The Law n. 190 of 6 November 2012 (*Legge n. 190/2012 "Disposizioni per la prevenzione e la repressione della corruzione e dell'illegalità nella pubblica amministrazione"* 2012) was introduced into the Italian legal system as an organic system to prevent corruption. Corruption is intended as a malfunction of the Public Administration, determined by a misuse of power, because it is oriented towards private purposes. The law aims to tackle the phenomenon with an innovative approach, not limited to repression (although always contemplated in the criminal field), but extended to policies of prevention, transparency, and the reorganization of Public Administrations. Recent studies on corruption, particularly in the healthcare sector, underline how systemic corruption can severely

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compromise public health outcomes, a trend observed globally (Fu *et al*., 2023; Hossain *et al*., 2023).

According to Law 190/2012 (*Legge n. 190/2012 "Disposizioni per la prevenzione e la repressione della corruzione e dell'illegalità nella pubblica amministrazione*" 2012) prevention must be carried out through planning and control activities, with a programming model that involves the articulations of government, and based on four essential points: transparency, training, codes of conduct, and risk analysis. The law's emphasis on transparency aligns with broader global efforts to mitigate corruption risks in public health, as evidenced by the implementation of real-time data analytics for procurement processes in healthcare sectors worldwide (Su *et al*., 2024).

A fundamental role in this model is played by the Italian National Anti-Corruption Plan (otherwise known as PNA), which ensures the coordination of national and international corruption prevention strategies in the Public Administration, and whose tools are updated periodically. The integration of risk analysis in this plan is consistent with international models that emphasize the role of digital tools in risk management, particularly in monitoring procurement and healthcare services (Dewi and Mahyuni 2024).

Since the first launch of the National Plan 2013-2016 was approved with resolution No. 72/2013 of the CIVIT (Commission for Evaluation, Transparency, and Integrity of Public Administrations) (Autorità Nazionale Anticorruzione 2015) we arrived with resolution no. 1064 of 13 November 2019 to the third PNA, concerning the programming for the three years 2019-2021. The plan's updates over the years reflect an increasing reliance on digital procurement processes, a trend mirrored in other healthcare systems, particularly in low and middle-income countries like Nigeria, where inefficiency and absenteeism due to corrupt practices have been linked to weak health system performance (Agwu *et al*., 2020).

Following the already enacted PNA and in consideration of resolution no. 12 of 28 October 2015 of the ANAC (Autorità Nazionale Anticorruzione 2015) a section specifically dedicated to health has been introduced (which we would like to point out and provide a general perspective on) to guide programming the plans of health companies and other persons assimilated to them; indications that over the years have been modified and integrated unevenly in the plans published subsequently and in its two updates. The 2019 PNA contains, in respect, a revision and consolidation combined in a single act of all the information provided to date, integrated with guidelines developed over time, while also being subject to specific regulatory acts. The gradual evolution of these plans highlights a shift towards incorporating emerging technologies such as digital risk management systems to combat corruption effectively, a trend noted in other countries like Romania, where historical patterns of corruption are being addressed in healthcare systems (Plopeanu 2024). Recent updates to the National Anti-Corruption Plan, particularly the 2023 update (resolution n. 605/2023) (Autorità Nazionale Anticorruzione 2023) continue to enhance the framework established by Law n. 190/2012 (*Legge n. 190/2012 "Disposizioni per la prevenzione e la repressione della corruzione e dell'illegalità nella pubblica amministrazione*" 2012) introducing new measures aimed at further reducing corruption risks and improving transparency in the healthcare sector.

The primary aim of this work is to provide an analysis of the evolution and implementation of anticorruption measures in the Italian healthcare sector. This includes examining the legislative and regulatory frameworks that have been established to combat corruption, specifically focusing on the role of the Italian National Anti-Corruption Authority (ANAC) and the National Anti-Corruption Plan (PNA). The study seeks to identify the key innovations, challenges, and critical issues in the application of these anticorruption measures within the healthcare context. By doing so, we aim to contribute to a better understanding of the effectiveness of current policies and provide insights for future improvements in combating corruption in healthcare. The effectiveness of such measures has been echoed globally, where anticorruption reforms in healthcare have been proven critical in improving health outcomes, as seen in both developing and developed

nations (Gaitonde *et al*., 2016; Gorodensky *et al*., 2022).

The first act to pave the way for today's organization and legislation on corruption in the Public Administration was the Legislative Decree n. 231/2001 (*D. Lgs n. 231/2001 "Disciplina della responsabilità amministrativa delle persone giuridiche, delle società e delle associazioni anche prive di personalità giuridica, a norma dell'articolo 11 della legge 29 settembre 2000, n. 300* 2001), which introduced the concept of administrative liability of companies for the crimes committed by directors, managers, or employees, establishing pecuniary or disqualifying sanctions. This model of administrative liability has parallels in many countries, where companies and even private healthcare entities are held responsible for corrupt practices, especially in public-private healthcare collaborations (Squalli 2024). This provision provides for the attribution of corporate crimes and crimes towards Public Administrations (including fraud, extortion, corruption, false accounting, stock manipulation, etc.) and is no longer exclusive to individuals who have committed the offense but also to legal persons, such as the companies they work for. Specific sanctions, including definitive disqualification from exercising the activity, prohibition of contracting/negotiating with the Public Administration, and prohibition to advertise goods or services, even definitively (art.16). It is up to the administration of the institution to determine this (art. 15).

Legislative Decree n. 231/2001(*D. Lgs n. 231/2001 "Disciplina della responsabilità amministrativa delle persone giuridiche, delle società e delle associazioni anche prive di personalità giuridica, a norma dell'articolo 11 della legge 29 settembre 2000, n. 300* 2001), however, it does not contain a specific reference relating to the health sector. Before reaching this specific mention, obtained only in 2015, it had to be passed first, with Legislative Decree n. 90/2014 (*D. L. n. 90/2014 "Misure urgenti per la semplificazione e la trasparenza amministrativa e per l'efficienza degli uffici giudiziari* 2014), converted into Law n. 114/2014 (*Legge n. 114/2014 "Conversione in legge, con modificazioni, del decreto-legge 24 giugno 2014, n. 90, recante misure urgenti per la semplificazione e la trasparenza amministrativa e per l'efficienza degli uffici giudiziari* 2014), the abolition of the Authority for the Supervision of the Public Contracts for Works, Services, and Supplies (otherwise known as AVCP) and grant the ANAC full power in the prevention of corruption in public administrations and the companies owned and controlled. Such changes are aligned with international practices where oversight bodies are being strengthened to better manage healthcare procurement and reduce opportunities for corruption, as noted in India's healthcare sector.

In this context, the task of ANAC is to prevent corruption by working in concert between public administrations and to improve the use of resources while reducing formal controls that involve procedural burdens and increase the costs of the public administration without the corresponding creation of value for citizens and businesses. Global comparisons show that countries implementing similar approaches, particularly with healthcare, have experienced positive outcomes in reducing both financial and systemic corruption (Rönnerstrand and Lapuente 2017). A text of Guidelines approved by ANAC is therefore issued, with numerous references to Legislative Decree 231/2001 (*D. Lgs n. 231/2001 "Disciplina della responsabilità amministrativa delle persone giuridiche, delle società e delle associazioni anche prive di personalità giuridica, a norma dell'articolo 11 della legge 29 settembre 2000, n. 300* 2001) about Organization, Management, and Control Models, which also contain specific obligations for subsidiaries to increase anti-corruption safeguards, planning, and control, or to introduce specific anti-corruption measures according to Law no. 190/2012 (*Legge n. 190/2012 "Disposizioni per la prevenzione e la repressione della corruzione e dell'illegalità nella pubblica amministrazione*" 2012). Additionally, with the same Law n.114/2014 (*Legge n. 114/2014 "Conversione in legge, con modificazioni, del decreto-legge 24 giugno 2014, n. 90, recante misure urgenti per la semplificazione e la trasparenza amministrativa e per l'efficienza degli uffici giudiziari* 2014), the task of preparing the PNA was assigned in full to ANAC, not in collaboration with the CIVIT, as it was in 2013, with the advantage of

identifying only one institutional body as the competent reference for anti-corruption.

The PNA is divided into a general first part, which deals with the preparation of anti-corruption measures within all public administrations, as well as towards private subjects controlled by them, and a second part that deals with the issue of corruption in specific environments, among which, with the aforementioned update with resolution no. 12 of 28 October 2015 (Autorità Nazionale Anticorruzione 2015), the health sector is specifically introduced. This move mirrors international efforts to specifically target health sector corruption, which has proven to be particularly pervasive in countries with both public and private healthcare actors, as seen in countries like Iran (Dargahi *et al*., 2024). In December 2023, ANAC introduced further updates to the PNA (resolution n. 605/2023) (Autorità Nazionale Anticorruzione 2023), building on the existing framework and incorporating new measures to address emerging challenges and enhance the effectiveness of anticorruption strategies. One of the key innovations is the formalization of digital procurement processes. This shift mandates that all public procurement activities be conducted through digital platforms, ensuring greater transparency and traceability. Additionally, the update reinforces the integration of real-time data analytics in monitoring procurement activities, allowing for more efficient detection and prevention of corrupt practices. Furthermore, the update aligns with the broader objectives of the National Recovery and Resilience Plan (PNRR), ensuring that anticorruption measures are harmonized with economic recovery efforts, particularly in the post-COVID era. This integration of economic recovery with anticorruption efforts mirrors approaches seen in countries like Ecuador, where public healthcare and procurement processes have been key focal points in addressing systemic corruption (Ortiz-Prado *et al*., 2023).

Method

This review was conducted and structured with a narrative approach to ensure a comprehensive analysis of anti-corruption legislation relevant to the healthcare sector in Italy. Two of the authors were responsible for the identification and retrieval of relevant legislative documents. They accessed governmental legal databases, including the Italian National Anti-Corruption Authority (ANAC) website, "Normattiva" website (Italian institutional database in which all numbered legislative acts published in the *Official Gazette* and/or in the *Official Collection of Legislative Acts* are stored), and other official legal repositories, ensuring that all legislation reviewed was sourced from authoritative and publicly accessible platforms. For comparison purposes with other countries' situation, PubMed/MEDLINE database research was performed using the keywords "corruption" linked with the Boolean operator AND/OR with the keywords "health", "healthcare", and "health systems".

The inclusion criteria for this review were established to select documents that specifically address corruption issues and anti-corruption measures in public administration, with a particular focus on healthcare. Documents that did not meet these criteria were excluded. After the initial identification of sources, two authors independently reviewed the content of the selected documents. They cross-checked each other's findings to ensure consistency and to minimize bias in the interpretation of the legislative texts. Any discrepancies were resolved through discussion and consensus. The review process involved assessing the historical evolution of the laws, their implementation strategies, and their practical impact on healthcare governance. Key legislative innovations and challenges in application were identified and analyzed.

Result and Discussion

The recipients of the PNA in the health sector are the companies and entities of the National Health Service (SSN), which are obliged to apply the provisions for the prevention of corruption (Article 1, co. 59, Law 190/2012) , and the guidelines for the preparation of the three-year plans for the prevention of corruption (PTPC). These entities include Local Health Authorities (Aziende Sanitarie Locali/ASL, ASP, AUSL, ULSS, ASS), Hospitals (Aziende Ospedaliere/AO), Hospitals of National Relief

and High Specialization (Aziende Ospedaliere di Rilievo Nazionale e di Alta Specializzazione/ ARNAS), University Hospitals (Aziende Ospedaliere Universitarie/AOU), Public Institutes of Assistance and Charity (Istituti Pubblici di Assistenza e Beneficenza/IPAB), Experimental Zooprophylactic Institutes (Istituti Zooprofilattici Sperimentali/IZS), and Institutes of Hospitalization and Scientific Care (Istituti di Ricovero e Cura a Carattere Scientifico/IRCCS). The alignment of these obligations with global trends is evident, as healthcare systems in countries like Ecuador and Brazil have faced similar challenges in implementing transparency across both public and private sectors (Machoski and de Araujo 2020; Ortiz-Prado *et al*., 2023).

The ANAC guidelines also apply to private law entities controlled by public administration operating in the health sector. Concerning non-public entities, such as classified hospitals and other entities accredited with the SSN, whose legal nature is governed by private law, a recommendation was addressed by ANAC to the relevant administrations. This aimed to promote transparency tools and prevent corruption and conflicts of interest, aligning with global best practices such as those implemented in Iran's medical laboratory systems to address conflicts of interest (Dargahi *et al*., 2024). The 2023 update to the PNA expanded the scope of entities required to comply with anti-corruption measures. For the first time, specific guidelines were introduced for private healthcare providers that receive public funds or are part of public-private partnerships, reflecting similar approaches in countries like Indonesia, where both private and public healthcare actors were included in anti-corruption measures related to waste management and healthcare (Astuti *et al*., 2024).

This inclusion ensures a uniform application of anti-corruption measures across both public and private sectors in the healthcare system. Furthermore, the update introduced stricter compliance requirements for all entities, including mandatory anti-corruption training programs for management and staff, aimed at fostering a culture of integrity and transparency at all organizational levels. Such initiatives have been mirrored in nations like Montenegro, where compliance with anti-corruption measures in healthcare has become crucial in the post-COVID landscape (Radević *et al*., 2022). Additionally, countries in southern Europe, including Italy and Greece, have strengthened centralized procurement processes as part of their anticorruption efforts to reduce inefficiencies in healthcare spending and minimize risks of abuse (Gaitonde *et al*., 2016).

The guidelines outline an organizational model for risk management. The entities must assign the role of Head of Corruption Prevention (R.P.C.) to a manager with specific knowledge of the organization, the healthcare facility, and its processes. The manager and their team are responsible for identifying risk aspects in the health sector, controlling conditions and behaviors not in line with good administrative management, and monitoring cases and processes, all while considering the external context. This focus on external pressures aligns with international practices seen in West Africa, where socio-political pressures have been recognized as major contributors to healthcare corruption (Onwujekwe *et al*., 2019). A key aspect of risk management is the creation of tailored mitigation strategies, a principle also observed in studies of healthcare systems in Nigeria. There, absenteeism and inefficiency within the public health workforce were linked to systemic corruption, highlighting the need for robust risk identification and management (Agwu *et al*., 2020). The importance of a rigorous internal organizational model is based on the idea that corruption can materialize when maladministration behaviors arise within the healthcare sector.

General risk areas identified include public contracts, positions and appointments, management of revenue, expenses, and assets, as well as controls, inspections, and sanctions. For example, in the procurement of goods or services, it is recommended that a team with diversified skills manage the process, which should be justified with technical reasons to avoid conflicts of interest. This risk management approach is critical in contexts like the European Union, where similar frameworks are applied to safeguard procurement processes

(Sommersguter-Reichmann and Reichmann 2024). Positions and appointments pose another risk, especially when the fragmentation of operational units artificially increases the number of positions to be filled. Correctly identifying the professional profile, setting transparent assessment criteria, and rotating members of the selection board are proposed solutions to mitigate this risk. In China, similar strategies were used to combat corruption in the healthcare sector, particularly within appointments and procurement processes (Fu *et al*., 2023).

The management of revenue, expenditure, and assets exposes administration to risks such as delays in disbursements, over-billing, and incorrect reporting. The Certification Implementation Path (PAC) serves as a fundamental tool to verify financial statements, a concept applied in countries like Brazil, where healthcare procurement practices were linked to significant financial losses due to corruption (Machoski and de Araujo 2020). Risks also arise in the management of real estate assets, where private interests may conflict with public goals. Such risks must be addressed through transparent procedures that promote impartiality and align with public interests. In terms of supervision, controls, and inspections, the standardization of the inspection program and the use of unannounced visits serve as key deterrents. The importance of "control over the controllers" has been emphasized in studies across several regions, including Turkey, where such oversight has been critical in reducing healthcare-related corruption and improving healthcare outcomes (Sommersguter-Reichmann and Reichmann 2024).

Specific risk areas in healthcare include freelance activity, waiting lists, contractual relationships with accredited individuals, pharmaceuticals, devices, research, sponsorships, and activities related to hospital deaths. Freelance activity and waiting lists present a risk of opportunistic behaviors, such as granting privileges or profits to the detriment of citizens. The digitalization of waiting lists and the adoption of IT management systems for ALPI bookings have been proposed to mitigate these risks, much like the solutions implemented in Ecuador, where IT systems have helped reduce corrupt practices in healthcare services (Ortiz-Prado *et al*., 2023). Contractual relationships with private entities expose the SSN to risks related to the misuse of public resources, including delayed authorizations and inadequate inspections. Rigorous controls and rotation of inspectors are necessary to prevent conflicts of interest. These risks mirror those faced by healthcare systems globally, including in countries like China and Bangladesh, where public-private partnerships have been particularly vulnerable to corrupt practices in healthcare service delivery (Fu *et al*., 2023; Hossain *et al*., 2023).

Pharmaceuticals, devices, research, and experimentation are areas highly susceptible to corruption. Proper inventory management through computerized systems is essential, much like that applied in healthcare systems worldwide to avoid fraud and promote transparency (Astuti *et al*., 2024). The out-of-hospital setting is also vulnerable to corruption, as doctors may prescribe certain medications for personal gain, a problem documented in numerous countries, including Brazil (Machoski and de Araujo 2020). Activities related to hospital deaths carry risks associated with funeral homes and potential conflicts of interest. Strengthening control measures, including staff rotation and confidentiality obligations, is critical to reducing these risks. These issues reflect a broader challenge seen globally, where healthcare providers must balance transparency with operational efficiency to mitigate corruption risks (Squalli 2024). The 2023 PNA update brought significant enhancements to risk analysis and management strategies. One of the critical updates was the introduction of a comprehensive digital risk management system, using real-time data analytics and automated alerts to identify and address potential corruption risks promptly. This proactive approach mirrors similar strategies in high-risk regions like West Africa, where real-time data has been crucial in detecting corruption in healthcare procurement (Onwujekwe *et al*., 2019). The update also emphasized transparency in risk management, requiring healthcare entities to publicly disclose risk assessments and mitigation plans, a practice already in place in countries like Iran

(Dargahi *et al*., 2024).

Essentially, the explicit and predetermined goal of ANAC in the publication of the latest anti-corruption plan is to "revise and consolidate in a single act of guidance all the information provided to date, integrating it with guidelines developed over time and subject to appropriate regulatory acts." This mirrors efforts in other healthcare systems, such as those seen in Brazil, where consolidation and streamlining of anti-corruption policies were critical to reducing inefficiencies in healthcare administration (Machoski and de Araujo 2020). Therefore, specifically in the healthcare sector, what has so far been examined and recorded in the 2019 PNA represents the transposition, integration, and unification of all the information provided separately by previous plans and their updates. This consolidation of healthcare-related anti-corruption strategies is critical, as countries like Iran have also sought to unify various anti-corruption measures into coherent frameworks that address both internal and external factors contributing to systemic corruption (Dargahi *et al*., 2024).

The real innovations indicated in the new PNA, however, do not exclusively concern healthcare but are applicable across all public administrations, including healthcare settings. Specifically, integration of the risk analysis phase is required, which involves analyzing not only the internal environment but also external pressures and potential criticalities arising from the local context. This expanded focus on external environments is critical for understanding systemic risks, as highlighted by studies from Bangladesh, where external socio-political factors often exacerbate corruption in healthcare procurement and service delivery (Onwujekwe *et al*., 2019; Hossain *et al*., 2023). Once these risks are identified, preventive measures and monitoring systems must be implemented. This mirrors global best practices seen in regions like Ecuador, where risk management in healthcare has increasingly involved real-time monitoring tools and digital platforms to ensure transparency and reduce opportunities for corrupt activities (Ortiz-Prado *et al*., 2023).

Specific guidance is also provided on the methods by which risks are assessed. The qualitative classification approach proposed by the PNA aims to ensure that each risk is associated with motivation based on evidence collected during analysis. This structured risk assessment strategy has parallels in healthcare systems worldwide, including Turkey, where qualitative risk assessments are used to determine levels of vulnerability in healthcare systems, especially in high-risk procurement sectors (Sommersguter-Reichmann and Reichmann 2024). Regarding the treatment of identified risks, administrations are expected to implement specific, timely measures within a reasonable timeframe. This approach, which avoids abstract or general proposals, is like strategies employed in China, where corruption risk mitigation in healthcare involves targeted interventions that are data-driven and designed to address specific vulnerabilities (Fu *et al*., 2023). The PNA's focus on concrete, actionable measures is also reflected in the practices of other nations where healthcare systems face endemic corruption challenges, such as Nigeria, where clear timelines and specific interventions have been emphasized to curb absenteeism and other corrupt behaviors (Agwu *et al*., 2020).

Lastly, the monitoring phase within the PNA has been updated to rely primarily on self-assessment methods in areas classified as low corruption risk. However, in higher-risk areas, self-assessment must be supplemented by direct monitoring actions from the RPC (Responsible for Corruption Prevention). This dual approach is essential for maintaining integrity in the system and reflects a global shift toward more sophisticated, layered monitoring mechanisms, as seen in Brazil, where self-assessment combined with external audits has proven effective in reducing corruption in municipal healthcare settings (Machoski and de Araujo 2020). Since its publication, the PNA Guidelines have been met with numerous criticisms and observations from stakeholders in the healthcare sector. One recurring criticism is that the Guidelines promote a redundancy of numerous principles that, while extensive, are not exhaustive. This has led to concerns that the Guidelines foster a prescriptive and sanctioning approach rather than a preventative one. Similar concerns have been raised in other regions, such as Ecuador's healthcare system, where an over-

reliance on prescriptive measures was found to be ineffective without adequate preventative strategies and resource allocation (Ortiz-Prado *et al*., 2023). There is also significant concern regarding the practical implementation of the PNA. The complexity of the plan, combined with a lack of resources available to the actors responsible for its implementation, has made the process cumbersome. This issue is not unique to Italy, as healthcare systems in many countries, including Montenegro, face similar challenges when trying to implement comprehensive anti-corruption frameworks without sufficient resources (Radević *et al*., 2022).

Many stakeholders argue that the real needs of the specific healthcare context are often overlooked, leaving little room for flexibility in adapting the plan to meet local requirements. This rigidity has also been a point of contention in countries like Brazil, where attempts to apply one-size-fits-all anti-corruption measures across diverse healthcare settings have proven problematic (Machoski and de Araujo 2020). Ultimately, the most critical voices have highlighted the need to strike a balance between strict rules and personal responsibility. This approach has been mirrored in other global healthcare systems, where the strict application of anti-corruption measures has been recommended only in cases of severe risk or critical events, such as in post-pandemic recovery phases (Squalli 2024). The 2023 update to the National Anti-Corruption Plan (Delibera n. 605 del 19 dicembre 2023) introduces several key innovations aimed at strengthening the anticorruption framework within the Italian healthcare sector. These innovations are designed to address emerging risks and enhance the overall effectiveness of anticorruption measures. Such updates mirror broader international trends in combating healthcare corruption, as seen in nations like China, where post-COVID reforms have similarly emphasized transparency and modernization (Su *et al*., 2024).

The update mandates the digitalization of the entire procurement process, from tendering to contract management. This digital transformation aims to increase transparency, reduce opportunities for corrupt practices, and streamline administrative procedures. In Brazil, digital tools and platforms have been pivotal in transforming procurement systems to address corruption, offering a comparable model to Italy (Machoski and de Araujo 2020). By ensuring real-time tracking and accountability, these tools help prevent corruption by minimizing human intervention in sensitive processes. Enhanced transparency requirements accompany these digital initiatives. The new provisions require detailed public disclosure of procurement activities, including contract awards, bidding processes, and performance evaluations. This is similar to approaches taken in Iran, where transparency in procurement has been crucial in reducing conflicts of interest (Dargahi *et al*., 2024). The measures extend to private entities involved in public contracts, ensuring that all stakeholders adhere to the same standards of accountability, reflecting a global push toward uniformity in anti-corruption standards in healthcare (Ortiz-Prado *et al*., 2023).

Stricter compliance and monitoring mechanisms introduced by the 2023 update require entities within the healthcare sector to adopt mandatory training programs on anticorruption practices. Enhanced monitoring mechanisms, such as real-time data analytics and automated alert systems, will be used to detect and prevent corrupt activities. Similar monitoring tools have been successfully implemented in Ecuador, where real-time analytics helped in tracking procurement activities and addressing corruption vulnerabilities in the public health sector (Ortiz-Prado *et al*., 2023). The update also broadens the scope of entities required to comply with the PNA, including newly identified organizations within the healthcare sector and affiliated private entities. This expansion ensures comprehensive coverage and uniform application of anticorruption measures across the sector, a step that mirrors global strategies where public-private partnerships in healthcare are increasingly subjected to uniform regulatory frameworks (Astuti *et al*., 2024).

The updated PNA emphasizes a more robust risk management approach, incorporating advanced risk assessment tools and methodologies. Entities are required

to conduct regular risk assessments and implement tailored mitigation strategies to address identified vulnerabilities. This is aligned with practices in countries such as West Africa, where risk assessments have played a key role in improving healthcare governance and reducing corruption (Onwujekwe *et al*., 2019). While the 2023 update to the PNA introduces significant advancements, it also presents several critical issues and challenges that need to be addressed to ensure effective implementation. Resource constraints remain a major concern, as the digitalization of procurement processes and enhanced monitoring mechanisms require substantial investments in technology and training. This issue is not unique to Italy, as similar challenges have been faced by healthcare systems in Montenegro, where financial limitations hindered the full implementation of anticorruption measures (Radević *et al*., 2022).

Additionally, the complexity of the new measures adds to the integration challenges of existing anticorruption frameworks. Ensuring coherence with previous guidelines and regulations may prove difficult for healthcare entities. This complexity has also been noted in Nigeria, where efforts to streamline anticorruption policies in the healthcare sector have faced obstacles in maintaining consistency and clarity across different frameworks (Agwu *et al*., 2020). Effective implementation also relies on stakeholder engagement. The cooperation of both public and private entities is critical to the success of the updated measures. Resistance or lack of buy-in from stakeholders could undermine these efforts, as seen in Brazil, where the lack of alignment between public and private sector actors has hindered the effectiveness of anticorruption measures in municipal healthcare (Machoski and de Araujo 2020). Operational challenges such as data management complexities and the need for ongoing system maintenance will also need to be addressed. This issue is mirrored in other global contexts, such as Turkey, where technical issues related to the digitalization of procurement have presented hurdles in ensuring seamless operations (Sommersguter-Reichmann and Reichmann 2024). Ensuring rigorous monitoring and enforcement of the new measures is crucial, but the increased workload and the need for specialized skills may strain existing oversight bodies and resources, as seen in Ecuador's healthcare reform efforts (Ortiz-Prado *et al*., 2023).

Conclusion

The implementation and continuous enhancement of anticorruption measures through the National Anti-Corruption Plan have significantly improved transparency in the Italian healthcare sector. The emphasis on digitalization, public disclosure, and rigorous monitoring has made information more accessible and processes more accountable. However, addressing the challenges of resource allocation, system integration, stakeholder engagement, operational management, and enforcement is crucial to sustaining and furthering these gains. The impact on transparency is a testament to the commitment of Italian authorities to foster a culture of openness and accountability. By continuing to refine and strengthen these measures, Italy can set a high standard for transparency in public administration, contributing to greater public trust and the effective prevention of corruption.

References

Agwu, P., Ogbozor, P., Odii, A., Orjiakor, C., & Onwujekwe, O., 2020. Private Money-Making Indulgence and Inefficiency of Primary Healthcare in Nigeria: A Qualitative Study of Health Workers' Absenteeism. *International Journal of Public Health*, 65(7), pp.1019–1026.

Astuti, F.A., Syafrudin., & Susilowati, I., 2024. Socioeconomic and Public Health Impacts of Waste Management in Piyungan Landfill, Bantul-Indonesia. *Kemas*, 19(4), pp.637–644.

Autorità Nazionale Anticorruzione., 2015. *Aggiornamento 2015 al Piano Nazionale Anticorruzione*. Determinazione n. 12 del 28 Ottobre 2015.

Autorità Nazionale Anticorruzione., 2023. *Piano Nazionale Anticorruzione Aggiornamento 2023*. Delibera n. 605 del 19 dicembre 2023.

Dargahi, H., Kooshkebaghi, M., & Isazadeh, N., 2024. Explaining the Concepts and Examples of Conflict of Interest and Its Management in The Medical Laboratory System of Iran: A Scoping Review. *Journal of Education and Health Promotion*, 13(1).

Dewi, I.G.A.A.K., & Mahyuni, L.P., 2024. Digital Healthcare: Is A Trend Or Necessity?. *Kemas*, 19(4), pp.530–540.

Fu, H., Lai, Y., Li, Y., Zhu, Y., & Yip, W., 2023. Understanding Medical Corruption in China: A Mixed-Methods Study. *Health Policy and Planning*, 38(4), pp.496–508.

Gaitonde, R., Oxman, A.D., Okebukola, P.O., & Rada, G., 2016. Interventions to Reduce Corruption in the Health Sector. *Cochrane Database of Systematic Reviews*, 2016(8).

Gorodensky, A., Bowra, A., Saeed, G., & Kohler, J., 2022. Anti-corruption in Global Health Systems: Using Key Informant Interviews to Explore Anti-Corruption, Accountability and Transparency in International Health Organisations. *BMJ Open*, 12(12).

Hossain, M.M., Rahaman, M.M., & Rahman, M.J., 2023. Covid-19 Corruption in the Public Health Sector - Emerging Evidence from Bangladesh. *Health Policy and Planning*, 38(7), pp.799–821.

Legge n. 114/2014., *Conversione in Legge, con Modificazioni, del Decreto-Legge 24 Giugno 2014*, n. 90, Recante Misure Urgenti per la Semplificazione e la Trasparenza Amministrativa e per l'efficienza Degli Uffici Giudiziari.

Legge n. 190/2012., Disposizioni per la Prevenzione e la Repressione Della Corruzione e Dell'illegalità Nella Pubblica Amministrazione.

Machoski, E., & de Araujo, J.M., 2020. Corruption in Public Health and Its Effects on the Economic Growth of Brazilian Municipalities. *European Journal of Health Economics*, 21(5), pp.669–687.

Onwujekwe, O., Agwu, P., Orjiakor, C., McKee, M., Hutchinson, E., Mbachu, C., Odii, A., Ogbozor, P., Obi, U., Ichoku, H., & Balabanova, D., 2019. Corruption in Anglophone West Africa Health Systems: A Systematic Review of Its Different Variants and the Factors that Sustain Them. *Health Policy and Planning*, 34(7), pp.529–543.

Ortiz-Prado, E., Izquierdo-Condoy, J.S., Mora, C., Vasconez-Gonzalez, J., & Fernandez-Naranjo, R., 2023. Poor Regulation, Desperation, and Misinformation, A Countrywide Analysis of Self-Medication and Prescription Patterns in Ecuador During the COVID-19 Pandemic. *Research in Social and Administrative Pharmacy*, 19(12), pp.1579–1589.

Plopeanu, A.P., 2024. Historical Origins of Corruption in the Romanian Public Health System - Path Dependency and Contagion Effect. *Health Economics Review*, 14(1).

Radević, I., Alfirević, N., & Lojpur, A., 2022. Corruption, Public Trust and Medical Autonomy in the Public Health Sector of Montenegro: Taking Stock of the COVID-19 Influence. *PLoS ONE*, 17(9).

Rönnerstrand, B., & Lapuente, V., 2017. Corruption and Use of Antibiotics in Regions of Europe. *Health Policy*, 121(3), pp.250–256.

Sommersguter-Reichmann, M., & Reichmann, G., 2024. Untangling the Corruption Maze: Exploring the Complexity of Corruption in the Health Sector. *Health Economics Review*, 14(1).

Squalli, J., 2024. Deciphering the Link Between Healthcare Expenditure, Corruption, and COVID-19 Mortality. *Scientific Reports*, 14(1).

Su, Z., Bentley, B.L., Yu, X., Jiang, J., Liu, Y., McDonnell, D., Cheshmehzangi, A., da Veiga, C.P., Xiang, Y.T., 2024. Where is the Money? Insights into China's post-COVID Healthcare Corruption-Busting Campaign. *Journal of Public Health Policy*, 45(2), pp.396–400.

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Effect Of Moringa Oliefera Supplementation During Pregnancy on Stunting in Children of Pre-School Age

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Abstract

Stunting is a growth failure due to a lack of nutrition that has lasted from pregnancy to 24 months of age. This study aims to examine the effect of moringa supplementation during pregnancy on stunting in preschool children (5-6 years old). This study is a follow-up study of a Randomized Control Trial with Double Blind study that provides moringa supplements in the form of PG (Powder Group), EG (Extract Group), and as well as IFA (Iron Folate Acid) supplements to pregnant women. The subjects were 303 children in six sub-districts in Jeneponto District who were children of mothers who received supplementation of PG, EG, and IFA during pregnancy. Children's height was measured using a microtoice. Data were statistically analyzed using the Logistic Regression test. The results showed a significant difference between the three groups. EG intervention had a significant effect on stunting in preschool-age children (5-6 years old). EG intervention (24.18%) showed the lowest prevalence of stunting among PG (25.47) and IFA (38.68%) interventions. EG prevented stunting by 2.215 times compared to the other intervention groups. The provision of Moringa extract to pregnant women has a better effect on reducing stunting.

Introduction

Stunting is a condition where a person's height is smaller than that of a person of the same age (Kementerian Kesehatan, 2021). Stunting is a linear growth disorder due to malnutrition from nutrient intake and chronic infectious diseases, characterized by a height-for-age z-score (HAZ) of less than two standard deviations. The problem of stunting is not caused by one factor but is caused by multi-factor (Beal *et al.*, 2018). Stunting is a process of stunted child growth occurring due to chronic malnutrition conditions (WHO, 2018). The short-term effect of stunting is impaired child growth, and the long-term is child development. This 1000 Days of Lfe period is the critical period at the beginning of life (Titaley *et al.*, 2019). Some of the direct causes of stunting in children are inadequate nutritional intake, infectious diseases, and poor parenting (Nugroho *et al.*, 2021; Zakaria *et al.*, 2016). Indirect factors affecting stunting include parenting, parents, income, maternal knowledge, and consumption patterns, and direct factors are genetics, intake, and infectious diseases (Sulistyaningsih *et al.*, 2018; Zakaria *et al.*, 2016).

The prevalence of stunting is 22% or 149.2 million children under 5 years globally by 2020. The prevalence of stunted children in Indonesia in 2018 was 30.8%. Then there was a decrease in 2019 the stunting rate was

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around 27.7% and reduced to 24.40% in 2021 (Kementerian Kesehatan, 2021), and to 21.6% in 2022 (Kementerian Kesehatan, 2022). The prevalence of stunting in South Sulawesi ranks 10th highest in Indonesia at 27.2%. Similarly, Jeneponto Regency has the highest prevalence of stunting in South Sulawesi at 39.8% (Kementerian Kesehatan, 2022). One of the local foods, rich in nutrients, is Moringa Oleifera, commonly known as Moringa leaves (Ariesthi *et al*., 2021; Fuglie, 2003). Moringa trees are easily grown in Indonesia and very common in the South Sulawesi area (Hastuti *et al*., 2020). This plant usually grows in dry places (Khan *et al*., 2014). A comparative study of fresh Moringa leaves, when compared to other foods, contains 7 times the vitamin C of oranges, 4 times the vitamin A of carrots, 4 times the calcium of milk, 3 times the potassium of bananas, and 2 times the protein of yogurt(Sultana, 2020). Moringa Oleifera leaves are rich in macronutrients and micronutrients such as calcium, potassium, zinc, magnesium, iron, and copper (Gopalakrishnan *et al*., 2016). Moringa content effectively increases hemoglobin (Hb) concentration, which plays the same role as iron-folate supplementation (Nadimin *et al*., 2015). Providing moringa leaf extract can also help repair DNA and prevent underweight at birth, a trigger for stunting (Nadimin *et al*., 2019). Moringa leaves contain several essential amino acids that are very beneficial for tissue growth in the fetus (Ulmy *et al*., 2020). Interventions with moringa supplementation for pregnant women, infants, and toddlers' nutritional status can prevent stunting in children.

The results of previous research on children aged 2-5 years showed a decrease in stunting cases in the EG group. Although previous interventions have proven the effect of moringa supplementation in children under five years of age, it is still necessary to see further the consistency of the efficacy of moringa leaf extract supplementation on children's nutritional status. Therefore, this study aims to examine the effect of moringa supplementation during pregnancy on stunting in preschool children (5-6 years old).

Methods

This study is a longitudinal follow-up study of an experimental study with a randomized clinical trial (RCT)-double-blind method since the second trimester of pregnancy. This study was conducted in Jeneponto Regency using 3 forms of intervention, namely moringa extract supplementation (EG), moringa flour (PG), and iron/folic acid tablets (IFA). The samples in this study were pre-school-age children (5-6 years old) with details of 106 PG samples, 106 IFA samples, and 91 EG samples. Data collection in the field was carried out by enumerators who had attended and passed the training. The qualifications of enumerators were those with a minimum education of S1 Nutrition Science or other health majors. Data on household and child characteristics were collected through interviews using a questionnaire. Height measurements used a microtoice twice as a measurement calibration. Stunting was defined based on WHO standards (HAZ <-2 SD). The determination of z-score values used the WHO Anthro Plus application.

Data were analyzed using the SPSS software application. Then, the data was processed by univariate, bivariate, and multivariate analysis. Univariate analysis aims to describe the characteristics of each variable. Then, bivariate analysis was conducted to determine the relationship between 2 variables with the Chi-Square Test. Multivariate analysis to determine the effect of other variables on stunting. The statistical test performed was logistic regression, where the variables included in the model had a p-value <0.25. The value of statistical significance of the relationship when the p-value <0.05.

Results and Discussion

Table 1 shows the characteristics of child age, birth weight, exclusive breastfeeding status, father's education, mother's occupation, and family income where there are 90 stunting cases. Table 1 also shows that the p-value of characteristic risk factors (child's age, child's birth weight, child's exclusive breastfeeding status, father's education, mother's occupation, and family income) in the analysis of the difference between characteristic risk factors and stunting has a p-value> 0.05. It indicates

Table 1. Analysis of Differences between Risk Factors and Stunting in Pre-School 5-6 years old in Jeneponto District

Characteristics	HAZ (HAZ)				N	%	p
	Stunting		Normal				
	n	%	N	%			
Age of Child							
60 - 70 months	78	31.7	168	68.3	246	100	0.113
71 - 81 months	12	21.1	45	78.1	57	100	
Birth weight							
Normal	86	29.7	204	70.3	290	100	0.931
LBW	4	30.8	9	69.2	13	100	
Exclusive breastfeeding							
Exclusive	42	32.1	89	67.9	131	100	0.433
Not Exclusive	48	27.9	124	72.1	172	100	
Father's Education							
Not in School	6	40.0	9	60.0	15	100	
Not graduated primary school	9	42.9	12	57.1	21	100	
Elementary school graduate	33	29.2	80	70.8	113	100	
Not graduated junior high school	3	75.0	1	25.0	4	100	0.203
Junior high school graduate	14	26.9	38	73.1	52	100	
High school graduate	17	22.4	59	77.6	76	100	
Not graduated high school	0	0.00	2	100	2	100	
Bachelor's Degree	6	35.3	11	64.7	17	100	
Mother's Occupation							
Work	9	29.00	22	71	31	100	0.931
Housewife	81	29.8	191	70.2	272	100	
Family Income							
Low (<2.4 million)	75	31.6	162	69.4	237	100	0.161
High (≥2.4 million)	15	22.7	51	77.3	66	100	

Source : Primary Data, 2023

no influence between the intervention group (child's age, child's birth weight, child's exclusive breastfeeding status, father's education, mother's occupation, and family income) and stunting.

Based on Table 2, the frequency distribution of HAZ nutritional status is 90 samples (29.7%) were stunted, and 213 samples (7 0.3%) were normal/not stunted. The frequency distribution of IMT/U nutritional status is 32 samples (10.6%) were wasted, and 271 samples (89.4%) were normal/not wasted. The frequency distribution of BB/U nutritional status is 93 samples (30.7%) were underweight, and 210 samples (69.3%) were normal nutrition. Table 2 also shows that the p-value in the frequency distribution of wasting nutritional status has a p-value> 0.05, so it can be concluded that there is no difference between the intervention groups when pregnant women with wasting variables. However, in the frequency distribution of stunting and underweight, the p-value <0.05, so it can be concluded that there is a difference between the intervention groups when the mother is pregnant with the variables of stunting and underweight.

Table 3 shows that children who received

Table 2. Analysis of Nutritional Status-based Groups in Pre-school Children 5-6 years old in Jeneponto District

Nutrition Status	PG		IFA		EG		Total		p
	n	%	n	%	N	%	n	%	
HAZ (HAZ)									
Stunting	27	8.9	41	13.5	22	7.3	90	29.7	0.042
Normal	79	26.1	65	21.5	69	22.8	213	70.3	
WHZ (IMT/U)									
Wasting	13	4.3	6	2.0	13	4.3	32	10.6	0.113
Normal	93	30.7	100	33.0	78	25.7	271	89.4	
WAZ (BW/U)									
Underweight	40	13.2	23	7.6	30	9.9	93	30.7	0.035
Normal	66	21.8	83	27.4	61	20.1	210	69.3	

Source : Primary Data, 2023

Table 3. Multivariate Analysis of the Effect of Interventions on Stunting in Pre-school Children 5-6 years old in Jeneponto Regency

Variables	p	OR	95% C.I	
			Lower Limit	Upper Limit
Intervention				
PG	0.074	1.744	0.947	3.214
EG	0.015	2.215	1.167	4.202
IFA	0.036	Ref	ref	ref
Child Age (60-70 months)	0.092	0.535	0.258	1.107
LBW	0.796	1.178	0.341	4.073
Breastfeeding (Not Exclusive)	0.572	1.162	0.690	1.954
Father's Education (Low)	0.232	0.728	0.432	1.226
Mother's Occupation (Working)	0.816	0.903	0.384	2.126
Family Income (Low)	0.431	1.319	0.662	2.628

Source : Primary Data, 2023

EG intervention during pregnancy had an effect on the incidence of stunting ($p<0.01$). The provision of EG prevented stunting by 2.215 times compared to other intervention groups. The rest of the variables showed no effect on the incidence of stunting in preschool children aged 5-6 years in Jeneponto Regency.

Results of the study on children aged 5-6 years showed that the EG intervention had a significant effect on stunting. EG intervention (24.18%) showed the lowest prevalence of stunting among PG (25.47%) and IFA (38.68%) interventions. EG prevented stunting by 2.215 times compared to the other intervention groups. In Jeneponto District, a study was conducted on the effects of PG, IFA, and EG interventions on stunting from birth to 5 years of age, followed by one on the same intervention groups of 5-6 years. The study on children aged 0-6 months showed a significant increase in weight in the PG and IFA groups but not in the body length of children given colostrum. In the PG intervention, the number of stunted children at 0 months of age was 2.7% while the IFA intervention was higher at 3.3%. In the age range of 2-5 months, stunting was highest in the PG intervention, which increased every month. EG and IFA interventions at 2-5 months showed better results than the PG intervention (Ulmy et al., 2020).

Then, the study at 6-12 months showed increased body weight and length in both the PG and IFA intervention groups. In this age range, the incidence of stunting fluctuated highly in all intervention groups, but there was little consistency in the IFA group. So, the age of 12 months shows the highest prevalence of stunting in the extract, which is 30.9%, then 28.2% in the PG intervention, and as much as 23.4% in the IFA group. So, we concluded that in the age range of 6-12 months, the IFA intervention showed better results (Sumiaty et al., 2020). Similarly, results of the study at the age of 12-17 months showed nutritional status that was not much different from the prevalence of stunting at the previous age, but at the age of 18-24 months showed different results, where the EG intervention group had fewer stunting incidents than the other intervention groups. In the EG intervention group, the prevalence of stunting reached 41.7%, which is lower than the PG intervention, which reached 48.7%, and the IFA intervention, which reached 42%. It can be concluded that at 24 months of age, the EG intervention is much better than PG and offsets the effect of the control group, or in this case, IFA (Sarih et al., 2020).

Results of the study in children aged 2-3 years showed that the prevalence of stunting in children was highest in the PG intervention (51.8%), then lower interventions in EG (39.3%) and IFA (37.8%), respectively. The PG intervention increased the prevalence of stunting in children with a risk of 1.787 times compared to the IFA intervention. The EG intervention can prevent stunting in 2-3-year-olds (Basri et al., 2022; Basri et al., 2021). The study in children aged 3-4 years showed that the EG intervention significantly reduced stunting in children aged 36-42 months. The EG intervention (25.2%) showed the lowest prevalence of stunting among other interventions, such as PG (41.5%) and IFA (33.3%). Administration of Moringa oleifera extract during pregnancy can prevent stunting in children aged 34-42 months (Basriet al., 2021). The research on children aged 4-5 years showed that the prevalence of stunting in the three groups was significantly different, and the lowest group was in the EG intervention (21.4%). Thus, this study indicates a decrease in stunting cases in EG group children from 0 months of age to 6 years of age. Moringa leaf extract showed better results in preventing stunting. Likewise, in the PG group, there was a decrease in stunting cases, although not significant, as presented in Figure 1 (Basri et al., 2022).

The macronutrient and micronutrient content of the moringa extract has a crucial function in improving pregnancy outcomes and preventing stunting in children (Lin et al., 2018). In a previous study, there was a difference in the effect given between moringa extract and moringa flour in preventing the prevalence of stunting. Moringa leaf extract showed a more positive efficacy in preventing stunting because moringa flour is obtained in powder form from drying (heating) so that the active chemicals in moringa are lost, while moringa extract is obtained from extracted moringa leaves that take all the active chemicals from moringa (Baldisserotto et al., 2018). In making moringa flour into 500 mg capsules, only a few moringa leaves are needed, while in making moringa extract into capsules, many moringa leaves are required to be made into 500 mg moringa extract, so that there is more moringa nutritional content in the extract (Basri et al., 2021). The active chemicals (phytochemicals) in moringa extract were found to be very much like flavonoids, alkaloids, steroids, carotenoids, and other chemicals where these various active chemicals contained many benefits in improving the nutritional status of mothers and children (Baldisserotto et al., 2018; Gull et al., 2016).

Laboratory examination results per each moringa extract capsule showed that the flavonoid/alkaloid content was 301.237 ppm. Some previous studies have shown that the flavonoid content of moringa extract using water extraction is around 11-15 grams/100 grams but will be greater if moringa extract uses ethanol/methanol extraction (Lin et al., 2018). The function of flavonoids is as an anti-cancer, anti-oxidant that can ward off free radicals and prevent and improve malnutrition in children (Falowo et al., 2018; Kasolo et al., 2010). Previous studies showed that giving moringa extract during pregnancy can reduce the prevalence of stunting because moringa

extract can improve pregnancy outcomes better , and it cannot be separated from the prevention of stunting in children (Basri et al., 2021). A study on the efficacy of Moringa Oliefera in malnourished children showed that stunting in children who received it at the beginning of the study was -2.6±1.8 and increased to -2.1± 2.0 at the end of the study. In addition, the group of children given moringa showed significant changes in nutritional status in the WAZ and HAZ z values. This study suggests that moringa can improve the nutritional status of children. Giving moringa leaf extract to pregnant women has a better effect on reducing the prevalence of stunting in children aged 4-5 years.

Conclusion

There is an effect of providing PG, IFA, and EG interventions on stunting in children from the age of 2 years to 6 years, where the provision of EG intervention is better than other interventions. The study in children aged 5-6 years showed that children who received EG intervention during pregnancy affected stunting ($p<0.01$). The provision of EG prevents stunting by 2.215 times compared to other intervention groups.

Reference

Ariesthi, K.D., Pattypeilohy, A., Fitri, H.N., & Paulus, A.Y., 2021. Additional Feeding Based on Local Food to Improve The Nutritional Status of Tooddlers. *Jurnal Kesehatan Masyarakat*, 17(1), pp.67–74.

Baldisserotto, A., Buso, P., Radice, M., Dissette, V., Lampronti, I., Gambari, R., Manfredini, S., & Vertuani, S., 2018. Moringa oleifera Leaf Extracts as Multifunctional Ingredients For "Natural And Organic" Sunscreens and Photoprotective Preparations. *Molecules*, 23(3).

Basri, H., Hadju, V., Zulkifli, A., & Syam, A., 2021. Stunted and Stimulation Affect Child Development in Jeneponto District, Indonesia. *Turkish Journal of Physiotherapy and Rehabilitation*, 32(3), pp.15018–15022.

Basri, H., Hadju, V., Zulkifli, A., Syam, A., Ansariadi, A., Stang, S., Indriasari, R., Helmiyanti, S., & Reski, R., 2022. Effect of Moringa Oliefera Supplementation During Pregnancy on Nutritional Status in Children 2–5 Years Old in Indonesia: A-Follow-Up Study. *Current Developments in Nutrition*, 6(Suppl.1), pp.885–885.

Basri, H., Hadju, V., Zulkifli, A., Syam, A., & Indriasari, R., 2021. Effect of Moringa oleifera Supplementation During Pregnancy on The Prevention of Stunted Growth in Children Between The Ages of 36 to 42 Months. *Journal of Public Health Research*, 10(2), pp.1–6.

Beal, T., Tumilowicz, A., Sutrisna, A., Izwardy, D., & Neufeld, L.M., 2018. A Review of Child Stunting Determinants in Indonesia. *Maternal and Child Nutrition*, 14(4), pp.1–10.

Falowo, A.B., Mukumbo, F.E., Idamokoro, E.M., Lorenzo, J.M., Afolayan, A.J., & Muchenje, V., 2018. Multi-Functional Application of Moringa Oleifera Lam. in Nutrition and Animal Food Products: A Review. *Food Research International*, 106, pp.317–334.

Fuglie, L.J., 2003. The Moringa Tree a Local Solution to Malnutrition? The Miracle Tree: Moringa Oleifera: Natural Nutrition for The Tropics. *Nature's Pharmacy*, 221, pp.22–35.

Gopalakrishnan, L., Doriya, K., & Santhosh, D., 2016. Moringa oleifera : A Review on Nutritive Importance and Its Medicinal Application. *Food Science and Human Wellness*, 5(2), pp.49–56.

Gull, I., Javed, A., Aslam, M.S., Mushtaq, R., & Athar, M.A., 2016. Use of Moringa oleifera Flower Pod Extract as Natural Preservative and Development of SCAR Marker for Its DNA Based Identification. *BioMed Research International*, 2016.

Hastuti., Hadju, V., Citrakesumasari., & Maddeppungeng, M., 2020. Stunting Prevalence and Its Relationship to Birth Length of 18–23 Months Old Infants in Indonesia. *Enfermeria Clinica*, 30, pp.205–209.

Kasolo, J.N., Bimenya, G.S., Ojok, L., Ochieng, J., & Ogwal-Okeng, J.W., 2010. Phytochemicals and Uses of Moringa oleifera Leaves in Ugandan Rural Communities. *Journal of Medicinal Plants Research*, 4(9), pp.753–757.

Kementerian Kesehatan RI., 2021. *Buku Saku Hasil Studi Status Gizi Indonesia SSGI Tahun 2021*.

Kementerian Kesehatan RI., 2022. *Hasil Survei Status Gizi Indonesia (SSGI) 2022*.

Khan, A.V., Uddin Ahmed, Q., Khan, A.A., & Shukla, I., 2014. In Vitro Antibacterial Efficacy of Leucas Cephalotes (Roth) Spreng. (Lamiaceae) against some Gram Positive and Gram Negative Human Pathogens. *International Journal of Agricultural and Food Research*, 3(3).

Lin, M., Zhang, J., & Chen, X., 2018. Bioactive

flavonoids in Moringa oleifera and Their Health-Promoting Properties. *Journal of Functional Foods*, 47(April), pp.469–479.

Nadimin., Hadju, V., As, S., & Buchari, A., 2015. The Extract of Moringa Leaf Has an Equivalent Effect to Iron Folic Acid in Increasing Hemoglobin Levels of Pregnant Women : A randomized Control Study in the Coastal Area of Makassar. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, 22(1), pp.287–294.

Nadimin., Hadju, V., As, S., Buchari, A., Haruna, I., & Hartono, R., 2019. *Increasing of Nutrition Status of Pregnant Women after Supplementation of Moringa Leaf Extract (Moringa Oliefera) in the Coastal Area of Makassar, Indonesia*.

Nugroho, E., Wanti, P.A., Suci, C.W., Raharjo, B.B., & Najib., 2021. Social Determinants of Stunting in Indonesia. *Journal Kesehatan Masyarakat*, 17(2), pp.625–634.

Sarih, K., Siradjuddin, S., Maddepungeng, M., Hadju, V., Saleh, A., Tanziha, I., & Hastuti, H., 2020. Moringa oleifera Intake During Pregnancy and Breastfeeding Toward Docosahexaenoic Acid and Arachidonic Acid Levels in Breast Milk. *Open Access Macedonian Journal of Medical Sciences*, 8, pp.757–761.

Sulistyaningsih, D.A., Panunggal, B., & Murbawani, E.A., 2018. Status Iodium Urine dan Asupan Iodium Pada Anak Stunting Usia 12-24 Bulan. *Media Gizi Mikro Indonesia*, 9(2), pp.73–82.

Sultana, S., 2020. Nutritional and Functional Properties of Moringa oleifera. *Metabolism Open*, 8, pp.100061.

Sumiaty., Tahir, A., Burhanuddin, B., Nurhaedar, J., & Veni, H., 2020. The Effect of Moringa Leaves on Pregnancy on Growth and Morbidity of 6–11 Month. *Enfermeria Clinica*, 30, pp.104–108.

Titaley, C.R., Ariawan, I., Hapsari, D., Muasyaroh, A., & Dibley, M.J., 2019. Determinants of the Stunting of Children Under Two Years Old in Indonesia: A Multilevel Analysis of the 2013 Indonesia Basic Health Survey. *Nutrients*, 11(5).

Ulmy, M.N., Tahir, A., Arsunan, A.A., Burhanuddin, B., & Veni, H., 2020. Effect of Moringa Leaves During Pregnancy on Growth and Morbidity in 0–5 Months. *Enfermeria Clinica*, 30, pp.61–65.

WHO., 2018. World Health Statistik 2018. *World Health Organization*, 10(2).

Zakaria, Hadju, V., As'ad, S., & Bahar, B., 2016. Effect of Extract Moringa Oleifera on Quantity and Quality of Breastmilk In Lactating Mothers, Infants 0-6 Month. *Jurnal MKMI*, 12(3), pp.161–169.

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Ergonomic Risk Assessment on Palm-Oil Harvesting Workers in East Kalimantan

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Abstract

Along with the growth of the palm-oil industry in Indonesia, work-related musculoskeletal disorders (WMSD) experienced by palm-oil harvesting workers also increased. This paper aims to evaluate ergonomic risk factors among harvesting palm workers in East Kalimantan and to propose suggestions to mitigate the risks. A total sample of 70 workers from 3 plantations in Muara Wahau, Babulu, and Muara Badak was observed in 2023. Gotrak survey and ergonomic risk factor (ERF) questionnaire of SNI 9011:2021 were utilized for determining the WMSD and identifying the ergonomics risk, respectively. The result showed that 91% of workers experienced pain after work, and 72% frequently experienced physical fatigue. The Gotrak survey on cutting and carrying bunches activity revealed high exposure risk for the neck (97%), followed by the shoulder (77%) and knee (55%). Meanwhile, during the activity of loading bunches onto the truck, high exposure risk occurs in the shoulders (73%), elbows (53%), and knees (53%). The result of the Kruskal-Wallis statistical test indicates that there is a difference in Gotrak levels among the three locations. The Gotrak level in Muara Wahau is the highest, followed by Babulu and Muara Badak. The results of the ERF questionnaire showed that loading to truck, followed by carrying FFB to the fruit collection point, were the two activities with high ERF scores, i.e., 39 and 34, respectively. Finally, improvements such as stretching exercises before and during work, as well as redesigning ergonomic T-hook and egrek, will mitigate the risk.

Introduction

Indonesia is a country that produces the main and largest palm oil with a plantation area of Elaeis guineensis in 2021 recorded at 15.08 million hectares. The plantation area increased by 1.5% compared to the previous year. The majority of this area is owned by Private Plantations (PBS), covering 8.42 million hectares (55.8%), followed by People's Plantations (PR), covering 6.08 million hectares (40.34%), and State Large Plantations (PBN), covering 579.6 thousand hectares (3.84%). This increase in plantation area also increased the national palm oil production by 2.9% from 2020, reaching 49.7 million tons in 2021. Most of the palm plantations are located in Sumatra and Kalimantan. East Kalimantan has the fourth-largest palm oil plantation area in Indonesia, after the provinces of Riau, West Kalimantan, and Central Kalimantan.

There are four main activities in palm oil harvesting. The activities in palm oil plantation harvesting begin with the picking of fresh fruit bunches (FFB) from the palm oil trees. For palm oil trees with a height of less than 3 meters, picking is done using a tool called "dodos," while those taller than 3 meters are harvested using an "egrek." In this process, mature FFBs are harvested by harvesting workers, and the fruits picked must amount to at least 21 bunches that have fallen from the palm oil tree. Afterward, the fallen bunches (i.e., called "berondolan") are collected and taken to the roadside. During this process, the workers are required to pick

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(a) (b)

FIGURE 1. Fresh Fruit Bunch (FFB) Harvesting Activities. (a) Harvesting FFBs with an "Egrek" (Sickle-Shaped Tool), (b) Collecting Fallen Fruit Bunches, i.e., “Berondolan”

up the fallen bunches until the area is clean. The transportation of FFBs and bunches to the main road can be done using a farm tractor or manually transported using pushcarts or baskets. Then, the FFBs are transported to the Palm Oil Mill using trucks or pickups. As seen in Figure 1, workers are adopting unnatural body postures during palm oil harvesting. These activities have the potential to cause injuries to the workers, resulting in decreased productivity. The impact of these awkward postures includes the occurrence of work-related musculoskeletal disorders (WMSD) among workers, such as pain in the neck, back, joints, knees, or hand tremor syndrome (Walker-Bone, 2002).

In manual handling activities, such as loading FFBs into loading carts, baskets, or onto trucks, awkward postures are also involved (Fig. 1© and Fig. 1(d)). These include twisting the torso, raising the upper arms above the shoulders, and manually lifting heavy loads (with FFBs weighing around 20-25 kg). These uncomfortable body postures are repeated by workers over extended periods. This indicates that workers are not following ergonomic principles in their work. According to a study (Sultan *et al*., 2022), working with non-ergonomic postures increases the risk of musculoskeletal disorders (MSDs) complaints. Therefore, studies on WMSD (work-related musculoskeletal disorders) in palm oil workers and ergonomic risk assessments are crucial to minimize the pain experienced by workers and reduce ergonomic risks. Numerous research studies have investigated the potential occurrence of work-related musculoskeletal disorders (WMSDs) among oil palm workers while engaged in the four primary activities of palm fruit harvesting. For example, these studies have been conducted in various locations, including Indonesian palm plantations (Syuaib, 2015), as well as in Malaysian palm plantations (Teo *et al*., n.d.), (Deros *et al*., 2016), (Nawi *et al*., 2016), (Henry *et al*., 2015), (Chan *et al*., 2022), and (Tumit *et al*., 2021). Additionally, research has been conducted in palm plantations across various countries, including Indonesia, Malaysia, Papua New Guinea, Cameroon, Ghana, and Myanmar (Myzabella *et al*., 2019), Thailand (Mongkonkansai *et al*., 2020), (Bhuanantanondh *et al*., 2021). However, such studies have been relatively limited in East Kalimantan. Only one study (Sultan *et al*., 2022) focused on Berau, while another study (Alisha *et al*., 2021) conducted research in West Kalimantan. Enhancing worker safety and health can have a positive impact on job performance, ultimately leading to increased productivity in palm oil plantations. In 2010, the World Bank highlighted that the safety and health of plantation workers posed a challenge to the sustainability of this industry in the future (Myzabella *et al*., 2019)

Methods

This research was conducted in three palm oil plantations located in Muara Badak, Muara Wahau, and Babulu, involving a total of 70 respondents. In Muara Wahau, 34 respondents were responsible for cutting FFBs, collecting

TABLE 1. The Level of Risk for GOTRAK Complaints

Frequency of pain	Severity			
	No issue/problem (1)	Uncomfortable (2)	Painful (3)	Very Painful (4)
Never (1)	1	2	3	4
Sometimes (2)	2	4	6	8
Often (3)	3	6	9	12
Always (4)	4	8	12	16

fallen bunches and FFBs, and transporting them to the collection point, which is usually located on the roadside. Eight respondents were tasked with loading FFBs onto trucks. The size of this plantation is 3,381 hectares. Meanwhile, in Babulu, due to its smaller plantation area of approximately 2 hectares, there is no division of tasks. Ten respondents are responsible for the entire process, from harvesting FFBs to loading them onto the pick-up truck. Furthermore, in Muara Badak, where the plantation covers an area of 7 hectares, there are 5 respondents tasked with picking FFBs and transporting FFBs and fallen bunches to the collection point, 5 respondents responsible for collecting fallen bunches, and finally, 5 respondents tasked with loading FFBs onto trucks. The variables studied include respondent profiles, work-related musculoskeletal disorders (GOTRAK), the severity level, and the frequency of these complaints occurring.

The equipment used for measuring WMSD is the GOTRAK survey questionnaire SNI 9011:2021, which assesses the severity and frequency of pain in various body segments, including the neck, shoulders, elbows, left and right sides of the back, arms, hands, buttocks, thighs, knees, calves, and feet. The assessment begins with a preliminary observation of an activity to identify hazard factors present in each task of the job. This checklist assists in identifying the combinations of hazard factors that pose the highest risks in the job. The assessment of ergonomic hazard potential is conducted by analyzing severity and frequency, and these values can be used to describe workplace conditions (see Table 1). If workers experience complaints with a high-risk level (a value ≥ 8) as shown in Table 1, further analysis is conducted by inquiring about which part of the job is causing the GOTRAK complaints. This analysis employs the ERF (ergonomic risk factor) checklist. If the score in the ERF checklist is equal to or less than 2, then it falls under the category of a safe workplace criterion. If the score falls between 3 and 6, it is classified as needing further investigation. If the score is greater than 7, then the workplace is deemed hazardous.

Results and Discussion

The interview results indicate that 64% of all workers have a dominant right hand for their work. The majority of workers have a length of service of ten years or more (57%). 47% often feel mental stress after work, and 81% often experience physical fatigue after work. This is because palm oil workers have targets to meet, and they work 9 hours a day with a 1-hour break, without any days off. Sundays are used to catch up on unfinished tasks. As a result, 96% of workers experience pain after work. Workers responsible for harvesting FFB until delivering them to the collection point in Muara Wahau experience a high-risk level for the neck (100%), elbow (79%), shoulder (62%), and knee (94%). Meanwhile, workers in Babulu performing all activities from harvesting FFB to transporting to the oil processing factory also face a high-risk level for the neck (90%), elbow (60%), shoulder (70%), and knee (70%). The complaints of neck and shoulder pain align with the research (Rahardjo, 2009) on palm oil harvesters in Ogan Komering Ilir, as well as with the studies (Prabawati & Lidiana, 2021) on PT GM Kalimantan and (Syuaib, 2015) on PT. Astra Agro Lestari in Kalimantan and West Sulawesi. 75% of palm oil harvesters and transporters to the collection point in Muara Badak experience a high-risk level for the neck and upper back. Meanwhile, 40% of fallen bunches (berondolan) gatherers face a high-

risk level for the knee and calf.

Workers responsible for loading fresh fruit bunches (FFB) onto trucks in Muara Wahau experience a high risk level for the upper back (88%), knee (88%), hand (75%), shoulder (75%), elbow (100%), lower back (50%), and hip (50%).In contrast, in Muara Badak, the transport workers experience a high risk level for the shoulder (80%) and hip (60%). The difference is due to workers loading FFB onto trucks in Muara Wahau and pick-up vehicles in Muara Badak, as the plantation in Muara Badak is smaller than in Muara Wahau. In the activity of cutting FFB, the majority of respondents experience severe and frequent pain in the neck. The reason for the high risk to the neck of harvest workers is that when harvesting using a tool called "egrek" on palm trees taller than 12 meters, workers have to look upwards at an angle of more than 5° (see Fig. 1 (a)). This position can exert excessive pressure on the neck muscles and increase the risk of injury. Workers also tend to lift their heads and necks excessively due to the "egrek" tool being insufficient in height, resulting in an uncomfortable or non-ergonomic angle for picking oil palm fruit. The weight of the "egrek" tool and the need to hold it at a height above the abdomen without support cause the majority of harvest workers to experience shoulder pain. The process of "egrek" work is often combined with the activity of moving from one palm tree to another for a relatively long duration (approximately 8 hours) each day, which leads to the majority of harvest workers also experiencing knee pain.

TABLE 2. Result of Kruskal-Wallis Test

	Location	N	Mean Rank
Egrek	Babulu	12	18.00
	DSN	12	27.46
	Badak	12	10.04
	Total	36	
Berondolan	Babulu	12	18.25
	DSN	12	27.54
	Badak	12	9.71
	Total	36	
Transporting to the palm fruit storage area	Babulu	12	17.79
	DSN	12	27.38
	Badak	12	10.33
	Total	36	
Loading onto the truck	Babulu	12	19.50
	DSN	12	24.75
	Badak	12	11.25
	Total	36	

Test Statistic[a,b]

	egrek	Berondolan	Transporting to the palm fruit storage	Loading onto the truck
Kruskal-Wallis H	16.876	17.560	16.124	10.235
df	2	2	2	2
Asymp. Sig.	.000	.000	.000	.006

a. Kruskal-Wallis Test
b. Grouping Variable: location

Transport workers must manually carry and then toss FFB with a weight of 20-25 kg into the truck bed. Based on observations, workers lift FFB weighing ≥ 13 kg with a distance of more than 10 inches from their bodies, and this action is repeated. This is what causes transport workers to frequently experience pain in the shoulders and elbows. Transport workers also perform their tasks by standing continuously for approximately 8 hours per day while carrying FFB, which leads to knee pain. Priyambada *et al*. (2019) also found that the shoulder is the body segment most frequently affected by MSDs. Furthermore, Henry *et al*. (2015) when lifting oil palm fruit, the center of gravity is in the hands, which results in pressure on the deltoid muscles in the shoulder. Therefore, workers who carry oil palm fruit often complain of discomfort in the shoulder area. After the load shifts to the shoulders, to stand upright from a bent position, the center of gravity shifts to the lower back. This occurs when lifting loads such as oil palm fruit and "tojok," in addition to the upper body weight, also concentrating on the lower back. The heavier the load lifted, the greater the pressure on the lower back. Consequently, workers frequently report hip pain.

The measurements taken with the "Gotrak" in these activities show that more than 40% of the respondents have a high level of risk. These complaints arise because the muscles experience pressure due to the repetitive and continuous physical workload without the opportunity for relaxation. Unnatural working postures, excessive muscle stretching, high-frequency vibrations, and direct pressure on soft muscle tissues can lead to complaints of pain. Considering this, it is necessary to analyze Ergonomic Risk Factors (ERF) to further examine the ergonomic risk factors experienced. The results of the ERF analysis will be used as input to design ergonomic risk controls to mitigate the occurrence of MSDs. A non-parametric statistical test (Kruskal-Wallis) was conducted to examine the differences in Gotrak/MSD levels that occurred in Babulu, Muara Wahau, and Muara Badak. The results indicate that there are differences in the level of Gotrak (see Table 2). Table 2 shows that the level of Gotrak in Muara Wahau is higher than in Babulu and Muara Badak across all investigated activities. The average level of Gotrak in Muara Wahau is the highest, followed by Babulu and Muara Badak. This is due to the much larger plantation area in Muara Wahau compared to Muara Badak and Babulu, resulting in larger harvesting targets or other activities for each worker. Additionally, because of the differing areas, transportation in Wahau utilizes large trucks, whereas in Babulu and Muara Badak, smaller pickup trucks are used. Furthermore, the conditions of the oil palm plantations are also different. In Muara Wahau, workers have to manually transport fresh fruit bunches (TBS) to the collection point using manual push carts. Meanwhile, in Babulu and Muara Badak, fruit pickers can use motorcycles equipped with baskets for fruit collection.

There are differences in tool usage in the activities of gathering loose fruit and loading FFB onto transportation equipment in the three researched locations. In Muara Badak and Babulu, for gathering loose fruit, no tools are used as opposed to what is done in Muara Wahau (see Figure 3). Meanwhile, the transportation equipment used for loading TBS into the processing plant is trucks in Muara Wahau and pick-up vehicles in Babulu and Muara Badak. ERF is assessed for each activity, not for each individual. The calculation of ERF is conducted by referring to the checklist found in SNI 9011: 2021. The checklist consists of three parts: upper body posture, lower body posture, and manual handling. In the calculation of working posture, if there is an awkward posture, measurements of the angles of the back and neck are required, as seen in the activity of gathering loose fruit (see Figure 2).

Table 2 shows the ERF scores for each activity. The table indicates that all activities have hazardous working conditions, as all the values are >7. From Table 3, it can be seen that the activity with the highest work risk is loading FFB onto the truck, followed by carrying fresh fruit bunches to the fruit collection point.

In harvesting activities using an "egrek," the ergonomic risks are mostly found in the upper body. Further, ergonomic hazards primarily exist in the manual material handling activities, such as carrying fresh fruit bunches to the fruit collection point, loading FFB onto the

FIGURE 2. Angle Measurement in the Activity of Gathering Fallen Bunches

TABLE 3. ERF Score for Each Activity

	Upper Part	Lower Part	MMH	SCORE
Collecting FFB (MB, MW, B)	**13**	3	8	24
Picking up loose fruit while squatting (MB, B)	7	7	6	20
Picking up loose fruit with a shovel (MB)	5	3	9	17
Carrying fresh fruit bunches to the fruit collection point (MW, MB, B)	7	8	**19**	**34**
Loading TBS to the truck (MW)	**16**	5	**18**	**39**
Loading FFB to pick up (MB, B)	8	2	**14**	24

Note: MB=Muara Badak, MW=Muara Wahau , B=Babulu. MMH=manual material handling

truck or pick-up truck. Table 3 showed that the least safe condition is found during the activity of loading Fresh Fruit Bunches onto trucks (score 39). This is because the arm or elbow is not supported at a position above the waist, the hand gripping the T-hook in a "power grip" position with a force of more than 5 kg. This is due to the weight of the FFB and the T-hook itself; the total weight is approximately 21.2 - 26.2 kg. In addition, the body is also bent at an angle of 20°. The riskiest factor is the lifting of objects weighing more than 13 kg and lifting them from a distance of more than 10 inches. Furthermore, the torso rotates while lifting. This is exacerbated by repetitive lifting activities (more than 5 times per minute). These results are consistent with the research by Abdullah *et al.* (2023) and Yu *et al.* (2023) conclude that workers in palm oil plantations are vulnerable to MSD (Musculoskeletal Disorders)

CTS (Carpal Tunnel Syndrome) is part of MSD, specifically affecting the hands and wrists. Observation results showed that palm oil workers often move their wrists repeatedly, exert force on the wrists, and adopt awkward wrist positions. This position occurs when workers gather fruit bunches. Exertful force is applied when carrying FFB to the pushcart. According to (Nandini *et al.*, 2022), there is a positive correlation between jobs requiring repetitive wrist movements and the occurrence of CTD. Therefore, palm oil workers also potentially suffer from CTS. In addition to facing musculoskeletal problems, oil palm workers are also exposed to the risk of pesticide exposure used to repel pests in oil palm trees. Research (Awantari & Susilowati, 2023) showed that a total of 16 people (80%) from 20 respondents had IgE levels that exceeded the reference limits. Meanwhile, eosinophil levels in eight people (40%) also exceeded the reference limits. Basophil levels in eight people (40%) likewise surpass the reference limits. They concluded that pesticide exposure can increase the probability of allergies.

The improvements for these non-

ergonomic activities are the redesign of the T-hook and egrek to make it ergonomic, as well as performing stretching exercises before and between work to reduce discomfort. Stretching should be done because even though the tools have been ergonomically designed, awkward body postures can still be encountered due to unchangeable working conditions, such as the palm tree's height of 12 meters, which forces workers to constantly look up at an angle greater than 5°. The suggested redesign for the T-hook mechanism aims to decrease the likelihood of injuries occurring among palm fruit transportation workers. This redesign concept was previously put into practice in a study (Surya & Gasali, 2014) to reduce worker fatigue and the occurrence of injuries. Alterations have been introduced to the T-hook handle, resulting in a more ergonomic design that aligns with the finger's anatomy and size (refer to Figure 3).

As suggested in Hidayat *et al*. (2013), the egrek is suggested to be redesigned by installing a spring or hydraulic mechanism between the sickle and the pole. The diameter of the pole needs to be adjusted to be as wide as the workers' grip (i.e., 4 cm). Furthermore, the poles' handles should be layered with padding or foam with a thread pattern to make them comfortable and not slippery. Hidayat *et al* (2013) implemented the newly designed egrek to minimize the WMSD that occurred among harvesting workers in North Sumatra. During the activity of loading Fresh Fruit Bunches onto trucks, the majority of workers experience pain in the lower back (88%), knees (88%), and elbows (100%). Therefore, stretching is focused on the lower back, knees, and elbows. Stretching for the lower back and knees is performed in both sitting and standing positions. The positions for stretching focused on the lower back and knees. These positions are held for 5 breaths and then repeated 4 times. The same sequence is then repeated for the opposite hand/leg (Panjaitan & Budhyanti, 2019).

Conclusion

From the analysis conducted, it can be concluded that palm harvesting activities carry a risk of musculoskeletal disorders. This is evidenced by the results of the Gotrak survey, which indicated that more than 40% of respondents experienced musculoskeletal disorders in all activities. Further observation using the ergonomic risk factor questionnaire revealed that all harvesting activities are classified as unsafe conditions for workers (because the score is >7). Manual handling activities such as loading Fresh Fruit Bunches onto trucks and carrying TBS to the fruit storage area are two activities with the highest ERF scores, namely 39 and 34. These disorders occur because muscles endure pressure due to the continuous and repetitive physical workload without the opportunity for relaxation. Unnatural working postures, excessive muscle stretching, and direct pressure on soft muscle tissues can also lead to complaints of pain. Redesign ergonomic T-hook and egrek that are comfortable for workers and conducting stretching are the proposed improvements for reducing the risk of WMSD among palm-oil workers. Stretching is focused on the neck, lower back, and knees. This stretching is conducted before starting work and after a work break. Furthermore, the use of protective gloves should also be considered for the safety needs of palm oil workers (Khanlari *et al*. 2023)

(a) (b)

FIGURE 3. (a) Current T-hook Design (b) Proposed Design Improvement for T-hook (Surya & Gasali, 2014)

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References

Abdullah, N.A., Shaberi, M.N.M., Nordin, M.N.A., Ripin, Z.M., Razali,M.F., Amri, W.M., Ali, W.M., Awang, B., & Ridzwan, M.I.Z., 2023. Field Measurement of Hand Forces of Palm Oil Harvesters and Evaluating the Risk of Work-Related Musculoskeletal Disorders (WMSDs) Through Biomechanical Analysis. *International Journal of Industrial Ergonomics,* 96.

Alisha, N., Halim, Rd., Syukri, M., Aswin, B., & Hidayati, F., 2021. Determinan Keluhan Muskuloskeletal Pada Pekerja Bongkar Muat Tandan Buah Segar (TBS) Kelapa Sawit. *Jurnal Ilmu Kesehatan*, 5(2), pp.366-374.

Awantari, A., & Susilowati, I.T., 2023. Humoral Inflammatory Markers of Total Immunoglobulin E (IgE) Exposure on Palm Oil Plantation Pesticide Sprayers. *Kemas*, 19(2), pp.203-211.

Bhuanantanondh, P., Buchholz, B., Arphorn, S., Kongtip, P., & Woskie, S., 2021. The Prevalence of and Risk Factors Associated with Musculoskeletal Disorders in Thai Oil Palm Harvesting Workers: A Cross-Sectional Study. *International Journal of Environmental Research and Public Health*, 18, pp.5474.

Chan, Y.S., Teo, Y.X., Gouwanda, D., Nurzaman, S.G., Gopalai, A.A., & Thannirmalai, S., 2022. Musculoskeletal Modelling and Simulation of Oil Palm Fresh Fruit Bunch Harvesting. *Scientific Reports*, 12, pp.8010.

Deros, B.M., Ali, M.H., Mohamad, D., & Indah, D.D., 2016. Ergonomic Risk Assessment on Oil Palm Industry Workers. *Iran Journal of Public Health,* 45(1), pp.44–51.

Henry, L.J., Jafarzadeh, E.A., Ramli, A., Ishak, I., Justine, M., & Mohan, V., 2015. Patterns of Work-Related Musculoskeletal Disorders Among Workers in Palm Plantation Occupation. *Asia Pacific Journal of Public Health,* 27(2), pp.1785–1792.

Hidayat, R., Huda, L.N., & Poerwanto., 2015. Analisis Perancangan Alat Bantu Kerja Operator Angkut Di Stasiun Pemanenan Pada PT. Perkebunan X. *e-Jurnal Teknik Industri FT USU*, 4(1), pp.25-32.

Khanlari, P., Ghasemi, F., & Heidarimoghdam, R., 2023. Protective Gloves, Hand Grip Strength, and Dexterity Tests: A Comprehensive Study. *Journal Heliyon*, 9(2).

Mongkonkansai, J., Thanapop, C., Madardam, U., Chekal, A., Epong, A., & Arwae, A., 2020. Factors Related to Musculoskeletal Disorders in Quality Control Palm Workers at Palm Purchasing Establishments in Sichon District, Nakhon Si Thammarat, Thailand. *Annals of Agricultural and Environmental Medicine*, 27(2), pp.207–210.

Myzabella, N., Fritschi, L., Merdith, N., El-Zaemey, S., Chih, H., & Reid, A., 2019. Occupational Health and Safety in the Palm Oil Industry: A Systematic Review. *International Journal of Occupational and Environment Medicine*, 10(4), pp.159–173.

Nandini, R.F., Lestari, M., Novrikasari., Andarini, D., Camelia, A., & Fujianti, P., 2022. Carpal Tunnel Syndrome Complaints in Female Packing Workers. *Kemas*, 17(3), pp.354-361.

Nawi, N.S.M., Deros, B., Rahman, M.N.A., Sukadarin, E.H., & Nordin, N., 2016. Malaysian Oil Palm Workers Are In Pain: Hazards Identification And Ergonomics Related Problems. *Malaysia Journal of Public Health Medicine*, 16(1), pp.50-57.

Panjaitan, L., Budhyanti, W., 2019. *Panduan Peregangan Mandiri.* Program Studi Fisioterapi. Universitas Kristen Indonesia, Jakarta.

Sultan, M., Isnaniah, S.A., Ramdan, I.M., 2022. Postur Kerja dan Keluhan Musculoskeletal Disorders Pada Pemanen Sawit di PT. Inti Energi Kaltim Kabupaten Berau. *Tropical Public Health Journal*, 2, pp.54–59.

Syuaib, M.F., 2015. Ergonomic Of The Manual Harvesting Tasks Of Oil-Palm Plantation In Indonesia Based On Anthropometric, Postures And Work Motions Analyses. *Agricultural Engineering International the CIGR e-journal*, 17(3), pp.248-262.

Tumit, N.P., Rambely, A.S., & Deros, B.M., 2021.The Effects of Age and Initial Shoulder Posture on the Upper Limb Range of Harvesting Movements among Oil Palm Harvesters. *Applied Science*s, 11, pp.10280.

Teo, Y.X., Chan, Y.S., Gouwanda, D., Nurzaman, S.G., & Thannirmalai, S., 2021.Quantification of Muscles Activations and Joints Range of Motions During Oil Palm Fresh Fruit Bunch Harvesting and Loose Fruit Collection, *Scientific Report*, 11, pp.15020.

Walker-Bone, K., 2002. Musculoskeletal Disorders in Farmers and Farm Workers. *Occupational. Medicine*, 52(8), pp.441–450.

Yu, X.T., Yon, S.C., Nurzaman, S.G., Gouwanda, D., & Gopalai, A.A., 2023. Investigation of Muscle

Synergies and Their Consistency Among Fresh Fruit Bunches Manual Harvesters in a Real-Life Oil Palm Industry. *International Journal of Industrial Ergonomics,* 97.

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Translation and Psychometric Analysis of the Brief Symptom Inventory in Adolescents with Substance Use Disorder

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Abstract

The Brief Symptom Inventory-18 (BSI-18) is an 18-item self-report checklist designed to screen for psychological symptoms in medical patients. This study aimed to assess the psychometric properties of BSI among a diverse group of Indonesian adolescents. This study involved 80 15 to 18-year-old adolescents from a drug rehabilitation center in West Java, Indonesia. The instrument was translated into Bahasa Indonesia, and its content validity index was calculated using Aiken's V formula. The CVI ranged from 0.73 to 1.00 for BSI. The factor loadings of each of the three scales in the BSI ranged from 0.43 and 0.88. The model was acceptable and appropriate when confirmatory factor analyses of the BSI were conducted. The Cronbach alpha coefficient of the BSI was 0.925. The findings of this study give evidence that the BSI is a viable and beneficial screening tool for detecting substance use problems among Indonesian adolescents.

Introduction

Drug consumption may offer a means for temporarily avoiding distressing emotions, thoughts, and trauma-related physiological responses (Suzuki *et al.*, 2014; Li and Seng, 2018), but can potentially increase mental health problems and emotional dysregulation in the long term. For some youth, substance abuse relapse may create a 'vicious cycle' with increasingly negative consequences related to both conditions (Garami *et al.*, 2019; Saladino, Hölzlhammer and Verrastro, 2020), and risk for substance use relapse among the adolescents who are in partial and/or early remission (Dworkin *et al.*, 2018). Excessive substance uses often co-occur with depressive illness (McCauley *et al.*, 2012). Alcohol is the most common substance used among the adolescent population (Avenevoli *et al.*, 2015; Zavaglia and Bergeron, 2017). Studies have found positive associations between alcohol use frequency and recurrent intoxication among depressed adolescents and early-onset depressive disorders with elevated levels of later addictive substance use. It has been reported that 10–25% of depressed subjects have co-occurring substance use disorder (SUD) both in general and clinical populations, with clearly higher figures in clinical populations (Ranjit *et al.*, 2019; Hunt *et al.*, 2020).

Despite the implementation of optimal medical interventions and comprehensive rehabilitation assistance, there persists a notable prevalence of recurrence among individuals diagnosed with substance use disorder (SUD) (Wang *et al.*, 2018)). According to research by the National Narcotics Agency (2020), around 70% of individuals who have received rehabilitation for drug addiction encounter relapse. Relapse is commonly characterized as the reappearance of symptoms associated with SUD following a period of decreased substance

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consumption. This phenomenon is frequently observed among young individuals and adults after treatment, with notable prevalence rates (Kabisa *et al.*, 2021). According to (Zeng, Lu and Chen, 2021), there is a positive correlation between the likelihood of relapse and the occurrence of relapse behavior. Hence, there is a requirement to assess recurrence rates in individuals following the completion of a recovery program (Astuti and Hastono, 2020; Oktriyanto, Amrullah and Titisari, 2020).

The Brief Symptom Inventory-18 (BSI-18; Derogatis, 2001) is a self-report checklist of 18 items. It was a concise tool to assess psychological symptoms in individuals receiving medical care. The BSI-18 has been extensively utilized in both research and clinical settings, encompassing a diverse patient population. Notable examples of its application include studies conducted by (Derogatis and Melisaratos, 1983; Mustanski *et al.*, 2007; Petkus *et al.*, 2010). The BSI-18 has been employed in the examination of oncology samples, as demonstrated by the works of (Bober *et al.*, 2013; Michel and Vetsch, 2015; Bitsko *et al.*, 2016; Vuotto *et al.*, 2017; Calderon *et al.*, 2020). The utilization of the BSI-18 in assessing adolescents who have undergone substance use disorder rehabilitation is substantiated by several factors. Firstly, the instrument's concise nature allows for efficient administration and completion. The BSI-18 comprehensively addresses key aspects of anxiety and depression, which are crucial areas of concern in this population. Furthermore, the inclusion of normative data specific to adolescents with a history of substance use disorder in the published manual further supports the applicability of the BSI-18 in this context. While the BSI has been sporadically employed by professionals and researchers in Indonesia, there is a lack of psychometric testing to establish its reliability within our context. This research evaluates the BSI psychometric properties among a representative sample of adolescents in Indonesia.

Methods

The study included a cohort of 80 teenagers from 15 to 18 years old. The participants for this study were selected from a drug rehabilitation facility in West Java, Indonesia. The study sample comprised individuals who voluntarily decided to participate in the research, and informed consent was obtained from both the participants' parents and the participants themselves. The Brief Symptom Inventory-18 (BSI-18; (Derogatis, 2001)) is a self-report checklist of 18 items. It was a concise tool to assess psychological symptoms in individuals receiving medical care. The BSI comprises three dimensions, namely somatization, depression, and anxiety. The BSI categorizes individuals with a GSI t-score of 63 or higher as clinically significant. The criteria for identifying cases using the BSI-18 questionnaire include two options: a t-score of 63 or higher on the Global Severity Index (GSI), or meeting the criteria on any two symptom scales. Additionally, the usual case-rule for the GSI involves a t-score of 63 or higher.

The process of translating a questionnaire encompasses four stages. Commencing with the initial forward translation, engaging an expert panel, employing the back-translation technique, and doing cognitive interviewing. According to the World Health Organization (2016), the concluding phase of the translation process involves the fulfillment of the questionnaire through the implementation of a pre-test and the creation of accompanying documentation. This endeavor generates bilingual versions in Bahasa Indonesia that accurately reflect the original notions in English. Moreover, the device possessed considerable value, exhibited rationality, and conformed to predetermined expectations. The tool was translated into Bahasa, a language spoken by the indigenous population of Indonesia, by two multilingual translators. The individuals received support from English language experts who were naturally fluent in Bahasa. Each translator is operating autonomously, and three reviewers have undertaken the validation process using the two translated versions. Consequently, the ultimate version of the Bahasa edition underwent evaluation by three nursing professionals, all of whom own a doctoral degree from an international institution and are proficient in Bahasa and English. In the meantime, another translator proficient in both languages altered their

course and performed a translation task from Bahasa to English, reversing the direction of the translation process. Subsequently, a researcher conducted a comparative analysis between the revised English rendition and the first English version, with another bilingual nursing expert engaged in the validation process for both languages.

The researchers utilized the Content Validity Index (CVI) to assess the content validity of the translated questionnaire, particularly focusing on the prioritization, relevance, and appropriateness of the phrasing (Campbell, 2014). Five individuals with expertise in the field were selected to evaluate the Bahasa questionnaire following forward and backward translation. Among these experts, three had a Doctor of Philosophy degree in nursing, while the remaining two were clinicians, consisting of one nurse and one physician. The questionnaire was subjected to expert evaluation, wherein reviewers assessed each item on the questionnaire and assigned a numerical value to it. Additionally, an alternative scale is available assessing factors encompassing multiple levels of content suitability and significance. System implemented wherein a single point is assigned to instances of inappropriate content. The question item ought to be removed. The two-point method evaluates information or items of a dubious nature. It requires a substantial level of exertion. A three-point system is proposed to provide an acceptable range with minimal effort. The 4-point scale encompasses suitable elements without modification, and no questions can be omitted. Upon the conclusion of the expert committee's review, the Content Validity Index (CVI) score was computed utilizing Aiken's V formula as described by Azwar (2015). The V value varies between 0 and 1.00. If the CVI has a value of 0.80 out of 1.00, it suggests it is significantly elevated. The higher the value of V, the greater the accuracy of the item and the validity of the exam. Once the items have undergone the content validity assessment, they are considered comprehensive.

Descriptive statistics were employed to elucidate the profile of the sample. The study applied exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to ascertain the factor structure of the BSI instrument. The evaluation of measurement fit indices is commonly proposed through the use of the root-mean-square approximation error (RMSEA), standardized root-mean-residual (SRMR), and comparison of fits (CFI) (Hu and Bentler, 1999). An optimal match is characterized by a root mean square error below 0.06 and a standard deviation below 0.08. Existing scholarly research has shown that Comparative Fit Index (CFI) values exceeding 0 indicate a favorable level of fit, while values below 0.8 indicates an acceptable level of fit. According to (Browne and Cudeck, 1992), The item correlation of the CRAFFT was examined using a Pearson correlation test. According to Calvache *et al*. (2020), when the subscales are aggregated and specific items are excluded, correlation coefficients exceeding 0.7 indicate that the dimensions have effectively represented the same concept.

The concept of "reliability" pertains to the extent to which a measurement is devoid of errors (Mokkink *et al.*, 2016). The present study employed the Cronbach Alpha coefficient to assess the reliability of the measurements. All study protocols adhered to the ethical principles stated in the Declaration of Helsinki. The study conducted at STIKes Abdi Nusantara has been approved by the ethics committee. The committee has granted a waiver for written informed parental consent and written assent. In June 2012 to February 2013, research assistants engaged with teenagers identified by clinic staff in the waiting areas of three distinct primary care clinics. Participants falling within the designated age bracket were invited to participate in the research study involving an anonymous survey. The patients who provided verbal agreement, were subsequently relocated to a designated area, where they were administered a comprehensive set of questions for completion.

Results and Discussion

The recommendations provided by the expert panel about minor revisions were incorporated into the scale before commencing the psychometric testing phase. The BSI content validity index (CVI) ranged from 0.73 to 1.00. These results suggest that the BSI properly valid in assessing food content.

Table 1. Reliability of BSI Scale

Scale	Cronbach's Item-total correlation (n = 144)	Item-total correlation (Range) (n = 144)	Intraclass correlation coefficient (n = 72)
BSI	0.925	0.533—0.728	0.765

The present study examined the favorable psychometric features of the Brief Symptom Inventory (BSI) in a sample of 80 Indonesian teenagers. Initially, a good level of internal consistency was achieved about the instrument. The analyses have shown support for the three-dimensional structure of the BSI scale, hence establishing the construct validity of the instrument. Nevertheless, the study failed to establish a specific threshold score determining whether patients with recurrent disorders should undergo further comprehensive assessment. The majority of the research examined the efficacy of the BSI in identifying instances of problematic alcohol or drug, as defined by meeting one or more criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders (DSM). Additionally, the research explored the BSI's ability to identify substance use disorders, as defined by meeting two or more criteria outlined in the DSM.

The existing scholarly literature has examined various factor structure models of the Brief Symptom Inventory (BSI). These models include five-factor structures observed in bereaved patients (Johnson, 1996), six-factor structures observed in different ethnic groups, both clinical and nonclinical, as well as college and university counseling center clients (Daoud *et al.*, 2010), eight-factor structures observed in individuals experiencing distress (Ruipérez *et al.*, 2001), and a single-factor structure of general distress observed in patients with epilepsy or psychiatric disorders (Kellett *et al.*, 2003; Endermann *et al.*, 2005). Researchers and practitioners in the field of addictive behavior now have the opportunity to utilize a scientifically validated version of the BSI Abuse Screening Test, which has undergone modifications. The results suggest that the BSI exhibits robust psychometric properties and holds potential utility within the context of Indonesia. Furthermore, research has demonstrated that the advantages of this intervention remain intact even when administered by individuals lacking medical training, hence broadening its potential range of utilization. Additionally, our research results provide a foundation for the possible utilization of the Brief Symptom Inventory (BSI) as a screening instrument within the framework of early detection and intervention initiatives.

Nevertheless, this study possesses certain limitations. The sample size of 80 adolescents is smaller than the sample sizes reported in previous validation studies conducted by (Bernard *et al.*, 2005; Bertini *et al.*, 2015). The current approach is inadequate for evaluating tools within socio-demographic subfields. The potential for self-reports to inaccurately portray survey respondents' substance usage and introduce bias is a result of respondents' apprehension of potential consequences or negative judgement. To mitigate potential questioning or intimidation responses were gathered in securely sealed envelopes that were opaque, ensuring anonymity. Additionally, under CIOMS protocols, the requirement for parental consent was removed. Numerous studies conducted in both clinical and educational settings have provided empirical evidence supporting the reliability of self-reported alcohol and psychotropic substance usage. However, it is imperative for researchers to thoroughly investigate the psychometric features of the scale in several independent societies. The inclusion of clinical data, such as comorbidities and family history, would have provided valuable insights. Ultimately, due to the data collection taking place in educational institutions rather than via clinical interviews, the attributes assessed were self-reported, rendering it challenging to ascertain with objectivity whether adolescents minimized or exaggerated their substance consumption. Self-

report measures have been found to possess more accuracy and reliability compared to alternative approaches when evaluating alcohol and drug usage. In Indonesia, a significant number of preventive efforts are implemented within educational institutions, hence establishing the BSI as a potent tool.

Conclusion

The results of this study provide empirical support for the effectiveness and utility of the BSI as a screening instrument for identifying substance use issues among Indonesian adolescents. Screening tools such as the BSI do not serve as diagnostic tools for substance use disorder. However, when these tools are precise and dependable, they assist service providers in directing their attention towards patients who are at a heightened risk in medical settings that are often bustling, where the majority of adolescent patients may not be engaging in alcohol or drug misuse. Further research is required to evaluate the sensitivity and specificity of the BSI to establish a more comprehensive and validated tool.

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References

Astuti, N.H., & Hastono, S.P., 2020. Is the Frequency of Smoking Affecting the Risk of Abusing Cannabis?. *KEMAS: Jurnal Kesehatan Masyarakat*, 16(1), pp.44–52.

Avenevoli, S., Swendsen, J., He, J.P., Burstein, M., Merikangas, K.R., 2015. Major Depression in the National Comorbidity Survey–Adolescent Supplement: Prevalence, Correlates, and Treatment. *Journal of the American Academy of Child & Adolescent Psychiatry*, 54(1), pp.37–44.

Bernard, M., Bolognini, M., Plancherel, B., Chinet, L., Laget, J., Stephan, P., & Halfon, O., 2005. French Validity of Two Substance-Use Screening Tests Among Adolescents: A Comparison of the CRAFFT and DEP-ADO. *Journal of Substance Use*, 10(6), pp.385–395.

Bertini, M.C., Busaniche, J., Baquero, F., Eymann, A., Krauss, M., Paz, M., & Catsicaris, C., 2015. Adaptación Transculturaly Validación del Test CRAFFT Como Prueba de Pesquisa Para Consumo Problemático, Abuso y Dependencia de Alcohol y Otras Sustancias en un Grupo de Adolescentes Argentinos. *Archivos Argentinos de Pediatría*, 113(2), pp.114–118.

Bitsko, M.J., Cohen, D., Dillon, R., Harvey, J., Krull, K., & Klosky, J.L., 2016. Psychosocial Late Effects in Pediatric Cancer Survivors: A Report from the Children's Oncology Group. *Pediatric Blood & Cancer*, 63(2), pp.337–343.

Bober, S.L., Zhou, E.S., Chen, B., Manley, P.E., Kenney, L.B., & Recklitis, C.J., 2013. Sexual Function in Childhood Cancer Survivors: A Report from Project REACH. *The Journal of Sexual Medicine*, 10(8), pp.2084–2093.

Browne, M.W., & Cudeck, R., 1992. Alternative Ways of Assessing Model Fit. *Sociological Methods & Research*, 21(2), pp.230–258.

Calderon, C., Ferrando, P.J., Lorenzo-Seva, U., Hernández, R., Oporto-Alonso, M., & Jiménez-Fonseca, P., 2020. Factor Structure and Measurement Invariance of the Brief Symptom Inventory (BSI-18) in Cancer Patients. *International Journal of Clinical and Health Psychology*, 20(1), pp.71–80.

Campbell, H., 2014. It Takes More Than Just Looking to Make a Difference: The Challenge for Planning Research. *The Routledge Handbook of Planning Research Methods*. Routledge, pp.24–32.

Daoud, F.S., & Abojedi, A.A., 2010. Equivalent Factorial Structure of the Brief Symptom Inventory (BSI) in Clinical and Nonclinical Jordanian Populations. *Eur J Psychol Assess.*, 26(2), pp.116–121.

Derogatis, L.R., 2001. *BSI 18, Brief Symptom Inventory 18: Administration, Scoring and Procedures Manual*. NCS Pearson, Incorporated.

Derogatis, L.R., & Melisaratos, N., 1983. The Brief Symptom Inventory: An Introductory Report. *Psychological Medicine*, 13(3), pp.595–605.

Dworkin, E.R., Wanklyn, S., Stasiewicz, P.R., & Coffey, S.F., 2018. PTSD Symptom Presentation Among People with Alcohol and Drug Use Disorders: Comparisons by Substance of Abuse. *Addictive Behaviors*, 76, pp.188–194.

Endermann, M., 2005. The Brief Symptom Inventory (BSI) as a Screening Tool for Psychological Disorders in Patients with Epilepsy and Mild Intellectual Disabilities in Residential Care. *Epilepsy Behav.*, **7**(1), pp.85–94.

Garami, J., Valikhani, A., Parkes, D., Haber, P.,

Mahlberg, J., Misiak, B., Frydecka, D., & Moustafa, A.A., 2019. Examining Perceived Stress, Childhood Trauma and Interpersonal Trauma in Individuals with Drug Addiction. *Psychological Reports*, 122(2), pp.433–450.

Hu, L., & Bentler, P.M., 1999. Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria Versus New Alternatives. *Structural Equation Modeling*, 6(1), pp.1–55.

Hunt, G.E., Malhi, G.S., Lai, H.M.X., & Cleary, M., 2020. Prevalence of Comorbid Substance Use in Major Depressive Disorder in Community and Clinical Settings, 1990–2019: Systematic Review and Meta-Analysis. *Journal of Affective Disorders*, 266, pp.288–304.

Johnson, L.C., Murphy, S.A., & Dimond, M., 1996. Reliability, Construct Validity, and Subscale Norms of the Brief Symptom Inventory when Administered to Bereaved Parents. *J Nurs Meas.*, 4(2), pp.117–127.

Kabisa, E., Biracyaza, E., Habagusenga, J.d-A., & Umubyeyi, A., 2021. Determinants and Prevalence of Relapse Among Patients with Substance Use Disorders: Case of Icyizere Psychotherapeutic Centre. *Substance Abuse Treatment, Prevention, and Policy*, 16(1), pp.1–12.

Kellett, S., Beail, N., Newman, D.W., & Frankish, P., 2003. Utility of the Brief Symptom Inventory in the Assessment of Psychological Distress. *J Appl Res Intellect Disabil.*,16(2), pp.127–134.

Li, Y., & Seng, J.S., 2018. Child Maltreatment Trauma, Posttraumatic Stress Disorder, and Cortisol Levels in Women: A Literature Review. *Journal of the American Psychiatric Nurses Association*, 24(1), pp.35–44.

McCauley, J.L., Killeen, T., Gros, D.F., Brady, K.T., & Back, S.E., 2012. Posttraumatic Stress Disorder and Co-Occurring Substance Use Disorders: Advances in Assessment and Treatment. *Clinical Psychology: Science and Practice*, 19(3), pp.283.

Michel, G., & Vetsch, J., 2015. Screening for Psychological Late Effects in Childhood, Adolescent and Young Adult Cancer Survivors: A Systematic Review. *Current Opinion in Oncology*, 27(4), pp.297–305.

Mokkink, L.B., Prinsen, C.A.C., Bouter, L.M., De Vet, H.C.W., & Terwee, C.B., 2016. The COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) and How to Select an Outcome Measurement Instrument. *Brazilian Journal of Physical Therapy*, 20, pp.105–113.

Mustanski, B., Garofalo, R., Herrick, A., & Donenberg, G., 2007. Psychosocial Health Problems Increase Risk for HIV among Urban Young Men who Have Sex with Men: Preliminary Evidence of a Syndemic in Need of Attention. *Annals of Behavioral Medicine*, 34(1), pp.37–45.

Oktriyanto, O., Amrullah, H., & Titisari, A.S., 2020. Family Function and Misuse of Drug in Adolescents in Indonesia. *KEMAS: Jurnal Kesehatan Masyarakat*, 16(2), pp.271–283.

Petkus, A.J., Gum, A.M., Small, B., Malcarne, V.L., Stein, M.B., & Wetherell, J.L., 2010. Evaluation of the Factor Structure and Psychometric Properties of the Brief Symptom Inventory—18 with Homebound Older Adults. *International Journal of Geriatric Psychiatry: A Journal of the Psychiatry of Late Life and Allied Sciences*, 25(6), pp.578–587.

Ranjit, A., Gum, A.M., Small, B., Malcarne, V.L., Stein, M.B., & Wetherell, J.L., 2019. Predictive Association of Smoking with Depressive Symptoms: A Longitudinal Study of Adolescent Twins. *Prevention Science*, 20, pp.1021–1030.

Ruipérez, M.A., Ibáñez, M.I., Lorente, E., Moro, M., & Ortet, G., 2001. Psychometric Properties of the Spanish Version of the BSI: Contributions to the Relationship Between Personality and Psychopathology. *Eur J Psychol Assess.*,3, pp.241–250.

Saladino, V., Hölzlhammer, L., & Verrastro, V., 2020. Criminality, Substance Abuse and Problematic Family Relations in Adolescence. *Journal of Addiction Medicine and Therapeutic Science*, 6(1), pp.16–20.

Suzuki, A., Poon, L., Papadopoulos, A.S., Kumari, V., & Cleare, A.J., 2014. Long Term Effects of Childhood Trauma on Cortisol Stress Reactivity in Adulthood and Relationship to the Occurrence of Depression. *Psychoneuroendocrinology*, 50, pp.289–299.

Vuotto, S.C., Krull, K.R., Li, C., Oeffinger, K.C., Green, D.M., Patel, S.K., Srivastava, D., Stovall, M., Ness, K.K., Armstrong, G.T., Robison, L.L., Brinkman, T.M., 2017. Impact of Chronic Disease on Emotional Distress in Adult Survivors of Childhood Cancer: A Report from the Childhood Cancer Survivor Study. *Cancer*, 123(3), pp.521–528.

Wang, T.R., Moosa, S., Dallapiazza, R.F., Elias, W.J., & Lynch, W.J., 2018. Deep Brain Stimulation for the Treatment of Drug Addiction. *Neurosurgical Focus*, 45(2), pp.E11.

Zavaglia, E., & Bergeron, L., 2017. Systematic Review of Comorbidity Between DSM Disorders

and Depression According to Age and Sex in Youth. *Canadian Psychology/Psychologie Canadienne*, 58(2), pp.124.

Zeng, X., Lu, M., & Chen, M., 2021. The Relationship Between Family Intimacy and Relapse Tendency Among People who Use Drugs: A Moderated Mediation Model. *Substance Abuse Treatment, Prevention, and Policy*, 16(1), pp.1–12.

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The Ins and Outs of Alpha-mangostin's Potential as An Antimalarial

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Abstract

Malaria drug resistance, including to development of resistance against artemisinin-based treatments, poses a major challenge to elimination efforts. Alpha-mangostin, an antioxidant with *in vitro* antimalarial activity, is hindered by its poor solubility. This study explores the antimalarial effects of water-soluble alpha-mangostin chitosan-alginate nanoparticles (ACAN) in mice with berghei malaria. Mice were treated with various doses of ACAN, compared to alpha-mangostin in polyethylene glycol (PEG), as well as in corn oil (ACO) and chloroquine as a standard. Growth inhibition rates were assessed, revealing no inhibition in the PEG and normal control (NC) groups, while ACO was less active. The effective dose 50 (ED_{50}) of ACAN was 264.5 mg/kg BW, containing only 15.87 mg of alpha-mangostin, suggesting that alpha-mangostin in ACAN may offer promising *in vivo* antimalarial activity. Further investigation is needed.

Introduction

Human malaria remains a significant problem in several countries due to its severity and challenges related to therapy, particularly for *Plasmodium falciparum.* In many tropical and subtropical regions, malaria continues to be a leading cause of disease and death (Chora *et al*., 2022). In 2020, there were 241 million reported cases of malaria, resulting in 627,000 deaths globally (WHO, 2021). Artemisinin-based combination therapy (ACT) is the treatment of choice due to the parasite's resistance to conventional drugs. However, signs of parasite resistance, especially partial resistance to ACT, are beginning to emerge in several countries, leading to slower responses to treatment (Hassett & Roepe, 2019; WHO, 2021). Resistance to ACT occurs against both artemisinin and its partner drugs through various mechanisms of action (Siddiqui *et al*., 2021). This issue poses a significant obstacle to achieving malaria elimination targets, highlighting the need for new antimalarial drugs.

Garcinia mangostana L. rind exhibits antioxidant activity (Susy Tjahjani *et al*., 2014) and has shown antimalarial activity *in vitro* (S. Tjahjani, 2017). Alpha-mangostin, one of the most abundant xanthones in *Garcinia mangostana* L. rind (John *et al*., 2021), not only has antioxidant properties but also demonstrates strong antimalarial activity, as shown in our previous *in vitro* studies (Susy Tjahjani & Widowati, 2013). Previous research has indicated that alpha-mangostin can act against *Plasmodium falciparum* by inhibiting its cysteine protease enzyme (Kuncoro *et al*., 2018). The extract of *Garcinia mangostana* L. rind, which is abundant in alpha-mangostin, demonstrates the ability to inhibit several proteins involved in the glycolysis process of the parasite (Chaijaroenkul *et al*., 2014).

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Additionally, there may be specific benefits to using antioxidants as antimalarials, as malaria itself induces oxidative stress in the host (Vasquez *et al*., 2021). However, the very poor solubility of alpha-mangostin in various safe solvents poses a challenge for *in vivo* studies, because low solubility is a critical factor affecting bioavailability, particularly for oral administration (Savjani *et al*., 2012).

Chitosan-eudragite nanoparticles enhance the solubility of alpha-mangostin and may improve its bioavailability, especially for oral use (Herdiana *et al*., 2020). According to another study, other alpha-mangostin nanoparticles, i.e., alpha-mangostin chitosan alginate nanoparticles, not only exhibit greater water solubility but also show promise for enhancing the performance and physicochemical properties of alpha-mangostin (Wathoni *et al*., 2019). Additionally, alpha-mangostin diluted in vegetable oil is absorbed quickly and distributed throughout the bodies of experimental animals (Zhao *et al*., 2016). Water-soluble organic solvent formulations, such as those containing polyethylene glycol, may also be utilized due to their chemical and physical stability (van der Vossen *et al*., 2017). *Plasmodium berghei* in mice is commonly used as a model for malaria caused by *Plasmodium falciparum* in humans. This study aimed to explore the antimalarial activity of alpha-mangostin chitosan-alginate nanoparticles (ACAN) in comparison to the antimalarial activity of alpha-mangostin mixed with other solvents, such as corn oil as well as 1-2 polyethylene glycol 400 (PEG 400) - distilled water (6/4, v/v) solution, to identify the most suitable oral preparation against *Plasmodium berghei*-infected mice.

Methods

Frozen Anka strain *Plasmodium berghei* was obtained from the Eijkman Institute for Molecular Biology. Alpha-mangostin was sourced from Biopurify Phytochemicals Ltd., Chengdu, China. The 46 male Swiss Webster mice aged 7-8 weeks, weighing 20-25 g, were procured from the School of Life Science and Technology, Bandung Institute of Technology (ITB). Chloroquine, used as a control drug, was obtained from Sigma-Aldrich. Other materials, including polyethylene glycol, chitosan, alginate, TPP (sodium tripolyphosphate), ethanol (96%), and citric acid, were also sourced from Sigma Aldrich. Alpha-mangostin, chitosan, and alginate were prepared in 0.1% solutions, while TPP was prepared in a 1% solution. Alginate and TPP were dissolved in distilled water, while alpha-mangostin was dissolved in 96% ethanol, and chitosan was diluted in 1% acetic acid. Alphamangostin, chitosan, TPP, and alginate were mixed in a volume ratio of 1:10:2:1 consecutively and slowly, with each step involving stirring, sonication, and pyrolysis (Muchtaridi *et al*., 2023).

This study received ethical approval from the Ethical Committee of the Faculty of Medicine, Maranatha Christian University (certificate number: 144/KEP/XI/2022). A true experimental study with a completely randomized design was used. After a one-week adaptation period under laboratory condition (23-24°C, 60-70% relative humidity, 12-hour light/dark cycle) with ad libitum access to food and water, mice were randomly divided into nine groups with five replicates per group: normal control without any treatment (NC), chloroquine control 20 mg/kg BW (Chloroquine), ACAN at doses of 100, 250, 500 mg/kg BW (ACAN1, ACAN2, ACAN3), 500 mg/kg BW alpha-mangostin in PEG (PEG), and alpha-mangostin in corn oil at doses of 125, 250, 500 mg/kg BW (ACO1, ACO2, ACO3). Each treatment group was housed in a hygienic cage. Chloroquine was diluted in a 0.5% hydroxypropyl methyl cellulose solution in aquadest, while ACAN was diluted in a 0.5% sodium carboxymethyl cellulose solution.

Frozen parasites were thawed and injected intraperitoneally and aseptically into a donor mouse. Parasitemia was monitored daily via thin blood smears from the tail aseptically, fixed in methanol, and stained with Giemsa, then parasitized red blood cells (pRBC) among 1,000 red blood cells (RBC) were counted under a light microscope to find out the parasitemia percentage. Once parasitemia reached 5-10%, the mouse was ethically euthanized using carbon dioxide (CO2), and the blood was taken by cardiac puncture. Each experimental mouse was injected intraperitoneally with 10^7 of these pRBC in 200 µL phosphate-buffered saline

(PBS). After reaching parasitemia around 2%, treatments were administered orally (200 µL) once daily for four days, as per Peters' 4-day suppressive test (Peters *et al*., 1975). The parasitemia percentage was calculated daily starting from day 0. At day 4 (the 5th day), the percentage of parasite growth inhibition was calculated using the formula: (parasitemia percentage of NC - parasitemia percentage of treatment group) / parasitemia percentage of NC x 100%. Mice were euthanized as previously described. Statistical analysis: Probit analysis was performed to determine the dose required to inhibit 50% of parasite growth (ED_{50}=effective dose 50). A lower ED_{50} indicates a more active antimalarial drug.

Results and Discussion

ACAN was successfully produced and was the same product as previously used (Muchtaridi *et al*., 2023) and the alpha-mangostin content in the nanoparticles was measured at 6%. The average of daily parasitemia percentage from NC, chloroquine, ACAN, and PEG groups was calculated, and the percentage of growth inhibition at day 4 (the 5th day) was summarized in Table 1.

Shown in Table 1, at day 4, the chloroquine group exhibited 100% parasite growth inhibition, while the PEG group showed only 4.2% inhibition (similar to NC). Notably, at equivalent doses, ACAN3 produced significantly higher inhibition than PEG, despite containing only 0.6% alpha-mangostin. Probit analysis revealed an ED_{50} of 264.5 mg/kg BW for ACAN, equating to 15.87 mg of alpha-mangostin. This is higher than the ED_{50} for chloroquine (1.4 mg/kg BW) (Mazhari *et al*., 2018) and artesunate (1.8 mg/kg BW) orally (Lombard *et al*., 2013). However, the presence of only 15.87 mg alpha-mangostin suggests strong potential antimalarial properties of the ACAN (Habte & Assefa, 2020). The average of daily parasitemia percentage for the NC and ACO groups was also calculated, with growth inhibition percentage at day 4 presented in Table 2. The ACO1 group exhibited 0.43% inhibition (negligible), while ACO3 demonstrated 27.14% inhibition, with an ED_{50} > 500 mg/kg BW.

Alpha-mangostin shows promising antimalarial activity against the *Plasmodium falciparum* 3D7 strain *in vitro* (S. Tjahjani *et al*., 2018; Susy Tjahjani & Widowati, 2013). It inhibits *Plasmodium falciparum* development,

Table 1: Parasitemia Percentage Average from Each of the NC, Chloroquine, ACAN, and PEG Groups Every Day and Percentage of Growth Inhibition at Day 4 (the 5th day)

Treatment group	% Parasitemia					% growth	% growth inhibition
	D0	D1	D2	D3	D4		
NC	**2.06** ±0.15	**6.22** ±0.40	**9.03** ±0.67	**10.14** ±0.71	**13.80** ±0.79	100	0
Chloroquine	**2.00** ±0.16	**2.18** ±0.26	**1.18** ±0.08	**0.14** ±0.11	**0.00** ±0.00	0.00	100
ACAN1	**2.04** ±0.23	**4.78** ±0.89	**7.96** ±0.63	**8.84** ±1.49	**8.34** ±1.86	60.43	39.57
ACAN2	**2.00** ±0.34	**4.84** ±0.56	**7.32** ±0.38	**8.56** ±0.40	**7.32** ±0.79	53.04	46.96
ACAN3	**2.02** ±0.24	**3.92** ±0.56	**7.20** ±0.67	**7.86** ±0.48	**6.30** ±0.95	45.65	54.35
PEG	**1.98** ±0.30	**6.2** ±0.38	**8.96** ±0.81	**10.44** ±0.49	**13.22** ±0.85	95.80	4.20

Table 2: Parasitemia Percentage Average from Each of the NC and ACOs Groups Every Day and Percentage of Growth Inhibition at Day 4 (the 5th day)

Treatment Group	% Parasitemia					% Growth	% Growth Inhibition
	D0	D1	D2	D3	D4		
NC	**2.15** ±0.33	**7.08** ±0.90	**10.38** ±1.08	**12.60** ±1.06	**15.13** ±0.85	100	0
ACO1	**1.90** ±0.16	**6.36** ±0.82	**11.46** ±1.48	**14.44** ±0.69	**15.06** ±1.73	99.57	0.43
ACO2	**2.10** ±0.32	**6.50** ±1.22	**10.14** ±1.96	**12.56** ±1.34	**12.34** ±2.81	81.59	18.41
ACO3	**1.98** ±0.19	**6.76** ±0.59	**10.10** ±1.25	**11.64** ±1.89	**11.02** ±2.14	72.86	27.14

leading to globin accumulation due to cysteine protease inhibition (Kuncoro *et al*., 2018) going to a parasite's death. Other studies indicate that several parasite glycolysis pathway proteins may also be targets of antimalarial activity of *Garcinia mangostana* L. rind extract (Chaijaroenkul *et al*., 2014) and alpha-mangostin is one of the most xanthone-containing contained in *Garcinia mangostana* L rind extract (John *et al*., 2021). However, *in vivo* results for alpha-mangostin against *Plasmodium berghei* have varied. As indicated in Table 1, parasitemia in the PEG group closely matched that of the NC group, even at a 500 mg/kg BW dose, with minimal growth inhibition. This may stem from the limited bioavailability of alpha-mangostin via oral administration, potentially due to poor gastrointestinal absorption. Similar conclusions were drawn by Upegui *et al*., who recommended modifications to enhance the therapeutic efficacy of alpha-mangostin (Upegui *et al*., 2015). Alpha-mangostin is also very insoluble in various safe solvents.

The same limited efficacy was observed with corn oil as a solvent, with an ED_{50} > 500 mg/kg BW, indicating very weak antimalarial activity (Habte & Assefa, 2020). In contrast, the nano formulation (ACAN) displayed superior antimalarial activity with an ED_{50} of 264.5 mg/kg BW. This formulation contains 6% alpha-mangostin, equating to 15.87 mg alpha-mangostin per 264.5 mg ACAN. The size of ED_{50} indicates its potential as an antimalarial. The low ED_{50} suggests potential for development as an antimalarial drug, i.e., if ED_{50} < 5-25 mg/kgBW (Sari *et al*., 2015). This indicates that alpha-mangostin in ACAN may exhibit significant antimalarial activity and warrants further investigation at higher doses or alternative administration routes.

The chitosan-alginate nanoparticles improve alpha-mangostin's water solubility and may enhance bioavailability and drug delivery. Moreover, advanced nanotechnologies offer a promising solution to reduce biological variability to counteract varied efficacy and safety, which becomes a challenge in drug design. These technologies may also be implicated in personalized medicine (Zhuo *et al*., 2024). Prior studies, such as the use of nano dendrimer G2 loaded with chloroquine, also showed that nanotechnology can enhance the activity and solubility of antimalarial drugs (Elmi *et al*., 2022). There are many other benefits of using nanotechnology for better drug design. Alpha-mangostin potentially also has many health benefits besides as an antimalarial, antioxidant, and anti-inflammatory, i.e, neuroprotective effect, antimicrobial, and anti-cancer property against many cancers: breast, colon, lung, pancreatic, hepatocellular, prostate cancer, also against leukemia by several mechanisms of action. But the lower water solubility and poor target selectivity become a challenge (Alam *et al*., 2023). Nanotechnology may also improve the performance of alpha-mangostin against it to overcome the poor drug-receptor interaction, poor bioavailability because of poor solubility, and potential systemic toxicity. The core and the surface of the nanoparticle may facilitate the drug delivery, and that's why they enhance therapeutic efficacy (Herdiana *et al*., 2021).

One of the components of ACAN is alginate. It is a product of brown algae or bacteria, and it is non-toxic, biodegradable, cheap, and safe to be consumed. It is a natural polysaccharide that has no immunogenic effect (Paques *et al*., 2014). Alginate may replace lactose for drug encapsulation because lactose may become a potentially allergenic agent. There is abundant alginate material in nature because of a large amount of algae in the marine environment. It also has many health benefits, such as enhancing insulin delivery and improving insulin resistance for diabetes management, a well-known weight loss treatment to enhance satiety, and most importantly thing is that alginate also has antioxidant activity (Puscaselu *et al*., 2020) which closely correlates with malaria pathogenesis and severity (Vasquez *et al*., 2021). Chitosan is another nanoparticle component of the ACAN. It has been reported that it has a low, non-toxic effect. Against humans, the toxicity has not been reported (Zoe *et al*., 2023). So, it is wise to have a toxicity test, especially an acute toxicity test, for this ACAN *in vivo*.

Alpha-mangostin's antioxidant properties (Susy Tjahjani & Widowati, 2013) may also provide added benefits in managing oxidative stress associated with malaria,

which closely correlates with disease severity (Vasquez *et al*., 2021). So, alpha-mangostin in ACAN acts as an antimalarial as well as an antioxidant, and it may potentially become an ideal combination. Another study also reported that antioxidant supplementation is recommended for malaria therapy (Gomes *et al*., 2022). It has great antioxidant activity through several mechanisms: as a direct free radical scavenger to purge several free radicals, such as peroxynitrite, singlet oxygen, as well as indirectly through the activation of the Nrf2 pathway to enhance endogenous enzymatic antioxidant production (Chen *et al*., 2018).

Because of the low enough ED_{50} of alpha-mangostin in the ACAN, which means a potential of antimalarial activity, it is recommended that further studies to determine the ED_{100} and studies using larger animals (such as primates) be carried out. For every new drug or new formulation of a drug, the toxicity needs to be kept in mind. According to previous studies, the oral LD_{50} (lethal dose 50) of alpha-mangostin in rats is between 1,250 - >2,000 mg/kgBW (Setyawati *et al*., 2023) and the therapeutic index is >10 (Tamargo *et al*., 2015). It means that alpha-mangostin itself is nearly a non-toxic compound, and this encourages further studies of it. Furthermore, as mentioned above, the toxicity test of alpha-mangostin in a new formulation (nanoparticle formulation) also needed to be studied, especially the acute toxicity test. Limitation of the Study: Since oxidative burst and several antimalarial drugs produce oxidative stress to kill the parasites (Vasquez *et al*., 2021). It is important to carefully consider whether administering an antimalarial drug with antioxidant activity would interfere with its antimalarial effects and reduce the parasite-killing efficacy, especially when it is used in combination with other antimalarial drugs.

Conclusion

Alpha-mangostin, when it is prepared in nanoparticles (specifically, alpha-mangostin chitosan-alginate nanoparticles), has been shown as the most suitable oral preparation antimalarial against *Plasmodium berghei*-infected mice with a low ED50. That's why further studies are needed to develop it.

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References

Alam, M., Rashid, S., Fatima, K., Adnan, M., Shafie, A., Akhtar, M.S., Ganie, A.H., Eldin, S.M., Islam, A., Khan, I., & Hassan, M.I., 2023. Biochemical Features and Therapeutic Potential of A-Mangostin: Mechanism of Action, Medicinal Values, and Health Benefits. *Biomedicine and Pharmacotherapy*, 163(January), pp.114710.

Chaijaroenkul, W., Thiengsusuk, A., Rungsihirunrat, K., Ward, S.A., & Na-Bangchang, K., 2014. Proteomics Analysis of Antimalarial Targets of Garcinia mangostana Linn. *Asian Pacific Journal of Tropical Biomedicine*, 4(7), pp.515–519.

Chen, G., Li, Y., Wang, W., & Deng, L., 2018. Bioactivity and Pharmacological Properties of A-Mangostin From The Mangosteen Fruit: A Review. *Expert Opinion on Therapeutic Patents*, 28(5), pp.415–427.

Chora, Â.F., Mota, M.M., & Prudêncio, M., 2022. The Reciprocal Influence of The Liver and Blood Stages of The Malaria Parasite's Life Cycle. *International Journal for Parasitology*, 52(11), pp.711–715.

Elmi, T., Ardestani, M.S., Motevalian, M., Hesari, A.K., Hamzeh, M.S., Zamani, Z., & Tabatabaie, F., 2022. Antiplasmodial Effect of Nano Dendrimer G2 Loaded with Chloroquine in Mice Infected with Plasmodium berghei. *Acta Parasitologica*, 67(1), pp.298–308.

Gomes, A.R.Q., Cunha, N., Varela, E.L.P., Brígido, H.P.C., Vale, V.V., Dolabela, M.F., de Carvalho, E.P., & Percário, S., 2022. Oxidative Stress in Malaria: Potential Benefits of Antioxidant Therapy. *International Journal of Molecular Sciences*, 23(11).

Habte, G., & Assefa, S., 2020. In Vivo Antimalarial Activity of Crude Fruit Extract of Capsicum frutescens Var. Minima (Solanaceae) against Plasmodium berghei -Infected Mice. *BioMed Research International, 2020.*

Hassett, M.R., & Roepe, P.D., 2019. Origin and Spread of Evolving Artemisinin-Resistant Plasmodium Falciparum Malarial Parasites

in Southeast Asia. *American Journal of Tropical Medicine and Hygiene*, 101(6), pp.1204–1211.

Herdiana, Y., Handaresta, D., Joni, I., Wathoni, N., & Muchtaridi, M., 2020. Synthesis of Nano-α Mangostin Based on Chitosan and Eudragit S 100. *Journal of Advanced Pharmaceutical Technology and Research*, 11(3), pp.95–100.

Herdiana, Y., Wathoni, N., Shamsuddin, S., & Muchtaridi, M., 2021. α-Mangostin Nanoparticles Cytotoxicity and Cell Death Modalities in Breast Cancer Cell Lines. *Molecules*, 26(17), pp.1–16.

John, O.D., Mouatt, P., Panchal, S.K., & Brown, L., 2021. Rind from Purple Mangosteen (Garcinia mangostana) Attenuates Diet-Induced Physiological and Metabolic Changes in Obese Rats. *Nutrients*, 13(2), pp.1–19.

Kuncoro, H., Widyawaruyanti, A., & Ersam, T., 2018. A-Mangostin Effect on Inhibition Development Stadium and Globin Accumulation Against Plasmodium Falciparum. *Pharmacognosy Journal*, 10(4), pp.783–788.

Lombard, M.C., N'Da, D.D., Tran Van Ba, C., Wein, S., Norman, J., Wiesner, L., & Vial, H., 2013. Potent in Vivo Anti-Malarial Activity and Representative Snapshot Pharmacokinetic Evaluation of Artemisinin-Quinoline Hybrids. *Malaria Journal*, 12(1), pp.1.

Mazhari, N., Nateghpour, M., Heydarian, P., Farivar, L., Souri, E., & Motevalli Haghi, A., 2018. In Vivo Anti-Malarial Activity of Heracleum Persicum Fruit Extract, in Combination With Chloroquine Against Chloroquine–Sensitive Strain of Plasmodium Berghei. *Iranian Journal of Public Health*, 47(6), pp.868–874.

Muchtaridi, M., Suryani, A.I., Wathoni, N., Herdiana, Y., Fouad, A., Mohammed, A., Gazzali, A.M., Lesmana, R., & Joni, I.M., 2023. Chitosan/ Alginate Polymeric Nanoparticle-Loaded α-Mangostin: Characterization, Cytotoxicity, and In Vivo Evaluation against Breast Cancer Cells. *Polymers*, 15, pp.1–24.

Paques, J.P., Van Der Linden, E., Van Rijn, C.J.M., & Sagis, L.M.C., 2014. Preparation Methods of Alginate Nanoparticles. *Advances in Colloid and Interface Science*, 209, pp.163–171.

Peters, W., Portus, J.H., & Robinson, B.L., 1975. The Chemotherapy of Rodent Malaria, XXII: The Value of Drug-Resistant Strains of P. Berghei in Screening For Blood Schizontocidal Activity. *Annals of Tropical Medicine and Parasitology*, 69(2), pp.155–171.

Puscaselu, R.G., Lobiuc, A., Dimian, M., & Covasa, M., 2020. Alginate: From Food Industry to Biomedical Applications and Management of Metabolic Disorders. *Polymers*, 12(10), pp.1–30.

Sari, S., Hafid, A.F., & Widyawaruyanti, A.T.Y., 2015. Antimalarial Activity of Multiple Dose and Single Dose Administration of Artocarpus Champeden Spreng. Stembark Extract on Plasmodium Berghei Infected Mice. *Jurnal Ilmu Kefarmasian Indonesia*, 13(1), pp.23–28.

Savjani, K.T., Gajjar, A.K., & Savjani, J.K., 2012. Drug Solubility: Importance and Enhancement Techniques. *ISRN Pharmaceutics*, 2012(100 mL), pp.1–10.

Setyawati, L.U., Nurhidayah, W., Khairul Ikram, N.K., Mohd Fuad, W.E., & Muchtaridi, M., 2023. General Toxicity Studies of Alpha Mangostin from Garcinia Mangostana: A Systematic Review. *Heliyon*, 9(5), pp.e16045.

Siddiqui, F.A., Liang, X., & Cui, L., 2021. Plasmodium Falciparum Resistance to ACTs: Emergence, Mechanisms, and Outlook. *International Journal for Parasitology: Drugs and Drug Resistance*, 16(January), pp.102–118.

Tamargo, J., Le Heuzey, J.Y., & Mabo, P., 2015. Narrow Therapeutic Index Drugs: A Clinical Pharmacological Consideration to Flecainide. *European Journal of Clinical Pharmacology*, 71(5), pp.549–567.

Tjahjani, S., 2017. Antimalarial activity of Garcinia mangostana L rind and its synergistic effect with artemisinin in vitro. *BMC Complementary and Alternative Medicine*, 17(1).

Tjahjani, S., Syafruddin, & Tjokropranoto, R., 2018. Interaction of Alphamangostin and Curcumin With Dihydroartemisinin as Antimalaria in Vitro. *IOP Conference Series: Earth and Environmental Science*, 125(1).

Tjahjani, S., & Widowati, W., 2013. Potensi Beberapa Senyawa Xanthone sebagai Antioksidan dan Anti-malaria serta Sinergisme dengan Artemisinin in Vitro. *J Indon Med Assoc*, 63(3), pp.95–99.

Tjahjani, S., Widowati, W., Khiong, K., Suhendra, A., & Tjokropranoto, R., 2014. Antioxidant Properties of Garcinia Mangostana L (Mangosteen) Rind. *Procedia Chemistry*, 13(2009), pp.198–203.

Upegui, Y., Robledo, S.M., Gil Romero, J.F., Quiñones, W., Archbold, R., Torres, F., Escobar, G., Nariño, B., & Echeverri, F., 2015. In vivo Antimalarial Activity of α-Mangostin and the New Xanthone δ-Mangostin. *Phytotherapy Research*, 29(8), pp.1195–1201.

Van der Vossen, A.C., Van der Velde, I., Smeets, O.S.N.M., Postma, D.J., Eckhardt, M., Vermes, A., Koch, B.C.P., Vulto, A.G., & Hanff, L.M., 2017. Formulating a Poorly Water Soluble Drug Into An Oral Solution Suitable For Paediatric Patients; Lorazepam as A Model Drug. *European Journal of Pharmaceutical Sciences*, 100, pp.205–210.

Vasquez, M., Zuniga, M., & Rodriguez, A., 2021. Oxidative Stress and Pathogenesis in Malaria. *Frontiers in Cellular and Infection Microbiology*, 11(November), pp.1–8.

Wathoni, N., Rusdin, A., Febriani, E., Purnama, D., Wahnidar, D., Azhari, S. Y., Panatarni, C., Joni, I.M., Lesmana, R., Motoyama, K., & Muchtaridi, M., 2019. Formulation and Characterization of α-Mangostin in Chitosan Nanoparticles Coated by Sodium Alginate, Sodium Silicate, and Polyethylene Glycol. *Journal of Pharmacy and Bioallied Sciences*, 11(supplement 4), pp.619–627.

WHO., 2021. World Malaria Report 2021. *World Malaria Report Geneva: World Health Organization.* Licence: CC.

Zhao, Y., Tang, G., Tang, Q., Zhang, J., Hou, Y., Cai, E., Liu, S., Lei, D., Zhang, L., & Wang, S., 2016. A Method of Effectively Improved α-Mangostin Bioavailability. *European Journal of Drug Metabolism and Pharmacokinetics*, 41(5), pp.605–613.

Zhuo, Y., Zhao, Y.G., & Zhang, Y., 2024. Enhancing Drug Solubility, Bioavailability, and Targeted Therapeutic Applications through Magnetic Nanoparticles. *Molecules*, 29(20), pp.1–35.

Zoe, L.H., David, S.R., & Rajabalaya, R., 2023. Chitosan Nanoparticle Toxicity: A Comprehensive Literature Review of in Vivo and in Vitro Assessments For Medical Applications. *Toxicology Reports*, 11(June), pp.83–106.

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Service Quality Perception and Service Satisfaction of COVID-19 Vaccination in Indonesia: A Participant's Vaccination Perspective

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Abstract

The COVID-19 vaccine is a crucial effort to break the chain of transmission of COVID-19. To achieve optimal, effective, and efficient results in community program implementation, monitoring and evaluation are essential. The purpose of this study was to evaluate the implementation of COVID-19 vaccination in Semarang. So, it was known that service quality perception, service satisfaction, and willingness to recommend vaccination to others. This study is an analytic observational study with a cross-sectional design in 2022. The total number of respondents was 512 people. Data collection was carried out directly by visiting respondents who had received COVID-19 vaccinations at public health centers and vaccination centers. The data obtained is then processed and analyzed with the final model using Binary Logistic Regression. Respondents with basic education (4.67 ± 0.449) and those using the collective registration mechanism (4.51 ± 0.495) showed a positive correlation with perceived service quality. Of the 9 procedural suitability items, 4 received higher satisfaction scores: staff asking about regular medication use (4.41 ± 0.612), confirmed COVID-19 history (4.42 ± 0.598), close contact history (4.42 ± 0.609), and post-vaccination observation for side effects (4.43 ± 0.608), all with p-value < 0.05. Overall, respondents were satisfied with the service quality, with 26.5% willing to recommend vaccination to others. This indicates that the COVID-19 vaccination service is running effectively and appropriately.

Introduction

The first Coronavirus Disease (COVID-19) vaccination in Indonesia was administered on January 13, 2021, as part of the government's flagship program to suppress the spread of the virus and reduce the severity of the disease (Kementerian Kesehatan, 2021). This program has been scientifically proven to be one of the most effective strategies in controlling the pandemic (Aziz *et al*., 2022; Sibanda and Haryanto, 2024). The initial vaccination strategy in Indonesia aligned with the recommendations of the World Health Organization (WHO), specifically prioritizing health workers operating in healthcare facilities. This approach aimed to protect them physically, ensure the continuity of healthcare services, and provide a sense of security to the broader community (World Health Organization, 2020).

At the beginning of the implementation of the vaccination policy, the issue that circulated in society was the public's distrust of the safety and *halal* issues of vaccines from a medical and religious perspective. So, to overcome this, the government's strategy was to release the results of vaccine tests that have been carried out by the Food and Drug Supervisory Agency (*BPOM*) and to release a halal fatwa from the Indonesian Ulema Council (*MUI*) (Majelis

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Ulama Indonesia, 2021). In addition, the Indonesian president became the first person to be injected with a vaccine to prove the safety of the vaccine content (Kementerian Kesehatan, 2021). This strategy has also been followed by regional heads to build public trust in vaccines. It is very important and highly dependent on the government's ability to communicate the benefits of vaccination and deliver vaccines safely and effectively (Mansoor, 2021; OECD, 2021).

Based on the initial trust-building strategy, the broader implementation of the national vaccination policy has played a vital role in strengthening public confidence in the effectiveness of COVID-19 vaccines. This has been strongly influenced by trust in health institutions and the government, which has been shown to significantly contribute to positive attitudes toward vaccination and increased public acceptance (Adhikari, Yeong Cheah and von Seidlein, 2022; Chung *et al*., 2022). Public accessibility to vaccination services and perceived benefits of vaccination have also been identified as key determinants of public willingness to participate in the immunization program (Akther and Nur, 2022). To facilitate public access and encourage participation, the Indonesian government has provided easily accessible vaccination centers, including community health centers (Puskesmas), hospitals, and temporary mass vaccination sites(World Health Organization, 2023). This strategy has proven effective, as reflected in the city of Semarang, Central Java, which received presidential recognition for achieving high vaccination coverage, 124.36% for the first dose and 112.30% for the second dose relative to the provincial target (Wulan, Widianawati and wahyuni, 2024) .

The high COVID-19 vaccination coverage achieved in Semarang was supported by innovative data management through a web-based platform known as Vaksinasi Terpadu COVID-19 Kota Semarang (VICTORI). (Prasetiyorini, Larasati and Lituhayu, 2022) Developed by the Semarang City Health Office (DKK), this platform was accessible to healthcare workers, health facilities, and the public, enabling more coordinated and efficient vaccination efforts across the city. Despite this success, no formal evaluation had yet been conducted to assess the quality of vaccination service delivery in Semarang, which limited efforts for continuous improvement. At the time this study was conducted in 2022, the COVID-19 pandemic was still ongoing, and the government had begun implementing the third (booster) dose of vaccination. In this context, ensuring high-quality vaccination services remains a crucial priority, not only from a technical standpoint but also from a psychological perspective. The uncertainty brought by the pandemic has triggered stress, loss of motivation, and a decline in physical health across all groups, including women and athletes (Sufyan *et al*., 2022; Hermahayu *et al*., 2022). Retrospective analyses from other countries have shown that effective vaccine rollout strategies, especially those supported by digital infrastructure and multisectoral coordination, can enhance public trust, promote equitable access, and strengthen the overall health system (Mathieu *et al*., 2021; Salvatore *et al*., 2022). Therefore, this study aimed to evaluate the implementation of COVID-19 vaccination services in Semarang during this critical period, focusing on healthcare service quality dimensions and public perceptions. The findings are expected to provide insights that support improvements in vaccination services and broader health system preparedness for future health crises.

Methods

This research is a cross-sectional study and was conducted in Semarang, Central Java, Indonesia. There are 37 community health centers, and we selected 8 community health centers representing geographic areas in the city and two vaccination centers coordinated by the Semarang Health Service. In this research, non-probability sampling techniques were used, especially convenience sampling techniques. Participants are people over 18 years who were vaccinated at the time this research was conducted (end of April to July 2022). while the study population is 18 years of age and over who have received the 2nd dose (until February 2022) in the study area, as many as 1,237,350 people (Dinas Kesehatan Kota Semarang, 2022). The minimum sample

size required after being calculated using Slovin's formula (margin of error, 5%) is 400 respondents. All subjects gave their informed consent for inclusion before they participated in this study. This study was conducted following the Declaration of Helsinki, and the protocol was approved by the Health Research Ethics Committee of Universitas Negeri Semarang (HERC number:199/KEPK/EC/2022).

The method used to recruit respondents is by identifying all people who meet the requirements and are willing to become respondents. After data collection, 513 questionnaires were collected. However, one was excluded because it was not filled out completely. So, the final total of questionnaires from respondents to be processed is 512. The number of questionnaires issued was small because there was a research team accompanying them during the questionnaire-filling period. A questionnaire consisted of five sections: respondent identity, condition of the current vaccination, compliance with vaccination procedures, quality perception, and satisfaction. The questions were developed by modification of the service quality questionnaire (*SERVQUAL*) by Parasuraman, healthcare service quality (*HEALTHQUAL*), and COVID-19 vaccination guidelines (for booster doses) (Berry, Parasuraman and Zeithaml, 1988; Lee, 2017). This modification was needed due to SERVQUAL is an instrument for service quality in general, and not specifically for health services. The HEALTQUAL is an instrument for measuring healthcare quality in hospitals. Due to these reasons, the modification was necessary for special health service programs like the COVID-19 vaccination program. All sections are closed-ended questions. We developed the questionnaire based on a discussion with a health officer in the Semarang City Health Office. Before collecting the main data, we trialed the questionnaire in a COVID-19 vaccination center in the study area with 30 respondents. The trial respondents were not included in the analysis of the main data.

All independent variables (respondents' characteristics, current vaccination condition, and compliance with vaccination procedures) are in categorical data, nominal and ordinal. The score of service quality perception was calculated by averaging all the aspects of the service quality perception score (continuous scale). After that, we did a normality test by Kolmogorov-Smirnov, and the result is not distributed normally. Next, we normalized the data using a data transformation test, but the data results were still not normal. So, we decided to use non-parametric tests. The Mann-Whitney analysis was carried out as a non-parametric test to find the significance of the difference between two averages, while the Kruskal-Wallis test was used as a non-parametric test to find the significance of more than 2 mean differences. Then, a non-parametric Mann-Whitney analysis was conducted to determine the correlation of procedure suitability with perceived quality and service satisfaction. Furthermore, bivariate analysis using Spearman was carried out to determine the correlation of overall satisfaction with perceptions of service quality. Finally, we analyze the existing variables with the final model using Ordinal Logistic Regression. All analyses were conducted using SPSS 22.0 (IBM Corporation, NY, USA)

Results and Discussion

The number of respondents who participated in this study was 512. Most respondents (63.5%) are male. There are 56.4% of respondents who have jobs with a low risk of being exposed to COVID-19, and 70.3% of respondents have received booster vaccines. The characteristics of the available respondents were then processed, and we correlated them with perceptions of quality and service satisfaction received by respondents. The results of the data processing are shown in Table 1.

The results of data processing shown in Table 1 show that respondents with basic education backgrounds perceive that the implementation of COVID-19 vaccination has been carried out with high service quality (4.67±0.449) compared to the perceptions of respondents with other educational backgrounds. Based on the results of the processing, the collective COVID-19 vaccination registration mechanism is perceived to be of higher quality by respondents than registering independently. Each category showed that gender, age, address, occupation, education,

TABLE 1. Characteristics of Research Respondents Correlation with Quality and Satisfaction

Characteristics Respondent		Number (%) Mean ± SD	Quality		Satisfaction	
			p-value	Mean ± SD	p-value	
Gender	Female	187 (36.5)	4,54 ± 0,507	0.076*	4.41 ± 0.592	0.445*
	Male	325 (63.5)	4,44 ± 0,571		4.35 ± 0.644	
Age Group	Adolescent	42 (8.2)	4,49 ± 0,564	0.115**	4.48 ± 0.505	0.570**
	Young adult	236 (46.1)	4,41 ± 0,586		4.39 ± 0.646	
	Adults	209 (40.8)	4,52 ± 0,520		4.33 ± 0.638	
	Older	25 (4.9)	4,59 ± 0,365		4.36 ± 0.490	
Domicile	Semarang City	432 (84.4)	4,47 ± 0,564	0.900*	4.37 ± 0.622	0.558*
	Outside Semarang City	80 (15.6)	4,50 ± 0,475		4.40 ± 0.648	
	High exposure risk of COVID-19	223 (43.6)	4,46 ± 0,585	0.671*	4.38 ± 0.609	0.998*
	Low exposure risk of COVID-19	289 (56.4)	4,49 ± 0,523		4.37 ± 0.638	
Education level	Basic Education	71 (13.9)	4,67 ± 0,449	0.000**	4.34 ± 0.696	0.45**
	Secondary Education	274 (53.5)	4,47 ± 0,549		4.35 ± 0.635	
	Higher Education	167 (32.6)	4,39 ± 0,574		4.43 ± 0.575	
Vaccine doses	One dose	27 (5.3)	4,46 ± 0,751	0.712**	4.33 ± 0.832	0.001**
	Two doses	125 (24.4)	4,44 ± 0,575		4.19 ± 0.668	
	Booster dose	360 (70.3)	4,49 ± 0,525		4.44 ± 0.580	
Vaccine type	Know the types of vaccines	498 (97.3)	4,47 ± 0,554	0.659*	4.38 ± 0.624	0.154*
	Unknown type of vaccine	14 (2.7)	4,47 ± 0,443		4.14 ± 0.663	
Vaccine location	Public Health Centre	329 (64.3)	4,48 ± 0,536	0.211**	4.36 ± 0.647	0.655**
	Vaccination Centre	121 (23.6)	4,42 ± 0,607		4.42 ± 0.602	
	Village/district	50 (9.8)	4,60 ± 0,461		4.34 ± 0.557	
	School/campus	12 (2.3)	4,39 ± 0,666		4.50 ± 0.522	

Vaccine	Cadre/Health worker	82 (16)	4,53 ± 0,480		4.39 ± 0.813	
	Village worker	140 (27.3)	4,50 ± 0,551		4.33 ± 0.568	
	School/Office/ Society/Organization	42 (8.2)	4,45 ± 0,747	0.361**	4.24 ± 0.617	0.122**
	Friends/relatives/family	125 (24.4)	4,42 ± 0,567		4.38 ± 0.577	
	Social media	123 (24)	4,47 ± 0,499		4.46 ± 0.590	
The rule of	Independent	61 (11.9)	4,23 ± 0,822		4.30 ± 0.587	
	Collective	451 (88.1)	4,51 ± 0,495	0.029*	4.38 ± 0.630	0.203*
How to register	Sign up directly	303 (59.2)	4,49 ± 0,478		4.39 ± 0.656	
	Through the website	127 (24.8)	4,46 ± 0,551		4.43 ± 0.542	
	Through the village cadre/devices	55 (10.7)	4,39 ± 0,692	0.378**	4.31 ± 0.605	0.085**
	School/office	27 (5.3)	4,47 ± 0,900		4.11 ± 0.641	

Note: *Mann-Whitney test; ** Kruskal-Wallis test; α = 0.05.
Source: Primary Data, 2023

vaccine type, vaccine location, vaccine information, registration mechanism, and registration method had the same satisfaction (α > 0.05). Respondents who received vaccine dose 2 (4.19 ± 0.668) and booster vaccine (4.44 ± 0.580) were more satisfied than respondents who received dose 1 vaccine (α < 0.05). The COVID-19 vaccination service has been running for a long time, from the first dose vaccination policy until the implementation of the third dose policy for all societies now. This study assesses the implementation of the COVID-19 vaccination received by society, both in terms of service quality and level of satisfaction based on the perspective of the service they received. The results showed that the respondents' characteristics, such as gender, age, and occupation, were not related to perceptions of service quality and satisfaction. This was in contrast with several previous studies, which showed that gender was statistically significantly associated with satisfaction with health services received (Onyeonoro *et al*., 2015; Rumi *et al*., 2021; Chen *et al*., 2016). Likewise, age and occupation correlated with the level of satisfaction with health services received (Chen *et al*., 2016; Jenkinson, 2002).

We found that the educational background of respondents was associated with their perception of service quality. The data showed that respondents with only a basic education (4.67 ± 0.449) reported a higher perception of service quality compared to those with higher educational attainment. This suggests that the level of education influences how individuals perceive and evaluate the quality of services they receive. Those with higher education tend to be more critical of their needs, leading to greater expectations and demands regarding the services provided. Consistent with our findings, previous studies have reported a correlation between patients' education levels and their perception of healthcare quality. Patients with lower education tend to accept healthcare services with fewer demands and often perceive the quality more positively (Munro and Duckett, 2016; Zhang *et al*., 2020). Another study found that countries with a greater proportion of highly educated adults also tend to have higher vaccination rates (Raghupathi & Raghupathi, 2020; Lupu & Tiganasu, 2024). Similar findings have been reported in various international studies, where

individuals with higher levels of education were more likely to hold elevated expectations and apply more rigorous standards when assessing healthcare services, often resulting in lower satisfaction or perceived quality (Alanazi *et al*., 2023; Yusefi *et al*., 2022; Lewis *et al*., 2004). This suggests that perceived service quality is shaped not only by the actual care delivered but also by patients' expectations and level of awareness regarding the healthcare system.

Based on the results of data analysis, it was found that the collective COVID-19 vaccination registration mechanism (4.51 ± 0.495) was perceived to be of higher quality than registering independently. In the context of the COVID-19 pandemic, vaccination is a war strategy in a country's national security emergency, so the collective mechanism is assessed and proven to be more effective than waiting for public awareness to vaccinate. This finding is reinforced by the results of a study on the legality of vaccination in the UK, which shows that voluntary vaccination is an inappropriate policy; thus, it is necessary to improve policies to implement mandatory collective vaccination in the context of a severe and vaccine-preventable pandemic outbreak (Cave, 2017). The satisfaction level of respondents who received booster doses of 4.49 ± 0.525 was higher than respondents who received doses 1 or 2. This happened because respondents had previous experience of being injected with vaccines, so that experience influenced the assessment of service satisfaction received. In line with this study, positive attitudes were shown by respondents who received booster vaccines because they believed booster vaccines could strengthen protection and prevent the severity of COVID-19 (Wang *et al*., 2022). However, research in Bangkok found the opposite fact that respondents' satisfaction with booster doses was low, which is caused by respondents already feeling enough with doses 1 and 2

TABLE 2. Scores of Item Conformance Procedures and Their Correlation with Quality and Satisfaction

No	The Suitability of Procedure		Number (%)	Quality		Satisfaction	
				Mean ± SD	p-value*	Mean ± SD	p-value*
1	Were you asked to complete your identity?	No	11 (2.1)	4,71 ± 0,342	0.130	4.55 ± 0.522	0.385
		Yes	501 (97.9)	4,47 ± 0,306		4.37 ± 0.627	
2	Did the staff measure your temperature before vaccination?	No	65 (12.7)	4,44 ± 0,432	0,080	4.35 ± 0.648	0.812
		Yes	447 (87.3)	4,48 ± 0,566		4.38 ± 0.623	
3	Did the staff measure your blood before vaccination?	No	9 (1.8)	4,72 ± 0,458	0,075	4.56 ± 0.527	0.400
		Yes	503 (98.2)	4,47 ± 0,551		4.37 ± 0.627	
4	Did the staff ask you about your allergy history?	No	51 (10.0)	4,53 ± 0,411	0,901	4.31 ± 0.510	0.248
		Yes	461 (90.0)	4,47 ± 0,564		4.38 ± 0.637	
5	Did the staff ask you about your previous medical history?	No	42 (8.2)	4,54 ± 0,406	0,812	4.26 ± 0.497	0.096
		Yes	470 (91.8)	4,47 ± 0,561		4.38 ± 0.635	
6	Did the staff ask you about your medication history regularly?	No	118 (23.0)	4,43 ± 0,518	0,093	4.26 ± 0.659	0.033
		Yes	394 (77.0)	4,49 ± 0,560		4.41 ± 0.612	
7	Did the staff ask you about your COVID-19 history?	No	105 (20.5)	4,46 ± 0,553	0,945	4.20 ± 0.699	0.003
		Yes	407 (79.5)	4,48 ± 0,550		4.42 ± 0.598	

No	The Suitability of Procedure		Number (%)	Quality		Satisfaction	
				Mean ± SD	p-value*	Mean ± SD	p-value*
8	Did the staff ask you about the close contact history with a COVID-19 suspect?	No	179 (35.0)	4,44 ± 0,529	0,198	4.28 ± 0.647	0.019
		Yes	333 (65.0)	4,49 ± 0,562		4.42 ± 0.609	
9	Were you asked to wait after being vaccinated to be observed (monitored) for side effects of the vaccine?	No	190 (37.1)	4,35 ± 0,540	0,000	4.28 ± 0.645	0.013
		Yes	322 (62.9)	4,55 ± 0,543		4.43 ± 0.608	

Note: *Mann-Whitney test with α 0.05
Source: Primary Data, 2023

Table 2 shows the perceived quality and satisfaction scores related to the scores for the procedure suitability items. Respondents who underwent an observation (monitoring) procedure for side effects after being vaccinated had a higher quality rating (4.55 ± 0.543) than respondents who did not undergo the procedure. From the 9 items on the suitability of the procedure, 4 items have more satisfaction than the other items, namely the procedures for staffs who ask for a history of taking drugs regularly (4.41 ± 0.612), procedures for staffs who ask for a confirmed history of COVID-19 (4.42 ± 0.598), procedures for staffs who asked for a history of close contact with patients with COVID-19 (4.42 ± 0.609), and the existence of an observation (monitoring) procedure for side effects after being vaccinated (4.43 ± 0.608) these four items had a p-value < 0.05. Respondents received vaccinations through several procedures that had been adapted to WHO recommendations. These procedures were then assessed and linked to the respondent's perceived quality and satisfaction. We found that, firstly, the procedure of asking for a history of routine drug consumption had a high level of satisfaction compared to respondents who did not receive the procedure. Second, the procedure for asking for a confirmed history of COVID-19 and the procedure for asking for a history of close contact with a person with COVID-19. These three findings indicate that respondents are satisfied with the vaccination service after going through safety procedures regarding several questions asked by officers related to their life history, especially their health. This finding is in line with previous research in which interpersonal interaction and empathy between patients and health workers are the strongest predictors of satisfaction with services received because of the formation of trust (Shan *et al*., 2016; Rumi *et al*., 2021). Other studies support this finding, emphasizing that health service quality is not solely dependent on technical execution, but also on how health personnel communicate and build trust with recipients. Therefore, a public health intervention must integrate broad-reaching education efforts with personalized, individual-level attention (Handayani *et al*., 2023).

The procedure for observing (monitoring) side effects after being vaccinated (4.43 ± 0.608) received the highest satisfaction rating from the respondents and was the only procedure that was considered quality compared to other procedures. The observation procedure shows the responsible attitude of the vaccination operator to the respondent so that the respondent feels safe in getting the vaccine they receive. Research in India also found the same thing, that the satisfaction of respondents who underwent the procedure for observing vaccine side effects was higher than those who did not undergo the procedure (Ukey *et al*., 2022). Individuals who underwent post-vaccination observation had a lower risk of post-acute COVID-19 syndrome (PASC), highlighting the importance of monitoring for long-term protection

TABLE 3. Score of Service Quality Perception Items and their Correlation with Overall Satisfaction.

	Service Quality Perception	Mean ± SD	p-value	*Spearman's Coef. Corr.*
1	Information on location, schedule, requirements, and vaccination procedures is clear and precise	4.51 ± 0.647	0.001	0.272
2	The quota/queue number for vaccination is easy for me to get	4.06 ± 1.306	0.001	0.161
3	Information on the flow of vaccination services is clear and precise	4.48 ± 0.737	0.001	0.343
4	The vaccination registration procedure is easy to do	4.56 ± 0.732	0.001	0.336
5	The vaccination waiting room is comfortable and clean	4.42 ± 0.775	0.001	0.349
6	The waiting room applies health protocols (has good air circulation and allows for social distancing)	4.42 ± 0.831	0.001	0.352
7	The injection site is comfortable, clean, and protects the privacy/ protects the genitals of vaccination participants	4.49 ± 0.756	0.001	0.347
8	Implementation of timely vaccination	4.49 ± 0.719	0.001	0.351
9	Queues for vaccine injections run regularly and quickly	4.51 ± 0.708	0.001	0.367
10	Staff answered well, quickly, and precisely when I needed information / asked questions	4.55 ± 0.660	0.001	0.346
11	Staff are capable and agile in their duties	4.60 ± 0.588	0.001	0.369
12	Staff check my health condition (screening) properly so that I feel safe to be vaccinated	4.58 ± 0.672	0.001	0.354
13	Staff perform the injection correctly	4.65 ± 0.596	0.001	0.314
14	Staff ensure that my data is entered into Care Protect correctly	4.49 ± 0.769	0.001	0.291
15	I have proof that I have been vaccinated	4.66 ± 0.622	0.001	0.187
16	After the injection, I was asked to wait for the vaccine reaction (observation)	3.81 ± 1.397	0.001	0.238
17	Vaccination staff are polite	4.61 ± 0.619	0.001	0.374
18	Vaccination staff are friendly	4.62 ± 0.632	0.001	0.379

Note: *Spearman test
Source: Primary Data, 2023

Table 3 shows the overall satisfaction score and its relationship to the scores for the perceived service quality items. Of the 18 items of service quality perception, all respondents were satisfied and very satisfied with the service quality (p-value < 0.05). Respondents were more satisfied with the item that the officer administered the injection correctly (4.65 ± 0.596) and obtained evidence of having been vaccinated (4.66 ± 0.622). We found that all respondents had a high level of satisfaction with the perceived quality of service received. From the 18 items of service quality perception, all respondents were satisfied and very satisfied with service quality (p-value < 0.05). The perception of service quality that gets the highest score is that the respondent receives proof of the vaccine after being injected. This happens because the proof of a vaccine or, in this case, a vaccine certificate is needed to complete various requirements for society sustainability in Indonesia, which is what makes people feel satisfied after getting the certificate. Please note that the policies that apply in Indonesia regarding all activities to prevent and spread COVID-19 are monitored through the Care-Protect application, such as the implementation of the COVID-19 vaccination. People who have been vaccinated will get a proof of certificate that appears in the Care-Protect application less than 24 hours after being injected. This makes the respondents feel satisfied as well as the vaccine service is of good quality. In addition, the benefits of using this application can be enjoyed by accessing various government public services. The usefulness of

TABLE 4. Multivariate Ordinal Logistic Regression Model Effects of Suitability of Vaccination Procedures and Services on Perception and Satisfaction of Vaccination Service Quality

Variable	Estimate	Std.Error	Sig.	Odds Ratio	95% Confidence Interval
Quality					
Were you asked to wait after being vaccinated to be observed (monitored) for side effects of the vaccine? [0]	-0.634	0.200		0.531	-1.026 – 0.242
Satisfaction					
Did the staff ask you about your COVID-19 history? [0]	-0.582	0.302	0.054	0.559	-1.174 – 0.010
The quota/queue number for vaccination is easy for me to get [1]	0.887	0.388	0.022	2.428	0.126 – 1.648
The vaccination waiting room is comfortable and clean [2]	-4.986	1.635	0.002	0.007	-8.192 - -1.781
Staff are capable and agile in their duties [4]	-1.112	0.485	0.022	0.329	-2.063 - -0.161
I have proof that I have been vaccinated [4]	0.992	0.447	0.026	2.697	0.116 – 1.868
Vaccination staff are friendly [4]	-1.366	0.571	0.017	0.255	-2.486 – 0.246

Source: Primary Data, 2023

the application makes the society satisfied with the service received

All dependent variables were subjected to multivariate testing using ordinal logistic regression. The test results show that seven variables have a significance of <0.05, which means they partially influence the perception of quality and satisfaction with COVID-19 vaccination services. Variables related to respondents' perceptions of quality and satisfaction with COVID-19 vaccination services are shown in Table 4. Based on the odds ratio in Table 4, respondents' perceptions of service quality tend to decrease by 0.53 times for respondents who are not asked to observe side effects after vaccination. In the service satisfaction category, respondents who received a proof certificate after being vaccinated increased their satisfaction trend by 2.69 times compared to those who did not receive proof of vaccination. Vaccine quotas that are difficult for respondents to obtain tend to reduce satisfaction by 2.42 times with vaccination services. In addition, waiting rooms that are uncomfortable and dirty tend to reduce satisfaction by 0.007 times compared to waiting rooms that are comfortable and clean. On the other hand, respondents who were not asked about their history of exposure to COVID-19 tended to decrease satisfaction by 0.05 times. Finally, when viewed from the perspective of vaccination service personnel, officers who are capable and agile increase the likelihood of respondent satisfaction by 0.32 times. Meanwhile, friendly officers also increased the tendency for respondent satisfaction by 0.25 times.

Finally, we found that the results of the multivariate ordinal logistic regression analysis showed that seven variables affect the tendency to increase respondents' perceived quality and satisfaction with COVID-19 vaccination. These variables were observed: side effects after vaccination, respondents who received a proof certificate after being vaccinated, vaccine quotas that are difficult for respondents, in addition, waiting rooms, respondents who were not asked about their history of exposure to COVID-19, vaccination staff who are capable, agile, and friendly. The physical comfort of the recipients of health services that are fulfilled is the main determinant of patient satisfaction (Jenkinson, 2002). Other research results show that aspects of administrative services, such as cleanliness of the waiting room, speed of service, and empathy from administrative officers, contribute greatly to patient satisfaction (Indarwati & Phuoc, 2018). In addition, emotional support,

such as empathy and positive attitudes from officers, also increased the level of satisfaction. Consistent with previous findings that public satisfaction with health center services is not only influenced by technical aspects, but also by clarity of procedures, fairness of service, and friendliness of officers (Sriatmi *et al*., 2018), and makes service recipients willing to recommend to others (Jenkinson, 2002).

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References

Adhikari, B., Yeong Cheah, P., & Von Seidlein, L., 2022. Trust is the Common Denominator for COVID-19 Vaccine Acceptance: A Literature Review. *Vaccine*, X(12), pp.1-10.

Akther, T., & Nur, T., 2022. A Model of Factors Influencing COVID-19 Vaccine Acceptance: A Synthesis of The Theory of Reasoned Action, Conspiracy Theory Belief, Awareness, Perceived Usefulness, and Perceived Ease of Use. *PLoS ONE*, 17(1), pp.1–20.

Alanazi, E., Alanazi, H., Alanazi, M., Alsadoun, A., Asiri, S., & Bahari, G., 2023. Quality Perceptions, Expectations, and Individual Characteristics among Adult Patients Visiting Primary Healthcare Centers in Saudi Arabia: A Cross-Sectional Study. *Healthcare*, 11(2), pp.208.

Aurelia, D., En Masrika, N.U., & Rahman, I., 2024. Vaccination with the Incidence of Post-Acute Sequelae COVID-19. *Jurnal Kesehatan Masyarakat*, 19(3), pp.462–470.

Aziz, M.H.N., Safaruddin, A.D.A., Hamzah, N.A., Supadi, S.S., Yuhao, Z., & Aziz, M.A., 2022. Modelling the Effect of Vaccination Program and Inter-state Travel in the Spread of COVID-19 in Malaysia. *Acta biotheoretica*, 71(1), pp.2.

Berry, L.L., Parasuraman, A., & Zeithaml, V.A., 1988. SERVQUAL: A Multiple-Item Scale for Measuring Consumer Perceptions of Service Quality. *Journal of Retailing*, 64(1), pp.12–40.

Cave, E., 2017. Voluntary Vaccination: The Pandemic Effect. *Legal Studies*, 37(2), pp.279–304.

Chen, H., Li, M., Wang, J., Xue, C., Ding, T., Nong, X., Liu, Y., & Zhang, L., 2016. Factors Influencing Inpatients' Satisfaction with Hospitalization Service in Public Hospitals in Shanghai, People's Republic of China. *Patient Preference and Adherence*, 10, pp.469–477.

Chung, R.Y.-N., Chung, G.K.-K., Chan, Y.-H., Lee, T.S.-K., Ho, E.S.-C., Chan, S.-M., Chen, J.-K., & Wong, H., 2022. Trust in Government and Compliance to COVID-19 Vaccination Policy. *Annals of Epidemiology*, 73, pp.48.

Dinas Kesehatan Kota Semarang., 2022. *Data Vaksinasi PerFaskes*. Kota Semarang.

Jenkinson, C., 2002. Patients' Experiences and Satisfaction with Health Care: Results of A Questionnaire Study of Specific Aspects of Care. *Quality and Safety in Health Care*, 11(4), pp.335–339.

Handayani, O.W.K., Zainafree, I., Farida, E., & Setyawati, V.A.V., 2023. Moving Education and Individual Education as of Communities Health Education Models in Health Emergency Conditions. *Jurnal Kesehatan Masyarakat*, 18(3), pp.416–422.

Hermahayu, H., Faizah, R., & Candra, A.R.D., 2022. The Psychological Impact of Covid-19 Restrictions on Athletes. *Jurnal Kesehatan Masyarakat*, 18(1), pp.130–138.

Indarwati, M., & Phuoc, P.T., 2018. Evaluation of Administrative Service Quality Towards JKN Patient Satisfaction. *Jurnal Kesehatan Masyarakat (KEMAS),* 14(1), pp.41–48.

Kementerian Kesehatan, 2021. *Program Vaksinasi COVID-19 Mulai Dilakukan, Presiden Orang Pertama Penerima Suntikan Vaksin COVID-19*.

Lee, D., 2017. Healthqual: A Multi-Item Scale for Assessing Healthcare Service Quality. *Service Business*, 11(3), pp.491–516.

Lewis, C.E., Woods, S.E., Lohr, J., Poynter, M., Engel, A.M., & Rusche, J., 2004. Level of Education and Patient Opinion: Significant Differences in Perceptions of Health Care. *Current Surgery*, 61(5), pp.504–510.

Lupu, D., & Tiganasu, R., 2024. Does Education Influence COVID-19 Vaccination? A Global View. *Heliyon*, 10(3), pp.e24709.

Majelis Ulama Indonesia., 2021. *Produk Vaksin Covid-19 Dari Sinovac life sciences Co.LTD. China dan PT. BIO Farma (Persero)*. Komisi Fatwa Majelis Ulama Indonesia.

Mansoor, M., 2021. Citizens' Trust in Government

as A Function of Good Governance and Government Agency's Provision of Quality Information on Social Media During COVID-19. *Government Information Quarterly*, 38(4), pp.101597.

Mathieu, E., Ritchie, H., Ortiz-Ospina, E., Roser, M., Hasell, J., Appel, C., Giattino, C., & Rodés-Guirao, L., 2021. A Global Database of COVID-19 Vaccinations. *Nature Human Behaviour*, 5(7), pp.947–953.

Munro, N., & Duckett, J., 2016. Explaining Public Satisfaction with Health-Care Systems: Findings from A Nationwide Survey in China. *Health Expectations*, 19(3), pp.654–666.

Nurmansyah, M.I., Rosidati, C., Yustiyani, Y., & Nasir, N.M., 2022. Measuring the Success of PeduliLindungi Application Use for Supporting COVID-19 Prevention: A Case Study among College Students in Jakarta, Indonesia. *Kesmas: Jurnal Kesehatan Masyarakat Nasional*, 17(sp1), pp.11–16.

OECD, 2021. *Enhancing Public Trust in COVID-19 Vaccination: The Role of Governments*. *OECD Science, Technology and Industry Policy Papers*.

Onyeonoro, U.U., Chukwu, J.N., Nwafor, C.C., Meka, A.O., Omotowo, B.I., Madichie, N.O., Ogbudebe, C., Ikebudu, J.N., Oshi, D.C., Ekeke, N., Paul, N.I., & Duru, C.B., 2015. Evaluation of Patient Satisfaction with Tuberculosis Services in Southern Nigeria. *Health Services Insights*, 8, pp.25–33.

Prasetiyorini, A.D., Larasati, E., & Lituhayu, D., 2022. Analisis Faktor-Faktor dalam Implementasi Website VICTORI di Dinas Kesehatan Kota Semarang. *Journal of Public Policy and Management Review*, 13(2), pp.1–10.

Raghupathi, V., & Raghupathi, W., 2020. The Influence of Education on Health: An Empirical Assessment of OECD Countries for the Period 1995-2015. *Archives of Public Health*, 78(1), pp.1–18.

Rumi, M.H., Makhdum, N., Rashid, M.H., & Muyeed, A., 2021. Gender Differences in Service Quality of Upazila Health Complex in Bangladesh. *Journal of Patient Experience*, 8, pp.1–6.

Salvatore, M., Purkayastha, S., Ganapathi, L., Bhattacharyya, R., Kundu, R., Zimmermann, L., Ray, D., Hazra, A., Kleinsasser, M., Solomon, S., Subbaraman, R. and Mukherjee, B., 2022. Lessons from SARS-CoV-2 in India: A Data-Driven Framework for Pandemic Resilience. *Science Advances*, 8(24), pp.1-10.

Shan, L., Li, Y., Ding, D., Wu, Q., Liu, C., Jiao, M., Hao, Y., Han, Y., Gao, L., Hao, J., Wang, L., Xu, W., & Ren, J., 2016. Patient Satisfaction with Hospital Inpatient Care: Effects of Trust, Medical Insurance and Perceived Quality of Care. *PLoS ONE*, 11(10), pp.1–18.

Sibanda, B., & Haryanto, B., 2024. Assessing the Impact of COVID-19 Vaccination Programs on the Reduction of COVID-19 Cases: A Systematic Literature Review. *Annals of Global Health*, 90(1), pp.1-10.

Sriatmi, A., Patriajati, S., & Fatmasari, E.Y., 2018. The Community Satisfaction and Participation of the Health Planning Process in Primary Health Care. *Jurnal Kesehatan Masyarakat (KEMAS)*, 14(2), pp.279–288.

Sufyan, D.L., Syah, M.N.H., & Nurbaya., 2022. Impact of COVID-19 Outbreak on Women Quality of Life in Indonesia. *Jurnal Kesehatan Masyarakat (KEMAS)*, 18(1), pp.67–73.

Ukey, U.U., Chaudhary, S.M., Sharma, S.K., Narlawar, U.W., Singh, R., & Dabir, A.J., 2022. Awareness and Satisfaction About COVAXIN Vaccination Services at an Immunization Clinic in Nagpur: A Cross-Sectional Study. *Cureus*, 2022, pp.1–9.

Wang, Z., Fang, Y., Yu, F.Y., Chan, P.S.F., Chen, S., & Sun, F., 2022. Facilitators and Barriers to Take up a COVID-19 Vaccine Booster Dose among Community-Dwelling Older Adults in Hong Kong: A Population-Based Random Telephone Survey. *Vaccines*, 10(6), pp.1-10.

World Health Organization., 2020. Ethics and COVID-19: Resource Allocation and Priority-Setting. *World Health Organization*, pp.1–5.

World Health Organization., 2023. *COVID-19 Vaccination Post Introduction Evaluation (cPIE) in Indonesia*. Jakarta.

Wulan, W.R., Widianawati, E., & Wahyuni, A.T., 2024. COVID-19 Vaccine Coverage Effectiveness Among Elderly with Geographical Information System Mapping: What About Indonesia? *Therapeutic Advances in Vaccines and Immunotherapy*, 12, pp.1-10.

Yusefi, A.R., Sarvestani, S.R., Kavosi, Z., Bahmaei, J., Mehrizi, M.M., & Mehralian, G., 2022. Patients' Perceptions of the Quality of Nursing Services. *BMC Nursing*, 21(1), pp.131.

Zhang, J.H., Peng, X., Liu, C., Chen, Y., Zhang, H., & Iwaloye, O.O., 2020. Public Satisfaction with The Healthcare System in China During 2013-2015: A Cross-Sectional Survey of The Associated Factors. *BMJ Open*, 10(5), pp.1-10.