Kesmas
Jurnal Kesehatan Masyarakat Nasional
(National Public Health Journal)
Quarterly Journal

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Kesmas

Volume 19
Issue 1 *February*

Article 1

2-29-2024

Implementation of Digital Health in Addressing Global Threats: Lessons from the Use of Technology during COVID-19 Pandemic in Indonesia

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Recommended Citation

Naili S, Anisa T, Kemal N S, et al. Implementation of Digital Health in Addressing Global Threats: Lessons from the Use of Technology during COVID-19 Pandemic in Indonesia. *Kesmas*. 2024; 19(1): 1-7
DOI: 10.21109/kesmas.v19i1.7053
Available at: https://scholarhub.ui.ac.id/kesmas/vol19/iss1/1

Shifa et al. *Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*. 2024; 19 (1): 1-7
DOI: 10.21109/kesmas.v19i1.7053

Kesmas: Jurnal Kesehatan Masyarakat Nasional (Kesmas: National Public Health Journal)

Implementation of Digital Health in Addressing Global Threats: Lessons from Technology Usage During the COVID-19 Pandemic in Indonesia

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Abstract

A systematic literature review was conducted to explore digital health implementation in Indonesia, focusing on digital health implementations during the COVID-19 pandemic, as well as benefits and lessons learned. A total of 10 relevant journals were identified through database searches and analyzed the trends in publications, productive journals, and top institutions involved in digital health studies. The findings revealed an increasing interest in digital health, with a growing number of published articles from 2021 to 2023. ScienceDirect emerged as the most productive journal, followed by PubMed and MDPI. Universitas Indonesia and Gadjah Mada University were the leading institutions in digital health studies in Indonesia. This study discussed digital health implementation during the pandemic, highlighting its role in epidemic surveillance, telemedicine services, and data systems for COVID-19 management. This study also emphasized the challenges faced in Indonesia's *3T* regions (remote areas) due to limited internet access and infrastructure. Overall, the findings contribute to understanding the digital health landscape in Indonesia and provide insights into its benefits and lessons learned.

Keywords: COVID-19, digital health, implementation, pandemic, telemedicine

Introduction

During the Coronavirus Disease 2019 (COVID-19) pandemic in the Southeast Asian region, there was a notable surge in internet usage, resulting in the identification of approximately 40 million new internet users.[1] COVID-19 is drives a significant increase in digital consumption as individuals explore new digital services. According to e-Conomy SEA 2020, the COVID-19 pandemic has led to the rapid growth of two sectors, including health technology.[2]

Information and communication technology for managing disease and health risks is called digital health. During a pandemic like COVID-19, digital health is not only crucial in preventing the transmission of the virus but is also anticipated to enhance accessibility to health services, minimize inefficiencies in the healthcare system, elevate the standard of care, reduce healthcare expenses, and offer healthcare and independent health tracking capabilities.[3]

The rapid digital acceleration has significantly influenced digital services, as 94% of newly acquired consumers express their intention to continue utilizing these services even after the pandemic subsides.[4] The pandemic has hastened the development of digital medical services to provide affordable and accessible healthcare.[4] Indonesia, as a Southeast Asian nation, faces challenges in terms of limited hospital accessibility and inadequate insurance coverage for digital health services. Consequently, leveraging digital technology in the realm of healthcare presents a viable solution to address health-related issues beyond the COVID-19 pandemic.[5]

The Blueprint for Digital Health Transformation Strategy 2024 outlines a schematic representation of key undertakings in health technology transformation, with a focal emphasis on three priority activities: the integration and advancement of health data systems, the integration and advancement of health application systems, and the establishment of digital health ecosystems.[6] The Indonesian Ministry of Communication and Informatics issued Decree No. 171 of 2020, which pertains to establishing the *PeduliLindungi* mobile application to facilitate health surveillance efforts for managing COVID-19. The decree designates the *PeduliLindungi* application as a complementary tool to aid in COVID-19 health surveillance.[7]

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Received : June 24, 2023
Accepted : January 02, 2024
Published : February 01, 2024

The implementation of the One Data initiative, as emphasized in the Indonesian Ministry of Health Regulation No. 21 of 2020, aims to improve the integration, interoperability, and utilization of government data. This initiative goes beyond internal use among institutions and also strives to meet the data needs of the public for the betterment of the community.[8] To maximize the efficacy of the *PeduliLindungi* application during the new normal era, Regulation No. 18 of 2022 by the Indonesian Ministry of Health mandates the implementation of One Health sector data through the Health Information System. Additionally, this regulation entails the incorporation of pertinent features and updates into the *PeduliLindungi* application, incorporating the concept of One Health.[9]

Based on this background, the authors embarked on a literature review to compile diverse studies focusing on enhancing digital transformation for optimal improvements. This study's primary objective was to garner a theoretical foundation and insights concerning digital health in Indonesia. This study involved a comprehensive examination of various aspects related to digital health in Indonesia. This included analyzing the implementation of digital health policies, the usage of digital health technologies during the COVID-19 pandemic, the benefits and advantages linked to the adoption of digital health solutions, and the valuable lessons learned from the experience of implementing digital health measures during the COVID-19 pandemic in Indonesia.

Method

This study employed a descriptive design and utilized a systematic literature review as its chosen methodology. A systematic literature review involved a rigorous and methodical examination of structured knowledge, ideas, or findings from previous studies that pertain to a specific subject. The primary goal of this study was to address study inquiries and provide solutions to the formulated study issues.

The objectives and questions were designed to align with the practical purpose of the systematic literature review, which was to gain a comprehensive understanding of digital health studies in Indonesia. This included exploring digital health implementation during the COVID-19 pandemic, identifying the benefits of adopting digital health solutions, and deriving insights from the experiences of implementing digital health measures in Indonesia during the COVID-19 pandemic. These objectives give rise to the following extensive study questions, such as: 1) How is digital health implemented in Indonesia? 2) What are the benefits and lessons learned from the implementation of digital health during the pandemic in Indonesia?

The literature search used search engines and databases, including Scopus, SAGE, ScienceDirect, ProQuest, and Portal Garuda. Data collection was performed by accessing the predetermined databases and conducting searches using keywords and Boolean operators (OR, AND, OR NOT, or AND NOT) to expand and specify the search, thus facilitating the identification of relevant journals or articles to be utilized. The database search utilized strings based on titles/abstracts and MeSH terms, serving as an initial step to explore study activities in the desired field and guide more focused study. The final Boolean search queries for this study were conducted on 10 June 2023.

At this stage, relevant articles and studies were selected, and the gathered literature was evaluated against the predefined inclusion and exclusion criteria aligned with this study's questions and objectives. The literature that met these criteria proceeded to the next screening phase. The inclusion criterias for the study are literature focuses on digital health; literature was written in Indonesian language or English; literature fell under the publication type of original, peer-reviewed, and published papers; the intervention in the study was related to the implementation of digital health; literature with or without a comparison of interventions was accepted; literature that could address study questions regarding the implementation of digital health during the pandemic in Indonesia; and literature published after January 2020. The exclusion criterias for this study are literature published in languages other than Indonesian language or English; literature fell under the publication type of editorial, interviews, commentaries, unstructured observations, and position papers; literature discussing the implementation of digital health during the pandemic in countries other than Indonesia; and literature published before January 2020. The literature was screened according to the inclusion and exclusion criteria.

In the selection process, irrelevant studies based on the title and abstract were excluded. However, in cases where there was uncertainty about whether to exclude a study, it was accepted for full-text screening. To ensure agreement among the authors, any discrepancies in their decisions were resolved through a consensus-building process.

The data identification involved searching, selecting, and assessing literature through online databases using predefined keywords. The literature assessment began with title selection, abstract screening, full-text view, and an examination of the objectives, methods, and findings. Subsequently, data extraction was performed from the identified literature by summarizing key points into an extraction table. This process allowed for the synthesis of extracted findings presented in the table. The synthesis stage involved consolidating the presented data into a cohesive set of study results.

The systematic selection and mapping process of all included reviews in the study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart, adhering to established standard data extraction

tools. The collected data underwent analysis and was summarized narratively, employing descriptive statistics presented in tables or graphs for each study objective. Microsoft Excel was utilized for calculating descriptive statistics and visualizing spatial data.

Results

A structured search through search strings based on the conceptual framework yielded 368,357 studies on implementation, 60,425 articles on digital health, and 2,568 publications on COVID-19 in Indonesia. The final Boolean search operation resulted in the identification of 58,626 relevant studies encompassing all three conceptual frameworks. The structured search strategies utilized in this study were based on MeSH Terms and included search strings related to implementation, digital health, and COVID-19 in Indonesia. The search string for each item are 1) "Implementation" OR "Health Plan" OR "Social Planning"; 2) "Digital Health" OR "eHealth" OR "Telemedicine" OR "Mobile Health" OR "Health Apps"; and 3) "COVID-19 in Indonesia".

From the initial pool of 58,444 studies, 49,701 duplicates were identified and removed. During the first selection stage, 8,879 studies were excluded based on title and abstract screening. Subsequently, in the second stage of full-text appraisal, 36 studies were further excluded. As a result, Figure 1 depicts the PRISMA flow diagram representing the final selection of ten reviews subjected to data extraction.

In this study, a standardized data extraction tool was employed to perform data mapping on all 10 reviews. The main objective was to assess the level of evidence provided by each review regarding all six endpoints. The results of this data mapping can be found in this URL (Appendix 1). This study identified ten journals that discuss digital health implementation in Indonesia. To answer the first and second study questions, a descriptive analysis was carried out to observe trends in published scientific articles, journals, and institutions actively involved in research in the field. Figure 2 illustrates the trend of increasing numbers of reviews over time. The data shows only one publication in 2021, but the number of reviewed articles grew to five in 2022.

Figure 2 shows that published articles increased from 2021 to 2023. This growth reflected the interest of academics and researchers in digital health. The growing trend also indicated that this trend will continue to increase in the coming years. Figure 3 displays the ten journals that have disseminated articles concerning digital health implementation in Indonesia during the COVID-19 pandemic. It was observed that ScienceDirect was the top journal with four publications in the field, followed by PubMed and MDPI with two articles each.

An exhaustive database search revealed that Universitas Indonesia and Gadjah Mada University stand out as the prominent institutions actively involved in conducting research related to the implementation of digital health in

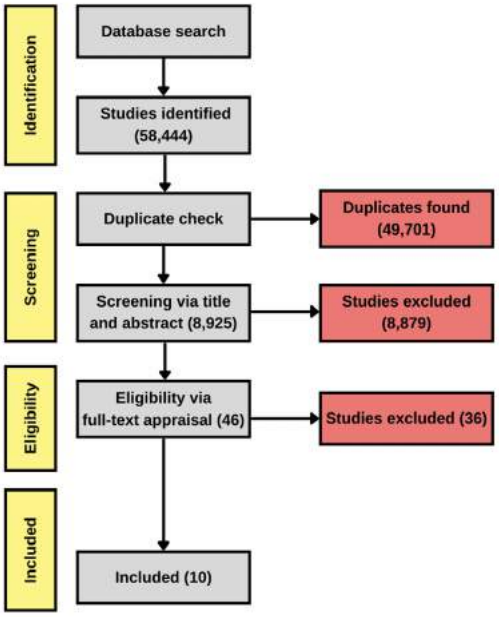

Figure 1. PRISMA Flow Diagram of the Selection

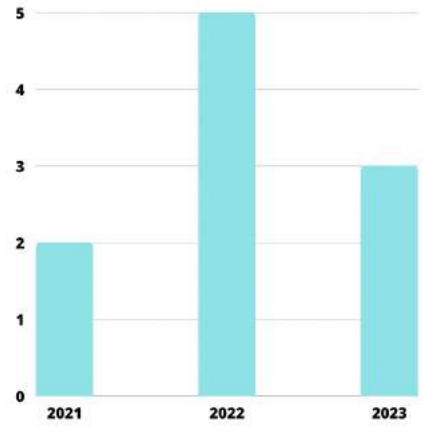

Figure 2. Simple Bar Chart Displaying the Number of Included Reviews by Year of Publication (n = 10)

Figure 3. Most Productive Journals (n = 10)

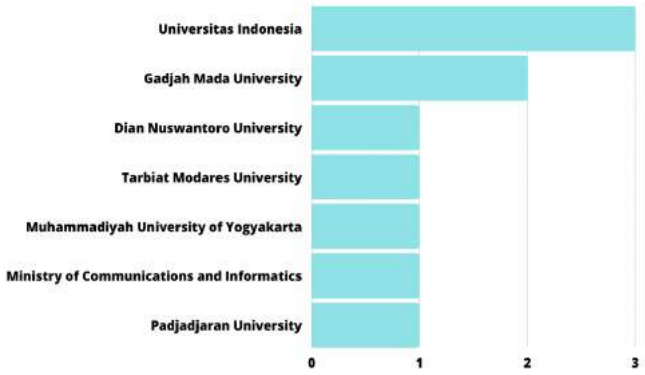

Figure 4. Top Institutions (n = 10)

Indonesia during the COVID-19 pandemic. Universitas Indonesia has contributed a total of three publications, while Gadjah Mada University has published two papers on this subject. It is worth noting that both of these institutions are based in Indonesia. Interestingly, this study also identified Tarbiat Modares University, an institute located in Tehran, Iran, as a contributor to the literature. Figure 4 illustrates the other institutions that made it to the top ten literature findings list.

Discussion

Digital Health Implementation During the COVID-19 Pandemic in Indonesia

Digital health plays a crucial role in improving the efficiency of health systems and expanding the availability of health services while maintaining affordability, which contributes to the advancement of universal health coverage. One such example is the enhancement of patient accessibility through digital interventions.[10] Digital health is utilized in epidemic surveillance as a highly effective approach to mitigate the transmission of COVID-19, as it enables swift and precise detection of infected individuals.[11] In China, collaborative efforts between government agencies and internet companies have resulted in the development of diverse applications for real-time monitoring of public health and individual behaviors. These applications are designed to accurately track and manage people's movements to enhance public health management.[12] Mobile data can serve as a crucial tool for tracking people's movements, aiding in identifying potential areas where the disease might spread.[13]

The partnership between the Indonesian Ministry of Health and eleven telemedicine platforms provided various services to COVID-19 patients, such as information services, consultations with doctors, and free delivery of medications. Digital health service applications across different provinces in Indonesia are classified into three groups: health services (comprising 63 services), health information systems (consisting of 82 systems), and helpdesk or customer management systems (including 51 types).[14]

Furthermore, to support patient treatment, two healthcare data systems have been developed, namely SIRANAP (inpatient information system) and Blood Plasma Donor. These digital technologies have been created through collaborative efforts involving the government, universities, and private sector partnerships, reflecting a multisectoral approach.[15] Throughout the COVID-19 testing phase, a comprehensive New All Record database, SILACAK, was established as an integrated system for recording COVID-19 test results and linking them with the national civil registration system.

Simultaneously, the Indonesian Ministry of Health introduced a telemedicine service to cater to COVID-19 patients who were self-isolating at home in response to the increased demand for consultations and the limited capacity of healthcare professionals to provide in-person consultations. The primary objective of this telemedicine service was to provide remote medical support to individuals in need during the pandemic.[16]

Implementing telemedicine in 3T/*tertinggal, terdepan, terluar* region (remote areas) faces various limitations, such as inadequate internet access, absence of a hospital management information system, strict telemedicine regulations and policies, health data protection commitment, HR constraints, and a lack of integrated systems. Nonetheless, the prospective success of telemedicine implementation in the 3T region is substantiated by the preexisting internet connectivity in most health facilities, coupled with the unwavering commitment of both the government and the private

sector to developing healthcare applications and regulations. According to a previous study, there were 13,011 health facilities, including 2,877 hospitals and 10,134 primary health care in 2019.[17] Among these, 3,126 health service facilities (24.03%) did not have internet access.[17] Despite this, people in the region have shown a growing interest in using the internet for health services, with 51.06% using it to find health information and 14.05% seeking consultations with health experts.[117]

Recently, there has been significant engagement from both the government and the private sector, particularly Indonesian startups, to advance the life science and healthcare domain. The primary focus of these efforts is to enhance healthcare services and accessibility while also integrating patient information. Additionally, the commitment aims to address potential challenges in the future healthcare industry proactively. This dedication has resulted in the development of numerous applications as concrete outcomes. Notably, the government has introduced applications like JKN Mobile, Digital Claim Verification, and Digital Acquired Immune Deficiency Syndrome Application, among others. Similarly, the private sector has contributed with applications such as Alodokter, GO-MED, Halodoc, K24Klik, KlikDokter, and others.[17]

Benefits and Lessons Learned from the Implementation of Digital Health During the Pandemic in Indonesia

The COVID-19 pandemic has imposed restrictions on regular community health services. Consequently, a pressing need for a flexible and inventive digital strategy within the health technology ecosystem has arisen.[18] Digital health literacy indicated the community's preparedness to embrace the digitization of the healthcare system. This aspect is of utmost importance due to the widespread dissemination of information through social media and the internet, which has led to the emergence of infodemics and consequently the dissemination of misinformation about COVID-19.

Such infodemics can worsen the pandemic as it becomes challenging for the public to access reliable sources to make well-informed health decisions, adversely affecting their overall health. To combat this, it is crucial to filter the infodemics through health literacy, specifically focusing on digital health literacy (DHL). A previous study revealed that all digital competence scores were below 4, highlighting the need for improvement in this area.[19] Low digital literacy reinforced infodemics. A DHL score of 4 indicated that the community needs guidance to engage in digital activities. The lowest competencies observed were in health-related content creation and safety, highlighting areas that require improvement to empower the community to navigate digital information responsibly during a pandemic.[19]

Age plays a pivotal role in acquiring and utilizing new technologies, owing to the physiological, cognitive, and sensory changes accompanying the aging process.[20] The elderly population often encounters difficulties embracing new technologies due to their limited technological proficiency. In contrast, younger generations, exposed to technology early on, form positive attitudes and beliefs, fostering a greater willingness to explore and employ novel technologies. Early exposure engenders a heightened comfort level with technology among the younger cohort, facilitating their seamless adaptation to emerging technological innovations.[20] Furthermore, individuals with more experience are likely to harbor favorable attitudes toward technology and acquire the necessary skills and knowledge to use it effectively. Conversely, those with less experience may require additional support to achieve proficiency and may exhibit reduced inclination toward technology adoption in the future.[20]

A study centered around nurses working in the outpatient department of a private hospital in western Indonesia found that 76% of the participating nurses perceived their level of knowledge concerning telemedicine operations to be moderate.[21] The study findings underscore the need to improve nurses' knowledge and proficiency in telemedicine, which can be achieved through education, training, and practical experience. By implementing telemedicine training programs, nurses are anticipated to enhance their understanding and confidence in utilizing telemedicine, ultimately fostering a positive attitude toward this innovative healthcare concept.[21]

A study focused on understanding the influence of user behavior and technological dimensions on the intention to use telemedicine applications in Indonesia found that various factors positively and significantly influence individuals' intention to use hospital telemedicine applications. These factors include the desire to avoid contamination, concerns about security and reliability, the perception of professionalism, ease of use, perceived benefits, and the quality of information the telemedicine applications provide.[22]

According to a previous study, most health professionals believe that healthcare applications can enhance their service activities with some improvements.[23] For example, the application should be accessible through smartphones since the surveyed health professionals express the belief that smartphones can facilitate their day-to-day tasks. If the application is intended for use in Indonesia, it is advisable to utilize and adapt the Indonesian language to Indonesian culture. This adaptation is deemed important by most health professionals in the study, as they perceive that linguistic and cultural customization can make the application usage process easier.[23]

According to user feedback from the prototype assessment, the average evaluation score for the application's pro-

totype, considering all material aspects, was 4.7, corresponding to a high 94.2% approval rate. These results suggested that the educational content and its implementation in the app were considered appropriate for patient education.[24]

Conclusion

This study emphasizes the importance of implementing digital health solutions in Indonesia during the COVID-19 pandemic. The integration of digital health technologies has proven to be crucial in enhancing the efficiency of the healthcare system, facilitating remote healthcare services, and bolstering epidemic surveillance through mobile applications and contact tracing tools. Collaboration between the government and telemedicine platforms has provided various digital health services, benefiting COVID-19 patients and supporting resource allocation. However, challenges in infrastructure and equitable access to digital health services persist, particularly in remote areas. Addressing these challenges and formulating supportive policies are essential to optimize digital transformation strategies and improve healthcare access in Indonesia in the future.

Abbreviations

COVID-19: Coronavirus Disease 2019; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; DHL: Digital Health Literacy.

Ethics Approval and Consent to Participate

Not Applicable.

Competing Interest

The authors declared no significant competing financial, professional, or personal interests that may affect the performance or presentation of the work described in this manuscript.

Availability of Data and Materials

All data and materials pertinent to the exemplary systematic review are publicly accessible through various databases, such as Scopus, SAGE, ScienceDirect, ProQuest, and Portal Garuda. Appendix 1 can be accessed here.

Authors' Contribution

NS was responsible for the manuscript, conceptualization, method (search strategy, study selection criteria, selecting studies, extracting studies, data analysis), and results; AT was responsible for conceptualization, introduction, analysis of the data, and results; KNS provided input and suggestions on the entire article.

Acknowledgment

Not Applicable.

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Kesmas

Volume 19
Issue 1 *February*

Article 2

2-29-2024

Daily Income Targets and Passenger Pressure on Safety Risky Riding Behavior Among Online Motorcycle Taxi Riders in Jakarta, Indonesia

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Recommended Citation

Zulkifli D, Agra M K, Azka H, et al. Daily Income Targets and Passenger Pressure on Safety Risky Riding Behavior Among Online Motorcycle Taxi Riders in Jakarta, Indonesia. *Kesmas*. 2024; 19(1): 8-17
DOI: 10.21109/kesmas.v19i1.7796
Available at: https://scholarhub.ui.ac.id/kesmas/vol19/iss1/2

Djunaidi et al. *Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*. 2024; 19 (1): 8-17
DOI: 10.21109/kesmas.v19i1.7796

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(Kesmas: National Public Health Journal)

Daily Income Targets and Passenger Pressure on Safety Risky Riding Behavior Among Online Motorcycle Taxi Riders in Jakarta, Indonesia

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Abstract

Online motorcycle taxi riders, a vulnerable group on the road, are more susceptible to serious injury than non-motorcycle riders. This study analyzed a correlation between daily income targets, passenger pressure, risk perception, safety attitudes, and risky riding behavior. This cross-sectional study used a semi-quantitative approach by collecting online-based questionnaires from 500 online motorcycle taxi riders in Jakarta, and 50 of them were obtained through offline interviews. The findings revealed a significant relationship between daily income targets, passenger pressure, risk perception (danger level, stochastic evaluation, and safety priority), safety attitudes (pragmatic attitude to rule violations and dissatisfaction with traffic rules), and risky riding behavior, with a p-value of <0.05. In particular, a pragmatic attitude to rule violations was the most impactful on risky riding behavior. Online motorcycle taxi companies should provide regular training on traffic laws and safe riding practices to improve road safety. This holistic approach may enhance safety through education, passenger awareness, and rigorous management.

Keywords: daily income target, passenger pressure, risk riding behavior, risk perception, safety attitude

Introduction

Motorcycles are the most popular mode of transportation in Asian countries, particularly Southeast Asia.[1] The number of motorcycles in Indonesia ranks the third largest in Southeast Asia. Thailand holds the top position among the Southeast Asian countries for having the highest number of motorcycles, with 87% of Thai households owning at least one motorcycle, followed by Vietnam in the second place.[1] According to data from the Indonesian National Police, as of January 2, 2024, 83.51% of motorized vehicles used in Indonesia were motorcycles, totaling around 159 million units.[2] Data from the Statistics Indonesia of Special Capital Region of Jakarta Province website shows that transportation in Jakarta, the capital and business city of Indonesia, is dominated by 79% of motorcycles, amounting to approximately 21 million units in 2022.[3] Advances in smartphone technology and internet connectivity have driven significant improvements in the transportation sector, especially in developing countries, with the introduction of online motorcycle taxi-hailing applications. These applications enable customers to order the nearest motorcycle taxi through an online platform.[4] Online motorcycle taxi services are in great demand in Indonesia as they offer flexible, reliable, and cost-effective mobility.

However, this situation has major safety implications as motorcycle riders are considered a vulnerable group on the road. When involved in an accident, motorcycle riders are more likely to suffer serious injuries than non-motorcycle riders due to the lack of protection for the vehicle's structure.[5] Serious injuries, as defined in the Model Minimum Uniform Crash Criteria 4th Edition, encompasses any injury other than a fatal one that leads to one or more of the following conditions: severe laceration resulting in the exposure of underlying tissues, muscles, or organs or causing significant blood loss; broken or distorted extremity (arm or leg); crush injuries; suspected skull, chest, or abdominal injuries (excluding bruises or minor lacerations); significant burns (second and third-degree burns covering 10% or more of the body); unconsciousness at the crash scene; and paralysis.[6] The World Health Organization reports that traffic accidents result in the loss of 1.35 million lives annually, ranking it as the eighth cause of death worldwide.[7] In

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Received : November 29, 2023
Accepted : January 29, 2024
Published : February 01, 2024

Indonesia, 74% of traffic accident-related deaths involve riders of two and three-wheeled motorcycles.[7] Based on the 2021 Statistics Indonesia of Special Capital Region of Jakarta Province report, a total of 4,507 motorcycle riders became traffic accident victims in Jakarta.[8]

Online motorcycle taxi services are also not immune from traffic accidents. Online motorcycle taxi riders are more susceptible to traffic accidents for more frequent rides compared to private motorcycle riders.[4] Furthermore, customers potentially influence the behaviors of online motorcycle taxi riders. Several studies from South Korea,[9] and China,[10] concluded that couriers often violated traffic rules to reach their destinations faster. A study involving 602 online motorcycle taxi riders in Vietnam indicated that 183 riders were involved in accidents, with 78.1% occurring due to risky riding behavior.[4] Another study on risky behavior among 328 motorcycle riders in Bali Province, Indonesia, revealed that 30% of riders often changed lanes to overtake other vehicles, almost 20% often ran red lights, and 10% of riders often engaged in distractions (using phones) while riding.[11]

Previous studies confirmed a correlation between risk perception, safety attitudes, and risky riding behavior. A study involving 621 riders in China showed that risk perception was significantly associated with risky riding behavior.[12] Riders with a higher level of risk perception were likely to avoid risky behaviors and took preventive measures against accidents, such as reducing vehicle speed.[13] Safety attitudes while riding are related to the riders' approaches to traffic rules and violation of the rules.[14]

In Indonesia, studies on riding behavior among motorcycle riders have been conducted in several provinces, such as Nanggroe Aceh Darussalam,[15] West Java,[16] Special Region of Yogyakarta,[16] East Java,[16] and Bali.[11] However, these studies did not specifically analyze which dimensions of risk perception and safety attitudes influence risky riding behavior. Additionally, most of them examined motorcycle riders (private motorcyclists), and only a few focused on those riders who use motorcycles for a living (e.g., online motorcycle taxi riders). Therefore, this study aimed to address these gaps through the following objectives: (1) to analyze a relationship between dimensions of risk perception (danger level, concern degree, stochastic evaluation, safety priority, and safety riding knowledge) and risky riding behavior among online motorcycle taxi riders in Jakarta in 2023; (2) to explicate a relationship between dimensions of safety attitudes (pragmatic attitudes to rule violations, attitudes to motorcyclist rule enforcement, and dissatisfaction with traffic rules) and risky riding behavior among online motorcycle taxi riders in Jakarta, 2023; and (3) to assess the influence of income targets and passenger pressure on the risky riding behavior among online motorcycle taxi riders in Jakarta in 2023. The study findings may assist the Special Capital Region of Jakarta provincial government in determining strategies to improve and enhance traffic safety, particularly among online motorcycle taxi riders while on the road.

Method

This cross-sectional semi-quantitative study took place in Jakarta from June to August 2023. The data were collected through online questionnaires distributed among the Jakarta online motorcycle taxi social media groups and offline interviews by approaching participants directly. The minimum sample size was calculated using the Lemeshow formula (Formula 1) to ensure accurate study findings.

The Lemeshow formula was used due to the absence of precise data on the exact number of online motorcycle taxi riders in Jakarta or Indonesia.[17] The minimum sample size required for this study based on the calculation was 384 samples. However, the questionnaires were distributed online to 500 online motorcycle taxi riders operating in Jakarta to ensure a more representative outcome, and 50 of them were interviewed offline. Before filling in the questionnaires, participants signed an informed consent form to confirm their conscious and voluntary participation in the survey.

The questionnaires were translated and tested for validity and reliability among online motorcycle taxi riders. The validity of questionnaire items was determined by comparing the calculated R with the tabulated R; if the calculated R more than the tabulated R, the item was considered valid. The calculated R ranged between 0.206 and 0.7211, while the tabulated R-value was 0.1966. The test results showed that all items had a composite reliability index value of Cronbach Alpha 0.907 (>0.6), indicating the questionnaire is reliable.

The respondent's identity questionnaire was applied to gather sociodemographic information. The Motorcycle Rider Behavior Questionnaire, modified by Chouchan et al.[18] was adopted to obtain information on risky riding behavior. This questionnaire comprises four dimensions: traffic errors, control errors, speed violations, and stunts. The

$$n = \frac{z^2_{1-\alpha/2} P\,(1-P)}{d^2}$$

Formula 1. Lemeshow Formula for the Minimum Sample Size Calculation

$$Range = \frac{\text{Maximum value} - \text{Minimum value}}{2}$$

Formula 2. Categorizing of Likert Scale Response Formula

Motorcycle Rider Behavior Questionnaire comprises a total of 32 items, with responses rated on a 4-point Likert scale: never (1), rarely (2), often (3), and always (4). The Riding Risk Perception Questionnaire, adapted from Wang et al.[17] consists of three dimensions: danger level, concern degree, and stochastic evaluation. The questionnaire included two additional dimensions: safety priority and safety riding knowledge.

The safety priority dimension comprises three items related to how daily income targets and passenger pressure influence the rider's safety priorities.[10,19] The safety riding knowledge dimension is structured based on literature review findings, resulting in two items related to either online motorcycle taxi riders receiving training on safe riding practices from the online taxi service providers or perhaps learning some riding principles through mass media.[20] The questionnaire consists of 16 items, with responses rated on a 4-point Likert scale ranging from strongly disagree (1), disagree (2), agree (3), to strongly agree (4).

The Safety Attitudes Questionnaire was adapted from the study by Kummeneje and Rundmo,[14] comprising three dimensions: pragmatic attitudes to rule violations, attitudes to motorcyclist rule enforcement, and dissatisfaction with traffic rules. The questionnaire consists of a total of 9 items. Responses to the questionnaire are rated on a 4-point Likert scale ranging from strongly disagree (1), disagree (2), agree (3), to strongly agree (4).

This study used a structured approach for data analysis. Univariate analysis was performed to explore each variable's data distribution and frequency. A bivariate analysis was conducted using a Chi-square test to determine the relationship between the variables. Data recording was done using median data. A simple approach was adopted to categorize Likert scale responses (Formula 2).

After calculating the maximum and minimum values on the Likert scale, a range of 2.5 was obtained, which can be interpreted as the boundary between the respondents' answers on a Likert scale. The analysis then used multiple linear regression with risky behavior as the dependent variable and risk perception, safety attitudes, income targets, and passenger pressure as independent variables. The aim was to comprehend the factors influencing risky behaviors among motorcycle taxi riders in Jakarta.

Results

Results of the study, derived from 500 online motorcycle taxi riders as respondents, provide an overview of the distribution of individual characteristics (such as sex, education, age, motorcycle type, motorcycle riding experience, and work period), risk perception, safety attitude, and risky riding behavior, as shown in Table 1. Most respondents were male with 447 (89.4%) respondents, secondary level-educated, including junior and senior high school levels with 412 (82.4%) respondents, and in the youth category with 347 (69.4%) respondents. A total of 395 (79.0%) respondents used automatic motorcycles, had a riding experience for 10 years or longer with 233 (46.6%) respondents, and worked

Table 1. Overview of Individual Characteristics, Risk Perception, Safety Attitude, and Risky Riding Behavior of Online Motorcycle Taxi Riders in Jakarta, 2023 (n = 500)

Variable	Category	n	%
Sex	Male	447	89.4
	Female	53	10.6
Education	Elementary	14	2.8
	Secondary	412	82.4
	Higher	74	14.8
Age	Youth (<35 years)	347	69.4
	Middle-aged (35–55 years)	129	25.8
	Senior (>55 years)	24	4.8
Motorcycle type	Automatic	395	79.0
	Manual	105	21.0
Motorcycle riding experience	Novice (≤3 years)	70	14
	Intermediate (4–9 years)	197	39.4
	Experienced (10 years)	233	46.6
Work period	≤5 years	431	86.2
	>5 years	69	13.8
Risk perception	Good	360	72.0
	Bad	140	28.0
Safety attitude	Positive attitude	437	87.4
	Negative attitude	63	12.6
Risky riding behavior	At risk	42	8.4
	Not at risk	458	91.6

as online motorcycle taxi riders for five years or less with 431 (86.2%) respondents.

The study found that 72.0% of respondents had good risk perception, which means that the respondents understood potential dangers and risks they might face while riding. Almost all the respondents (91.6%) exhibited non-risky riding behavior. This evaluation process involved positive or negative assessments of an object and was referred to in the literature as "attitude."

Risk Perception

Most online motorcycle taxi riders, totaling 433 (86.6%) respondents, were aware of traffic situations and riding activities as potentially risky for riders and other road users. Then, 357 (71.4%) respondents felt concerned about accident-related risks, riding behaviors, or a specific traffic environment. Many perceived possible risks while riding, as 283 (56.6%) online motorcycle taxi riders estimated the potential losses that might occur while riding a motorcycle. A total of 329 (65.8%) did not prioritize safety. However, 328 (65.6%) respondents had received a safe riding-related education or training that could help minimize errors and improve traffic skills (Table 2).

Safety Attitude

Regarding the safety attitude variable, this study observed 433 (86.6%) respondents opposing a pragmatic attitude to the rule violation. A total of 320 (64.0%) respondents opposed current motorcyclist rule enforcement. The respondents here perceived that the existing supervision and rules were inadequate. Also, intensified monitoring and stricter penalties for riders violating the rules were needed.

Risky Riding Behavior

Of all the respondents, 444 (88.8%) rarely made traffic errors and indicated paying attention to the road users and traffic signs, thereby minimizing traffic errors. Regarding control errors, 90.6% of the total respondents rarely or did not encounter control errors and had reasonable control over the motorcycle while riding.

Of the 500 respondents, 65.8% set the income targets, which led to driving late at night and risking their safety (Table 3). In addition, 60.2% of respondents fastened their speed of riding upon their passengers' requests, violated the traffic rules, and disregarded safety. A total of 50 online motorcycle taxi riders were interviewed offline in September 2023, which aimed to delve deeper into understanding the impact of daily income targets and passenger pressure on risky riding behavior. The respondents expressed their dedication to work despite facing challenging situations. Most respondents continued to work despite being tired and often worked overtime to meet their family's financial needs.

Table 2. Overview of IRisk Perception, Safety Attitude, and Risky Riding Behavior Dimensions (n = 500)

Element	Variable	Category	n	%
Risk perception	Danger level	Alert	433	86.6
		Not alert	67	13.4
	Concern degree	Worried	143	28.6
		Not worried	357	71.4
	Stochastic evaluation	Possible	283	56.6
		Impossible	217	43.4
	Safety priority	Priority	171	34.2
		Not a priority	329	65.8
	Safety riding knowledge	Understand	328	65.6
		Not understand	172	34.4
Safety attitude	Pragmatic attitude to rule violation	Support	67	13.4
		Oppose	433	86.6
	Attitude to motorcyclist rule enforcement	Support	180	36.0
		Oppose	320	64.0
	Dissatisfaction with traffic rules	Satisfied	279	55.8
		Dissatisfied	221	44.2
Risky riding behavior	Traffic error	Error	56	11.2
		Not error	444	88.8
	Control error	Error	47	9.4
		Not error	453	90.6
	Speed violation	Violate	82	16.4
		Comply	418	83.6
	Stunt	Extreme	45	9.0
		Not extreme	455	91.0

Table 3. Overview of Daily Target Income and Passenger Pressure (n = 500)

Variable	Category	n	%
Daily target income	Forcefully	329	65.8
	Not forcefully	171	34.2
Passenger pressure	Accept request	301	60.2
	Dismiss request	199	39.8

Table 4. Relationships Between Individual Characteristics, Risk Perception, and Safety Attitudes Including Each Dimension of Risky Riding Behavior

Variable	Category	Risky Riding Behavior						OR (95% CI)	p-value
		At Risk		Not at Risk		Total			
		n	%	n	%	n	%		
Sex	Male	38	8.5	409	91.5	447	100	1.138 (0.390–3.325)	1.000
	Female	4	7.5	49	92.5	53	100		
Education	Elementary	5	35.7	9	64.3	14	100		
	Secondary	29	7	383	93	412	100	–	0.001
	Higher	8	10.8	66	89.2	74	100		
Age	Youth (<35 years)	32	9.2	315	90.8	347	100	–	0.573
	Middle-aged (35-55 years)	8	6.2	121	93.8	129	100		
	Senior (>55 years)	2	8.3	22	91.7	24	100		
Motorcycle type	Automatic	27	6.8	368	93.2	395	100	0.440 (0.225–0.862)	0.025
	Manual	15	14.3	90	85.7	105	100		
Motorcycle riding experience	Novice (≤3 years)	5	7.1	65	92.9	70	100	–	0.712
	Intermediate (4-9 years)	19	9.6	178	90.4	197			
	Experienced (≥10 years)	18	7.7	215	92.3	233	100		
Work period	≤5 years	23	12.2	165	87.8	188	100	2.150 (1.137–4.064)	0.026
	>5 years	19	6.1	293	93.9	312	100		
Danger level	Alert	23	34.3	44	65.7	67	100	11.390 (5.756–22.538)	<0.001
	Not alert	19	4.4	414	95.6	433	100		
Concern degree	Worried	7	4.9	136	95.1	143	100	0.474 (0.205–1.092)	0.107
	Not worried	35	9.8	332	90.2	357	100		
Stochastic evaluation	Possible	11	5.1	206	94.9	217	100	0.434 (0.213–0.885)	0.029
	Impossible	31	11.0	252	89.0	283	100		
Safety priority	Priority	4	2.3	167	97.7	171	100	5.452 (1.912–15.544)	0.001
	Not priority	38	11.6	291	88.4	329	100		
Safety riding knowledge	Understand	28	8.5	300	91.5	328	100	0.949 (0.486–1.855)	1.000
	Not understand	14	8.1	158	91.9	172	100		
Pragmatic attitude to rule violation	Support	29	43.3	38	56.7	67	100	24.656 (11.839–51.348)	<0.001
	Oppose	13	3.0	420	97.0	433	100		
Attitude to motorcyclist law enforcement	Support	13	7.2	167	92.8	180	100	0.781 (0.395–1.544)	0.586
	Oppose	29	9.1	291	90.9	320	100		
Dissatisfaction with the traffic rules	Satisfied	6	2.2	273	97.8	279	100	8.854 (3.657–21.436)	<0.001
	Dissatisfied	36	16.3	185	83.7	221	100		
Passenger pressure	Accept request	37	12.3	264	87.7	301	100	5.438 (2.099–14.090)	<0.001
	Dismiss request	5	2.5	194	97.5	199	100		
Daily income target	Forcefully	37	11.2	292	88.8	329	100	4.207 (1.622–10.912)	0.003
	Not forcefully	5	2.9	166	97.1	171	100		

Notes: OR = Odds Ratio, CI = Confidence Interval

Riders frequently complied with passengers' requests, mainly due to concerns about their ratings. Their compliance stemmed from fears of a negative impact on their ratings, significantly affecting the frequency of their orders. These riders had often received requests from customers to speed up their rides, especially when passengers were late for work. Understanding that their performance was judged based on customer ratings, they tended to comply. This means that there were significant impact of passenger pressure on the decisions and behavior of online motorcycle taxi riders, and was a crucial factor in their performance.

Individual Characteristics and Risky Riding Behavior

The analysis showed that education (p-value = 0.001), type of motorcycle (p-value = 0.025), and work period as an online motorcycle taxi rider (p-value = 0.026) were significantly related to risky riding behavior, which met a criterion

of p-value<0.005 (Table 4). Online motorcycle taxi riders with higher education performed better safety perceptions. Respondents with automatic motorcycles had a 0.44-fold likelihood of exhibiting risky riding behavior compared to respondents with manual motorcycles. Those with ≤5 years of working experience had a 2.1 times likelihood of exhibiting risky riding behavior. Sex, age, and motorcycle riding experience did not have a significant relationship with risky riding behavior.

Risk Perception and Risky Riding Behavior

The risk perception dimensions significantly associated with risky riding behavior were danger level (p-value < 0.001), stochastic evaluation (p-value = 0.029), and safety priority (p-value = 0.001), with each demonstrating a p-value < 0.05. Respondents with a "not alert" risk perception had an 11.39-fold likelihood of exhibiting risky riding behavior. The stochastic evaluation results showed that those who perceived an "impossible" risk to stochastic evaluation had a 0.434-fold likelihood of exhibiting risky riding behavior. The analysis results for safety priority indicated that respondents who did not prioritize safety had a 5.45-fold likelihood of exhibiting risky riding behavior compared to respondents who did. In essence, riders with higher safety priorities were less likely to engage in risky riding behavior, mainly due to a more positive attitude toward traffic safety.

Safety Attitude and Risky Riding Behavior

The analysis showed that pragmatic attitudes to rule violations and dissatisfaction with traffic rules were significantly related to risky riding behavior with a p-value < 0.001, meeting a criterion of p-value < 0.005. Riders with a pragmatic attitude to violating rules were 24.6 times more likely to exhibit risky riding behavior. Dissatisfaction with traffic rules increased the likelihood of risky riding behavior by 8.85 times.

Daily Income Target, Passenger Pressure, and Risky Riding Behavior

The study found a significant relationship between daily income targets (p-value < 0.001), passenger pressure (p-value = 0.003), and risky riding behavior, meeting a criterion of p-value < 0.005. The respondents fastening their speed at passengers' requests were 5.4 times more likely to exhibit risky riding behavior. Similarly, respondents pushing for income targets were 4.2 times more likely to exhibit risky riding behavior.

Based on Table 5, the online motorcycle taxi riders prioritizing daily income targets and complying with passengers' requests to fasten their speed were significantly less likely to prioritize safety while riding (OR values: 54.902 and 62.749, respectively). Pragmatic attitudes to rule violations and dissatisfaction with the traffic rule were the most dominant elements affecting risky riding behavior (p-value < 0.005). Riders with supportive attitudes to rule violations were 16.3 times more likely to engage in risky riding behavior, while those dissatisfied with traffic rules were 4.3 times

Table 5. Relationships Between Daily Income Target and Passenger Pressure on Safety Priority

Variable	Category	Safety Priority						OR (95% CI)	p-value
		Priority		Not Priority		Total			
		n	%	n	%	n	%		
Daily income target	Forcefully	28	8.5	301	91.5	329	100	54.902 (31.349–96.151)	<0.001
	Not forcefully	143	83.6	28	16.4	171	100		
Passenger pressure	Accept request	16	5.3	285	94.7	301	100	62.749 (34.276–114.874)	<0.001
	Dismiss request	155	77.9	44	22.1	199	100		

Notes: OR = Odds Ratio, CI = Confidence Interval

Table 6. Interconnected Impact of Risk Perceptions and Safety Attitudes on Risky Riding Behavior

Variable	B	SE	p-value	OR	95% CI
Pragmatic attitude to rule violations	2.675	0.393	0.000	14.515	6.721–31.349
Dissatisfaction with the traffic rules	1.330	0.491	0.007	3.783	1.445–9.903
Passenger pressure	0.956	0.532	0.072	2.600	0.917–7.372

Notes: B = Regression Coefficient, SE = Standard Error, OR = Odds Ratio, CI = Confidence Interval

more likely to do so. However, the variable of passenger pressure did not significantly influence risky riding behavior, as the p-value did not reach the significance criterion of <0.005.

Discussion

The major study finding indicated that 458 respondents (91.6%) demonstrated non-risky or rather safe riding behaviors. This finding suggested that a significant portion of the studied online motorcycle taxi riders in Jakarta tended to adhere to traffic rules, had good control of the vehicles, maintained a reasonable speed, and exhibited safer riding behavior. However, further analysis is needed to understand the factors behind such behavior and to implement targeted measures for safer riding practices.

Risk Perception

This study found a strong correlation between the risk perception variable and risky riding behavior among online motorcycle taxi riders in Jakarta. A significant correlation between risk perception variables was revealed, specifically in the dimensions of danger level, stochastic evaluation, safety priority, and risky riding behavior. These findings were in line with a previous study, which indicates that risk perception has a direct impact on risky riding behavior.[17] Riders who consider riding activities to be potentially dangerous are likely to engage in non-risky riding behaviors, which relates to how they estimate the probability of accidents while riding. Those aware of risks are more cautious and prepared to prevent them.[14,17]

A recent study suggests that stochastic evaluation and the level of concern are significantly related to the risk perception of e-bike riders.[17] Online motorcycle taxi riders who were more concerned about riding and believed in higher risks were likely to demonstrate a positive attitude to traffic safety and exhibit safe riding behaviors. These findings suggest that risk awareness could shape a positive safety attitude, which, in turn, could influence safer riding behavior among online motorcycle taxi riders.

Safety Attitudes

This study revealed a relationship between safety attitude dimensions and risky riding behavior among online motorcycle taxi riders. Safety attitudes are directly related to risky riding behavior.[17] It was said that many models representing the cause-and-effect relationship between attitude and behavior had been proposed and proven in social sciences.[21]

In this study, the dimensions of pragmatic attitudes to rule violation and dissatisfaction with traffic rules demonstrated a significant correlation with risky riding behavior. This indicated that riders who had a feeling that traffic rules were too restrictive or were dissatisfied with the existing traffic rules were likely to engage in riskier riding behaviors. These findings were in line with a previous study stating that a pragmatic attitude to traffic rule violations was an important predictor for rule violations while cycling.[14] The more pragmatic the riders were, the more likely they were to violate traffic rules, such as running a red light on an empty road or violating traffic without supervision or for reasons of a faster route.[14]

Dissatisfaction with traffic rules among motorcyclists became an essential predictor for situations involving conflicts with other road users.[14] During the interviews with online motorcycle taxi riders, several riders admitted to traffic rule violations for practical reasons or under certain situations. In this study, although online motorcycle taxi riders normatively knew and understood that violating these rules could be dangerous, they still considered it as a solution under certain situations on the road. This emphasized an urgency for the riders to carefully assess risks and prioritize safety while considering practical factors in their job.

Daily Income Target

The interviews with online motorcycle taxi riders resulted in many of them setting daily income targets. The interview narrative underlined income targets and decisions to continue working or picking up passengers even in less safe road conditions. The need to gain specific income targets often forces the riders to risk their safety and take higher risks to achieve their financial goals.[22] According to a previous study, economic demands encourage people to take jobs as online motorcycle taxi riders, particularly in Jakarta, where the living cost tends to be higher than other areas.[23]

Apart from economic factors, flexible working hours were also a significant interest for online motorcycle taxi riders. However, the impact of such flexibility was that many riders worked late into the night to gain their daily income targets, sometimes ignoring safety issues. This phenomenon indicated that strong financial demands forced them to work beyond normal working hours to meet their high economic needs, particularly in big cities like Jakarta.

Although the analysis indicated that the daily income targets of online motorcycle taxi riders could affect their riding behavior, it is important to note that online motorcycle taxi riders' application operates on an order distribution

system with algorithms to determine the number of orders received daily. This phenomenon means that the daily income targets of online motorcycle taxi riders were no longer the main factor in risky riding behaviors. Even though they personally set daily income targets, the application only enables limited orders based on the system set up by the company.

Online motorcycle taxi riders often call such limited orders as "*anyep*" (quiet). The riders insisting on meeting their daily income targets tend to work late into the night. The interviews also pointed out certain influential factors to the order distribution system, including passenger rating or feedback based on the riders' service performance.

Passenger Pressure

Online motorcycle taxi riders often said that they were demanded to comply with passengers' requests or instructions, even when these actions were contrary to road safety. Based on the interviews, the fear of receiving a bad rating could force online motorcycle taxi riders to disregard safety measures and fulfill passengers' requests, even if that means engaging in risky behaviors, such as speeding up to meet customer requests. In this context, passenger rating was considered very important as it affected the number of orders riders could receive. This suggested significant pressure for the riders to compromise safety to maintain or improve their ratings on the online motorcycle taxi platform.

While, most riders interviewed mentioned their concerns regarding passenger reviews and willingness to comply with any passenger pressure. If necessary, some passengers expressed a different viewpoint. They stated that they were indifferent to the ratings and pressure from passengers, such as being asked to speed up, break traffic, or run a red light. The reasons behind the indifferent attitudes of riders to passengers' demands, which endanger safety, include prior experience of accidents due to traffic rule violations. These riders considered the accidents as "the lesson learned" and were committed not to repeat such actions in the future.

Additionally, these riders felt a moral responsibility as the head of household or the main financial support for their families. This sense of responsibility motivated them to prioritize their safety by thinking of their families at home. They also mentioned that passengers were not even held responsible if the riders were penalized for violating traffic rules upon the passengers' requests. Therefore, they tended to reject passengers' requests, which compromised safety, and they were unbothered by receiving negative ratings due to rejecting such requests.

Passenger pressure demanding a speed-up frequently occurs in office areas during rush hours. Online motorcycle taxi companies have established rules and guidelines for their riders and consider two distinct types of violations: those reported by customers and those detected by the system.[23] Hence, the companies monitor their riders' riding speeds through their systems. Each violation is classified into one of five levels, depending on the severity of the riders' violations. Sanctions imposed for such violations range from warnings, a 30-minute suspension, deactivation of incentives for three days, and a seven-day suspension to cancel the partnership. Therefore, online motorcycle taxi riders cannot comply with passengers' demands for speeding up as they are monitored by their companies.

Conclusion

Risky riding behavior among online motorcycle taxi riders in Jakarta is strongly associated with their daily income targets, passenger pressure, risk perception, and safety attitudes. The daily income targets and passenger pressure significantly influence risky riding behavior. Financial needs influence daily income targets, which may lead to risky riding behavior to meet those targets. Safety training for riders could be implemented to minimize risky riding behaviors among online motorcycle taxi riders in Jakarta. The companies can provide their riders with periodic training on riding safety and also make campaigns to educate passengers about any risk of risky riding behavior. The companies may also strengthen monitoring and assessment of their riders' riding behaviors by providing guidance or implementing sanctions for risky behaviors and incentives for safe riding.

Abbreviations

Not Applicable.

Ethics Approval and Consent to Participate

This study was approved by the Research and Community Engagement Ethical Committee of the Faculty of Public Health, Universitas Indonesia, with the number Ket- 621/UN2.F10. D11/PPM.00.02/2023. Written informed consent was obtained from all the participants.

Competing Interest

The authors declare no significant competing financial, professional, or personal interests might have affected the performance or presentation of the work described in this manuscript.

Availability of Data and Materials

The primary author can provide all data and materials from this study.

Authors' Contribution

ZD, AMK, and AH contributed to the design and implementation of the research. AH and NP were involved in the data analysis, while ZD and AMK provided supervision. ZD, AMK, AH, and NP were involved in manuscript preparation, content refinement, and administration. All the authors discussed the results and contributed to the final manuscript.

Acknowledgment

Not Applicable.

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Kesmas

Volume 19
Issue 1 *February*

Article 3

2-29-2024

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Recommended Citation

Nutthajit O, Narisa K B, Supat W, et al. The Effects of Environmental Noise on Annoyance, Stress, and Urine Cortisol Levels Among Residents Living Near Industrial Sites in Bangkok, Thailand. *Kesmas*. 2024; 19(1): 18-26
DOI: 10.21109/kesmas.v19i1.7521
Available at: https://scholarhub.ui.ac.id/kesmas/vol19/iss1/3

Onmek et al. *Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*. 2024; 19 (1): 18-26
DOI: 10.21109/kesmas.v19i1.7521

Kesmas: Jurnal Kesehatan Masyarakat Nasional (Kesmas: National Public Health Journal)

The Effects of Environmental Noise on Annoyance, Stress, and Urine Cortisol Levels Among Residents Living Near Industrial Sites in Bangkok, Thailand

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Abstract

People are exposed to environmental noise each day. It may be annoying, cause stress, induce hormonal changes, and negatively affect long-term health. This study aimed to determine the effects of environmental noise on annoyance, perceived stress, stress symptoms, and urine cortisol in people living in a selected area. This cross-sectional study was conducted from April to October 2022 on 142 participants. Urine samples were collected to determine cortisol levels, and perceived stress, stress symptoms, and environmental noise annoyance were evaluated using questionnaires. Stress symptoms correlated with traffic, industrial, and community noise, but not aircraft noise. Community noise correlated most strongly with all stress symptoms. Only community noise exposure was correlated with perceived stress. People reported that industrial and community noise affected their health and daily activities. Cortisol correlated with only traffic noise annoyance. Environmental noise was associated with stress symptoms and stress hormones. In brief, sound level is not the only indicator of stress or health impacts, but annoyance and concern over the effects of noise may negatively affect stress and health.

Keywords: annoyance, cortisol, environment, noise, stress

Introduction

The effects of environmental noise exposure have been intensifying, particularly for urban and industrial residents.[1] Environmental noise, the unwanted irritating noise, is one of the most significant environmental issues which has a negative impact on human health and wellbeing.[2] Sources of noise are transportation (traffic, aircraft), community, industrial plants (noise generated by operating machines), and other sources.[3] Traffic noise on the road is the main problem in urban areas.[4] Noise from trains or aircraft affects the surrounding area.[5,6] Some sources of community noise include the lawnmower, barking dogs, kitchen appliances, and television.[7] Mechanical processes and moving equipment are some of the biggest causes of industrial noise in the manufacturing industry.[8]

The impact of exposure to environmental noise is disruptive and depends on noise sensitivity.[9] It may cause anxiety, depression, tension, stress, and low self-esteem in some individuals.[10] Occasionally, it is identified as negative emotions associated with stress and the perception of stress. This raises inappropriate coping mechanisms (e.g., alcohol and tobacco use). According to a previous study, exposure to traffic noise could increase stress hormone levels,[11] and induce oxidative stress, which results in cell inflammation.[12] A prior study in Ahvaz City, Iran, revealed a correlation between various types of noise and human disease.[13] The effects of noise on the mind and body are irritability, nervousness,[14] emotional shifts, distraction, rapid heartbeat, changes in breathing rate, high blood pressure,[15] insomnia, and decreased work effectiveness.[16]

The mechanism of environmental noise exposure on the function of the endocrine system (hypothalamus, pituitary, and adrenal)[17] has shown changes in various hormonal levels after noise exposure, such as norepinephrine, dopamine, serotonin, and cortisol.[18] Due to the secretion of hormones, many factors are involved, such as stress and diet. A study found that cortisol could be used as a biological marker of noise exposure and is usually used to assess environmental noise exposure.[19]

The health impacts of environmental noise exposure may cause sleep disturbances and annoyance during daily ac-

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Received : September 29, 2023
Accepted : February 15, 2024
Published : February 29, 2024

tivities. A long-term accumulation of annoyances will induce stress. Stress affects the production and secretion of stress-related hormones, such as cortisol, and the functioning of various body systems, such as blood pressure, metabolism, and mood. Long-term stress-related hormone stimulation will cause various diseases, including cardiovascular disease, diabetes, high blood pressure, obesity, and others.[20] Sources of environmental noise could be annoying, with varying exposure times, patterns, and effects on those exposed. Therefore, considering the health outcomes of several interrelated variables, holistic information should be gathered regarding both the physical and psychological factors involved.

This study investigated how environmental noise annoyance was related to stress, individual stress perception, and the body's response to stress. Additionally, the result might consider taking advantage of a stress assessment or a cortisol level measurement. The outcomes could be relied upon to be reliable and indicate the severity of annoyance, stress, or ongoing health results. This study aimed to investigate the effects of environmental noise on feelings of annoyance, perceived stress, stress symptoms, and cortisol levels after exposure to various environmental noises. The study outcomes would reveal which environmental noise exposures had the most impact on stress among people. It would be beneficial to make people aware of the long-term health impacts. Planning could be used to conduct surveillance and reduce the impact of noise exposure. Considering legal measures to increase control and punishment, the results are expected to serve to develop an assessment on the effects of noise exposure.

Method

This descriptive study determined the proportion of effects of environmental noise on noise annoyance, stress symptoms, and perceived stress, the statistical correlation of stress symptoms and perceived stress with noise annoyance, and urinary cortisol level. The participants of this study were residents of the Khlong Luang District in communities close to an industrial site on the border of Bangkok. The area is 10–15 kilometers from Don Mueang International Airport and is in the same direction as the airport takeoff and landing. People in the area experienced the aircraft noise at a level which did not pose a risk to their hearing.[21] Residential accommodations included detached houses, row houses, and dormitories or apartments.

Participants were required to meet the following criteria: at the aged of 18–60 years; not having shift work; not experiencing symptoms or receiving treatment for mental illness; not taking a dietary supplement containing omega 6, magnesium, and vitamin A; not receiving other hormones including thyroid, estrogen, and leptin; not taking medications, such as contraceptives, hydrocortisone, and spironolactone; or experiencing an illness during their participation in the study. Consequently, the overall population reached a total of 200 people. An estimate of a proportion in the population was limited.

The Kreicie and Morgan equation was applied to calculate 200 people who met the criteria. A 5% margin of error was included in the proportion estimation at 50%. The number of samples calculated was 132, and 10 people were added for missing data. The total sample size was 142 people. Morgan's table was used to determine the sample size. Urine samples were collected to determine cortisol levels, and questionnaires were used to assess stress levels, symptoms of stress, and annoyance levels from environmental noise exposure.

This study was conducted from April to October 2022. From 7 to 9 a.m., when cortisol secretion peaked, 10 cc of urine was collected from the participants. The samples were delivered to the biochemistry laboratory at the Faculty of Allied Health Science, Thammasat University, Thailand, in a cold container of 2–8°C. The cortisol was then analyzed by enzyme-linked immunosorbent assay using the standard protocol of PerkinElmer (2012) for urine cortisol analysis (ELISA kit). This method detected the presence of cortisol antigens in urine samples. The method depended on the use of antibodies to identify a specific target antigen through specific interactions between the antibody and the antigen.[22]

The questionnaire was adapted from the standard stress evaluation questionnaire to meet the scope of this study and was evaluated by five experts consisting of researchers and specialists, with two specializing in environmental health, one in stress assessment, one in public health, and one in statistics. The validity test results were obtained as the index of item-objective congruence (IOC) = 0.86, content validity ratio (CVR) = 1, and content validity index (CVI) was greater than 0.8 (relevance 1, clarity 0.97, simplicity 0.96, and ambiguity 0.99).

The questionnaire was tried out with 30 people in a nearby factory to find the reliability (alpha coefficient) of the whole questionnaire, which was 0.935. Three sections were included in the questionnaire: 1) general information, 2) stress evaluation (stress symptoms and perceived stress), and 3) noise annoyance evaluation. The following are details of the stress evaluation and annoyance rating:

a) The stress symptoms scale was designed based on a book entitled Stress Management for Dummies by Elkin.[23] The questionnaire inquired about the frequency of stress-related symptoms, such as headaches, difficulty sleeping or staying asleep, unexplained muscular discomfort, jaw pain, out-of-control anger, and frustration for each selection

made on the rating scale: 0 = never, 1 = sometimes, 2 = often, and 3 = very often;

b) The Perceived Stress Scale was applied to examine stress. The tool was developed by Cohen.[24] The questions asked about experiences and thoughts during the previous month and inquired about each frequency. The alternate scale for each question was 0 = never, 1 = practically never, 2 = sometimes, 3 = quite often, and 4 = very often;
c) Participants completed a self-report of annoyance to assess feelings of annoyance from noise exposure and perceptions of the effects of noise on health and life. Using a 5-point Likert scale with values ranging from "very slightly" to "extremely," Self-Reported Measures asked participants to rate the extent to which they experienced each feeling in response to noise over a specific period.

Result

A total of 142 people (92 males and 50 females) participated in this study, with a mean age of 35.76 years. They had been industrial workers staying near the factory and around the industrial site. They were exposed to environmental noise, including industrial, traffic, community, and aircraft sources of noise. Most of them did not have records of hearing problems, such as otologic illness or hearing loss in the past (94.34%), taking medications for ear infections or experiencing hearing loss (97.18%), or suffering from an auditory or hearing organ injury (94.37%). About 19% of them had hearing problems.

Self-reported annoyance levels of environmental noise and the perceptions of the impacts of environmental noise exposure on health and life are shown in Table 1. Most participants reported only a low level of annoyance from the environmental noise, with an average of 1.5–2.49 of 5 scores. Industrial noise had the highest mean score of noise at 2.13±0.95, followed by traffic noise and community noise at 2.07±0.89 and 1.93±0.82, respectively. While, for the aircraft noise, 1.71±0.73 was the lowest mean score. Most participants felt that environmental noise had little impact on their health and daily life, with average scores of 1.85±1.00 and 1.85±1.01 for health and daily life, respectively.

Table 1. Noise Annoyance Self-Report

	Very Slightly (1)	A little (2)	Moderately (3)	Quite a bit (4)	Extremely (5)	Total	Mean±SD
Aircraft noise	63	58	20	-	1	142	1.71±0.73
Traffic noise	37	70	24	9	2	142	2.07±0.89
Industry noise	39	57	39	2	5	142	2.13±0.95
Communities noise	43	73	21	2	3	142	1.93±0.82
Effect on life	66	41	28	2	5	142	1.87±1.01
Effect on health	63	52	17	5	5	142	1.85±1.00

Note: SD = Standard Deviation

Table 2. Correlation of Stress Symptoms and Perceived Stress with the Annoyance Level of Environmental Noise

	Symptom Stress	Perceived Stress	Annoyance			
			AN	TN	IN	CN
Symptom stress	1.00					
Perceived stress						
r	0.201*	1.00				
p-value	0.02					
AN annoyance						
r	0.16	0.04	1.00			
p-value	0.07	0.61				
TN annoyance						
r	0.236**	0.11	0.534**	1.00		
p-value	0.01	0.22	<0.01		a	
IN annoyance						
r	0.182*	0.11	0.342**	0.467**	1.00	
p-value	0.03	0.19	<0.01	<0.01		
CN annoyance						
r	0.349**	0.199*	0.345**	0.432**	0.465**	1.00
p-value	<0.01	0.02	<0.01	<0.01	<0.01	

Notes: Pearson Correlation (r), * = Correlation is significant at the 0.05 level (2-tailed), ** = Correlation is significant at the 0.01 level (2-tailed), AN = Aircraft Noise, TN = Traffic Noise, IN = Industry Noise, CN = Communities Noise.

The correlation between stress symptoms and perceived stress with noise annoyance scores of each environmental noise source is explained in Table 2. It shows that stress symptoms are correlated with annoyance of traffic noise (r = 0.236, p-value = 0.01), industrial noise (r = 0.182, p-value = 0.03), and community noise (r = 0.349, p-value = 0.05), but not aircraft noise. Only community noise annoyance correlates with perceived stress (r = 0.199, p-value = 0.02). The T-test was applied to compare the level of noise annoyance level between those experiencing normal and high stress. The results showed that participants with normal and high stress experienced different levels of annoyance. Those bothered by the traffic, industry, and community noise showed statistically significant differences (p-value < 0.05) in symptom stress levels. However, there was no difference in stress levels when exposed to aircraft noise.

Regarding stress symptoms and environmental noise annoyance, this study found that they were significantly correlated. In Table 3, community noise annoyance is the most significantly correlated with all symptoms of stress. In addition, industrial and traffic noise has been correlated with some stress symptoms, such as fatigue, headaches, anxiety, eating disorders, and muscle pain. Fatigue and eating disorders were the only two symptoms correlated with aircraft noise annoyance. However, when considering the correlation level, the most significant correlation between noise annoyance and stress symptoms was found to be generally weak. The correlations between community noise with eating disorders (r = 0.481, p-value < 0.05) and difficulty falling asleep (r = 0.403, p-value < 0.05) were moderate.

The correlation between environmental noise annoyance and perceived effects on health and life is shown in Table 4. Participants reported that environmental noise affected their daily lives, with industrial and community noise causing negative health impacts. The results showed that environmental noise annoyance was correlated with the sensation of affecting life: traffic noise (r = 0.234, p-value = 0.11), industrial noise (r = 0.420, p-value < 0.05), and community noise (r = 0.357, p-value < 0.05). The perceived negative health impacted from the environmental noise were correlated with industrial noise (r = 0.386, p-value < 0.05) and community noise (r = 0.276, p-value < 0.05). Industrial noise had the strongest correlation with its effect on life and health.

Table 3. The Correlation Between Each Stress Symptom and the Annoyance Level of Environmental Noise

	Annoyance			
	AN	**TN**	**IN**	**CN**
Headache				
r	0.05	0.12	0.189*	0.319**
p-value	0.56	0.17	0.03	<0.05
Tense muscle, sore neck, and back pain				
r	0.16	0.220**	0.12	0.269**
p-value	0.06	0.01	0.16	<0.05
Fatigue				
r	0.209*	0.238**	0.227**	0.255**
p-value	0.02	0.01	0.01	<0.05
Anxiety, worry, and phobia				
r	0.08	0.245**	0.235**	0.377**
p-value	0.38	<0.05	0.01	<0.05
Difficulty falling asleep				
r	0.10	0.17	0.14	0.403**
p-value	0.25	0.05	0.10	<0.05
Bouts of anger/hostility				
r	-0.01	0.15	0.09	0.291**
p-value	0.96	0.07	0.31	<0.05
Boredom, depression				
r	0.00	0.13	0.208*	0.239**
p-value	0.99	0.14	0.02	0.01
Eating too much or too little				
r	0.216*	0.305**	0.299**	0.481**
p-value	0.01	0.00	0.00	<0.05
Diarrhea, cramps, gas, and constipation				
r	0.12	0.14	0.16	0.270**
p-value	0.18	0.12	0.07	<0.05
Restlessness, itching, and tics				
r	0.04	0.06	0.11	0.314**
p-value	0.61	0.52	0.23	<0.05

Notes: Pearson Correlation (r), * = Correlation is significant at the 0.05 level (2-tailed), ** = Correlation is significant at the 0.01 level (2-tailed), AN = Aircraft Noise, TN = Traffic Noise, IN = Industry Noise, CN = Communities Noise.

Table 4. The Correlation of Environmental Noise Annoyance with Perceived Effects on Life and Health

	Perceived Effect on Life	Perceived Effect on Health	Annoyance			
			AN	TN	IN	CN
Perceived effect on life	1.00					
Perceived effect on helath						
r	0.888**	1.00				
p-value	<0.05					
AN annoyance						
r	0.14	0.11	1.00			
p-value	0.11	0.21				
TN annoyance						
r	0.234**	0.13	0.534**	1.00		
p-value	0.01	0.13	<0.05			
IN annoyance						
r	0.420**	0.386**	0.342**	0.467**	1.00	
p-value	<0.05	<0.05	<0.05	<0.05		
CN annoyance						
r	0.357**	0.276**	0.345**	0.432**	0.465**	1.00
p-value	<0.05	<0.05	<0.05	<0.05	<0.05	

Notes: Pearson Correlation (r), * = Correlation is significant at the 0.05 level (2-tailed), ** = Correlation is significant at the 0.01 level (2-tailed), AN = Aircraft Noise, TN = Traffic Noise, IN = Industry Noise, CN = Communities Noise.

Table 5. Correlations Between Environmental Noise Exposures and Cortisol Level

	Cortisol	Annoyance			
		AN	TN	IN	CN
Cortisol	1				
AN annoyance					
r	0.104	1			
p-value	0.245				
TN annoyance					
r	0.185*	0.534**	1		
p-value	0.037	<0.05			
IN annoyance					
r	0.139	0.342**	0.467**	1	
p-value	0.120	<0.05	<0.05		
CN annoyance					
r	0.165	0.345**	0.432**	0.465**	1
p-value	0.064	<0.05	<0.05	<0.05	

Notes: Pearson Correlation (r), * = Correlation is significant at the 0.05 level (2-tailed), ** = Correlation is significant at the 0.01 level (2-tailed), AN = Aircraft Noise, TN = Traffic Noise, IN = Industry Noise, CN = Communities Noise.

This study observed the physiological response to the annoyance effects resulted by environmental noise by determining a correlation between annoyance and cortisol levels. The results are shown in Table 5. This study found a correlation between environmental noise annoyance levels and urinary cortisol levels. Cortisol was correlated with annoyance caused by exposure to traffic noise only (r = 0.185, p-value = 0.037). While, Table 6 shows the correlation between the perceived effect of environmental noise exposure and cortisol level. Cortisol was significantly correlated with the perceived effects of environmental noise on life (r = 0.255, p-value = 0.003) and health (r = 0.266, p-value = 0.002).

Discussion

Exposure to environmental noise causes feelings of annoyance expressed at the level of annoyance and gives rise to symptoms of stress.[25] Table 1 shows the results of the self-reported annoyance. The results might not accurately represent the level of noise to which a person was exposed but rather their attitude to the noise. Additionally, stress could be attributed to an individual's attitude to or perception of negative effects associated with noise exposure.[7]

Table 6. Correlations Between Cortisol Level and the Concerned Effect of Noise

	Cortisol	Perception of Effect on Life	Perception of Effect on Health
Cortisol	1		
Perception of effect on life			
r	0.255**	1	
p-value	0.003		
Perception of effect on health			
r	0.266**	0.888**	1
p-value	0.002	<0.05	

Notes: Pearson Correlation (r), * = Correlation is significant at the 0.05 level (2-tailed), ** = Correlation is significant at the 0.01 level (2-tailed).

This study showed that industrial noise and traffic noise had the highest average level of annoyance. However, the figure turned out to be lower when considering the average perceived impact on life or health. Therefore, annoyance might result from exposure to noise and negative attitudes to noise. The findings of this study were consistent with the findings of other studies that noise annoyance was classified as a psychological state.[25,26] There were many non-acoustic factors associated with annoyance in different ways.[25] Age, education level, and community size were all the factors that could make noise annoying.[26]

The correlation between noise annoyance and stress symptoms, which are correlated with all noise sources, excluding aircraft noise, is shown in Table 2. This might be due to the fact that participants included in this study did not live in an area directly affected by aircraft noise, thereby excluding the detection of such a correlation. This differed from the findings of other studies showing a significant relationship between stress and aircraft noise.[5,27] Nevertheless, this study revealed that people's stress levels were actually affected by environmental noise, with community noise having the strongest correlation with stress symptoms correlated with perceived stress.

After examining the correlation between stress symptoms and the level of annoyance caused by each source of noise in Table 3, apparently, the strongest association is found between stress symptoms and community noise annoyance. A prior study explained factors contributing to the significant impact of community noise on people's stress.[28] The interactions between neighbors and community members also affected both stress and sleep.[28] This occurred as the community noise did not only disturb sleep or daily life at an intense level but was also accompanied by negative emotions, sentiments, or attitudes.[29]

For example, vulgarity, insults, and cursing make those hearing them more stressed.[30] In addition, symptoms of stress, including fatigue, anxiety, concern, and excessive or insufficient appetite, were associated with environmental noise exposure in this study. Several previous studies also found associations relevant to these symptoms in both physiological and psychological stress responses,[30] including cardiovascular disease,[31] metabolic disorder,[32] cognitive impairment, and sleep disturbance.[7]

For experiencing noise from different sources, several studies found variables affecting noise sensitivity, including residential characteristics, duration, period, or frequency of noise exposure, sex, age,[33] and even the spatial restrictions enforced by industrial zones in residential areas.[34] This study showed that the participants performed a range of annoyance levels that varied from low to moderate. As a result, it was possible that additional factors, for which those variables were not gathered, contributed to its occurrence. However, the study was intended to confirm stress levels through cortisol measures. It was an indicator which could be used to quantify the stress level within the body.[35]

Cortisol has been used to measure stress levels and the effects of noise exposure in the environment. The results presented in Table 5 figure out such a correlation with only traffic noise annoyance. This result differed from other studies that found a correlation between noise from airports,[36] and noise from the community.[37] This might depend on many factors involved, especially the characteristics of different samples and the limited sample size. However, several previous studies revealed that noise exposure affected cortisol levels.[27,29,38-40]

A study in Denmark reported the adverse effects of traffic noise, as the exposure to traffic noise resulted in poor mental health and increased levels of perceived stress.[29] A meta-analysis showed that residential street traffic noise was associated with anxiety and depression, with a 4% higher incidence of depression and anxiety increasing by 12%,[27] which could lead to mental illness.[29] The noise annoyance might mediate the relationship between traffic noise and psychological illness.[38] It had also been correlated with psychotropic drug use,[39] in which noise in a socially susceptible context might lead to substance abuse and be associated with suicide.[40] This study showed that those perceiving that the environmental noise negatively affected their lives and health had a higher cortisol level.

Conclusion

This study has shown that environmental noise annoyance is associated with stress, symptoms of stress, and biological (hormonal) changes in the body. The environmental noise annoyances, such as traffic noise, industrial noise, and community noise, have a significant correlation with stress symptoms. The noise annoyance is the most strongly correlated with the following stress-related symptoms: fatigue, anxiety, concern, and excessive or inadequate appetite. In contrast, perceived stress is the only correlated with community noise annoyance. The correlation between levels of stress and annoyance indicates that people experiencing higher stress levels also have a higher level of annoyance.

Abbreviations

IOC: Item-objective Congruence; CVR: Content Validity Ratio; CVI: Content Validity Index.

Ethics Approval and Consent to Participate

This study is based on a research project approved by the Human Research Ethics Committee of Thammasat University (Science), (HREC-TUSc), COA No. 045/2564.

Competing Interest

The author declared that no significant competing financial, professional, or personal interest might have affected the performance or presentation of the work described in this manuscript.

Availability of Data and Materials

All study data are available upon reasonable request to the corresponding author. The identities of the participants remain classified.

Authors' Contribution

NO reviewed literature, conceptual frameworks, and research methodologies, coordinated with the sample group, collected samples, analyzed results, and developed the first draft of the study report. NB and SW participated in the research concept and methodology, including recommendations for noise measures, cortisol collection and analysis, data analysis, and solutions. All authors read and approved the final manuscript.

Acknowledgment

The authors are pleased to acknowledge the participants and coordinators for completing the data collection. Also, the authors thank the Faculty of Public Health, Thammasat University, Thailand for funding this research.

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Kesmas

Volume 19
Issue 1 *February*

Article 4

2-29-2024

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Recommended Citation

Hadis N, Abbas R, Mir Saeed Y, et al. The Importance of Blood Pressure Control in the Survival of Peritoneal Dialysis Patients Using a Multistate Model. *Kesmas*. 2024; 19(1): 27-34
DOI: 10.21109/kesmas.v19i1.7593
Available at: https://scholarhub.ui.ac.id/kesmas/vol19/iss1/4

Najafimehr et al. *Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*. 2024; 19 (1): 27-34
DOI: 10.21109/kesmas.v19i1.7593

Kesmas: Jurnal Kesehatan Masyarakat Nasional (Kesmas: National Public Health Journal)

The Importance of Blood Pressure Control in the Survival of Peritoneal Dialysis Patients Using a Multistate Model

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Abstract

Since less attention has been paid to the effect of passing blood pressure states on the survival of peritoneal dialysis (PD) patients, this study aimed to investigate the survival of PD patients with and without hypertension, estimate the probability of hypertension, and determine the influential factors. In this retrospective cohort study, the data of 700 patients visiting dialysis centers from all provinces of Iran from 1997-2009 were analyzed. For data analysis, the multistate survival model was used. The median survival time (months) and five-year survival were 75% and 56%, respectively. Males had a higher probability of hypertension (63%) than females (52%). The risk of death in normotensive patients increased with age and fast blood sugar (FBS) (age: HR = 1.02, p-value <0.001; FBS: HR = 1.03, p-value = 0.034) and decreased with increasing protein albumin (albumin: HR = 0.60, p-value = 0.015). When experiencing hypertension, the death risk increased with age (age: HR = 1.03, p-value <0.001); also, higher serum albumin and blood urea nitrogen (BUN) had a protective effect against mortality (albumin: HR = 0.66, p-value = 0.038; BUN: HR = 0.99, p-value = 0.014). Paying attention to age, obesity, and blood sugar in PD patients seems necessary.

Keywords: blood pressure, dialysis, hypertension, Multistate Model

Introduction

End-stage renal disease (ESRD) means an irreversible decline in kidney function that is severe enough to be fatal if dialysis or transplantation is not performed. Kidney failure or its reduced function causes a maladaptive process, including fluid retention. Among people living with ESRD, fluid retention significantly leads to hypertension, ventricular dysfunction, and additional cardiovascular events.[1] Several studies revealed that diabetes, high blood pressure, and glomerular disease are the major causes of ESRD.[2,3] Also, the ESRD prevalence is higher in cardiac patients and the elderly. Therefore, the growth of the elderly population and the increasing number of diabetic patients in recent years may allow the ESRD prevalence to rise in the future.[2,3]

Peritoneal dialysis (PD) is an attractive and cost-effective treatment for kidney failure, introduced in the late 1970s.[4] The home-based nature and flexibility of this method has increased its use compared to hemodialysis in many parts of the world.[5] Although the mortality rate of patients undergoing outpatient PD treatment has decreased in recent years, their survival rate is still a matter of concern, in which even after 10 years, the probability of survival of these patients may reach lower than 11%.[6]

One of the crucial issues in treating kidney disease is controlling blood pressure. High blood pressure is both a cause and a consequence of chronic kidney disease (CKD), and it affects most CKD patients.[7] The systematic review and meta-analysis studies showed a high prevalence of hypertension in kidney patients. The combined prevalence in both CKD and ESRD patients is estimated at 23%, and the prevalence in CKD patients is estimated at 32%.[8,9] Moreover, in Iran, the prevalence is estimated at 35% for kidney disease patients.[10]

Hypertension has been recognized as the most common comorbidity for PD patients, and the risk of death among patients with hypertension is higher than among those without hypertension. A study on survival concluded that blood pressure was a predictor of death among dialysis patients, and PD patients with high blood pressure had shorter

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Received : October 17, 2023
Accepted : February 13, 2024
Published : February 29, 2024

survival compared to others.[11] In addition, increased blood pressure due to increased serum sodium concentration causes cardiac complications and subsequently shortens the survival time of dialysis patients.[12]

Although many studies have introduced risk factors for hypertension (e.g., diabetes, age), the effectiveness of prevention requires two factors: first, accurate prediction of the onset of hypertension, and second, identification of transition patterns between different states of blood pressure.[13] However, in the existing literature, the intermediate between the normal and diseased states has not been well studied. The natural progression of high blood pressure is a dynamic process, and people living with CKD may experience different stages of its progression over time. Therefore, observing its natural progression is necessary for early diagnosis and prevention.[14]

The low rate of PD patients' survival has led many studies to determine its causes and generated a large amount of data.[15-16] Accurate and efficient methods are required for effective use of the data. Since ESRD patients might experience different states of blood pressure before death, hypertension could be considered an intermediate condition accelerating death.[17-18] Risk factors for death may differ from risk factors for intermediate outcomes. Ignoring the intermediate states and the time elapsed until they occur may lead to inaccurate results. Therefore, a multistate survival model is used to examine patient survival rates by considering a correlation between intermediate states of the disease.[19]

Despite the importance of blood pressure control for kidney patients, examining the survival of dialysis patients from the hypertension aspect as an intermediate state has received less attention. Therefore, this study aimed to examine the probability of survival of PD patients with or without passing through the hypertensive state, calculate the probability of transitioning to a hypertensive state before death and identify influential factors to PD patients' survival passing through blood pressure states. The aforementioned cases were still ambiguous for PD patients, and the multistate model was used in this study to solve these problems.

Method

This retrospective cohort study obtained data from the Iranian peritoneal dialysis registry project.[20] The information on patients with kidney failure who had visited the 46 dialysis centers from all Iranian provinces was recorded. The patients were given the necessary information to participate in the study, and those with full consent were included. Each person was identified by only one ID; other personal information was kept confidential and could not be extracted.

For data collection, several forms in the same electronic format were sent to the dialysis centers, and the completed forms were returned to the main registry center in Alborz Province, Iran. The data could be extracted after obtaining approval from the relevant officials. The executive and operational duties of this plan were approved by the Department of Organ Transplantation and Special Diseases, Deputy for Medicare, Iranian Ministry of Health in 2004. Such duties accommodate coordination between related organizations, which include research centers and the Nephrology Association, planning for holding meetings and training the technicians, designing data extraction software, confirming data quality, etc.

The patients were followed up from 1997 to 2009. The minimum follow-up time was five days, and the maximum was 12 years. This study examined the data of patients visited at least twice. The data collection forms included the demographic, clinical, and laboratory characteristics of the patients, as well as their treatment and follow-up process. In this study, basic characteristics, such as sex (male/female), age (year), weight (kg), height (m), comorbidity (yes/no), triglycerides/Trg (mg/dL), fast blood sugar/FBS (mg/dL), protein albumin (g/dL), serum sodium/Na (mg/L), potassium/K (mol/L), creatinine/Cr (mg/dL) and blood urea nitrogen/BUN (mg/dL) were analyzed considered as the independent variable. Time (months) was considered right-censored for patients who were still alive or whose conditions were unclear until the last follow-up.

To observe the patients' conditions, their systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured and recorded at each visit. A mercury sphygmomanometer was used to measure blood pressure after a 10- to 20-minute rest period. To record blood pressure, each patient was measured twice, and the average of the two times was calculated. A patient's blood pressure, according to guidelines by medical associations, consists of four stages: normal (SBP <120 mmHg and DBP <80 mmHg), elevated (SBP in the range of 120–129 mmHg and DBP <80 mmHg), hypertension stage I (SBP in the range of 130–139 mmHg or DBP in the range of 80–89 mmHg, and hypertension stage II (SBP ≥140 mmHg or DBP ≥90 mmHg).[21]

The inclusion criteria included those aged >18 years and prescribed peritoneal dialysis therapy. Exclusion criteria included kidney transplant or hemodialysis. In addition, people whose information was incomplete or did not want to continue the treatment were excluded from the study. In this study, it was possible to access the data of 1,800 patients. Among these patients, 700 patients had normal or elevated blood pressure. The rest of the patients either did not have normal blood pressure or had incomplete information and were excluded from the study. Hence, the clinical changes of 700 patients with normal or elevated states were observed. For data analysis, the effect of the mentioned independent

variables on the survival of patients with or without passing through hypertensive status was determined.

Considering that dialysis patients might experience different blood pressure conditions before they died, and these interdependent conditions affected their time of death, a multistate model was required to examine the survival rate. Therefore, multiple stages of blood pressure were used to build a three-state survival model so that state 1 included normal or elevated blood pressure, state 2 included hypertension (stage I or II), and death was considered as state 3 (absorbing state). The graph of this model is shown in Figure 1.

In this model, the state change is considered an event, and the time until the occurrence of each event is calculated. Multistate models can be used for the transition from state s to r, ($r \neq s$) with the aid of the Cox proportional hazards model and formulated as on Formula 1. The level of 5% was considered statistically significant, and analysis was done using a free version of R 4.2.2 software and the mstate statistical package.

Results

Of the examined 700 dialysis patients, 423 (60.4%) were females, and the rest were males. The youngest person aged 20 years, and the oldest aged 87 years. The mean body mass index (BMI) of all patients was 23.02±4.96. Also, 583 (83.3%) people had at least one comorbidity. Of the total population studied, 400 (57.14%) people had hypertension, while 278 (39.71%) people had experienced death (directly from the normal state or passing through the hypertensive state). The details of patients' characteristics based on the occurrence of the event can be seen in Table 1.

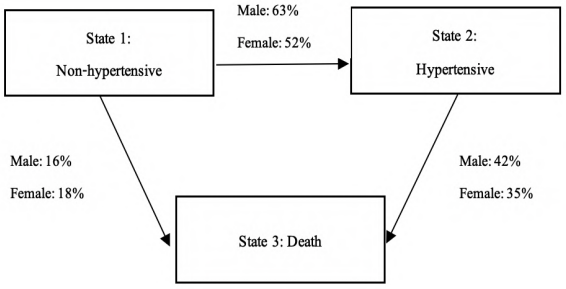

Figure 1. Diagram of Transitions for Peritoneal Dialysis Patients

$$q_{rs}(t) = q_{rs,0}(t)\, exp(\boldsymbol{X}_{rs}{}^{T}\boldsymbol{\beta})$$

Notes:
$q_{(rs,0)}$ = the baseline risk
X = vector of predictor variables
β^{T}_{rs} = the unknown parameters

Formula 1. Hazard of Transition Model

Table 1. Main Characteristics of Peritoneal Dialysis Patients by Blood Pressure States

Variable	Category	Overall	Non-hypertensive	Hypertensive	Survivor	Dead
Age (Mean±SD)		50.70±16.35	50.28±16.74	50.98±16.10	64.70±15.67	56.52±15.59
Sex, n (%)	Male	277 (39.6)	101 (33.66)	176 (44.0)	157 (37.20)	120 (43.16)
	Female	423 (60.4)	199 (66.34)	224 (56.0)	265 (62.80)	158 (56.83)
BMI (Mean±SD)		23.02±4.96	22.52±5.42	23.35±4.60	22.99±5.12	23.06±4.73
Comorbidity, n (%)	Yes	583 (83.3)	235 (83.8)	348 (83.3)	329 (79.3)	254 (89.1)
	No	117 (16.7)	47 (16.7)	70 (16.7)	86 (20.7)	31 (10.9)
FBS (Mean±SD)		124.26±62.91	124.23±67.28	124.28±59.87	117.93±54.60	133.48±72.47
Trg (Mean±SD)		175.77±92.26	173.17±97.43	177.52±88.67	173.16±81.42	179.57±106.12
K (Mean±SD)		4.64±0.75	4.62±0.70	4.65±0.78	4.67±0.75	4.59±0.75
Na (Mean±SD)		139.32±3.91	139.19±3.89	139.41±3.92	139.38±3.82	139.24±4.05
Cr (Mean±SD)		6.51±2.76	6.49±2.64	6.51±2.83	6.65±2.67	6.29±2.86
Albumin (Mean±SD)		3.97±0.43	3.71±0.44	3.84±0.42	3.83±0.47	3.73±0.36
BUN (Mean±SD)		77.97±40.89	77.56±39.57	78.26±41.79	80.21±41.55	74.71±39.75

Notes: SD = Standard Deviation, BMI = Body Mass Index, FBS = Fasting Blood Sugar, Trg = Triglycerides, K = Potassium, Na = Sodium, Cr = Creatinine, BUN = Blood Urea Nitrogen.

According to Table 1, to compare patients in terms of blood pressure, the amounts of BUN, Albumin, Cr, Trg, BMI, and age among patients with high blood pressure are higher than others. The percentage of males in the hypertensive group (44%) was higher than the non-hypertensive group (33%). In comparison, the percentage of females in the non-hypertensive group (66%) was higher than the hypertensive group (56%). People in two groups of blood pressure were similar in having or not having comorbidity.

The comparison of patients in terms of death showed that BUN, Albumin, Cr, Na, K, and age were lower for those who died than those who survived. However, Trg and FBS were higher for those who died than those who survived. Also, males had the highest percentage of deaths (43%), while females had the highest percentage among survivors (62%) (Table 1). The median overall survival time of patients was 75 months. The patient's survival at one-year, five-year, and ten-year intervals was 93%, 56%, and 37%, respectively. The median time until the occurrence of hypertension was 59.46 months. The probability of hypertension after one, five, and ten years of follow-up was 33%, 69%, and 87%, respectively.

Frequency of Transitions between Defined Blood Pressure States and Death

The number and percentage of people whose blood pressure had or had not changed by the end of the study varied among the male and female populations (Figure 1). Of 277 males in non-hypertensive states, 176 (63%) had reached hypertensive state, 46 (16%) had died, and 55 (20%) had not experienced any change in blood pressure state. Of 176 males experiencing high blood pressure, 102 (58%) had no change in condition, and 74 (42%) had died. In general, in the male population, the number of deaths was 120 (43%). In the female population, out of 423 females in the non-hypertensive state, 224 (52%) had reached a hypertensive state, 80 (18%) had died, and 120 (28%) remained in the non-hypertensive state. Of 244 females experiencing high blood pressure, 146 (65%) remained in such condition, and 78 (35%) died. A total of 158 (14%) people died in the female population. To conclude, the percentage of deaths among patients experiencing high blood pressure was higher for males than for females. Also, males had a higher probability of high blood pressure compared to females.

Risk Factors for High Blood Pressure or Death

The results of the Cox regression model on the risk of high blood pressure or death in Table 2 show that the risk of high blood pressure increases by 4% with one kg/m^2 increase in BMI. Also, the risk increases by 2% with one g/dL increase in albumin. The risk of death without experiencing hypertension increases by 2% with a one-year increase in age and by 3% with a one mg/dL increase in FBS, while it decreases by 40% with a one g/dL increase in albumin. The risk of death with hypertensive experience increases by 3% with a one-year increase in age, while it decreases by 34% and 1% with a one g/dL increase in albumin and one mg/dL increase in BUN, respectively. No significant effects are seen for other variables with no asterisk in the Table 2.

Predicting the Probability of Transition to High Blood Pressure or Death Using the Cox Model

The transmission risk, which considers the patients' significant conditions, is shown in Figures 2 and 3. According to Figure 2, the cumulative risk of transition from a hypertensive state to death is greater than the risk of transition

Table 2. Effects of Covariates on Transition Intensity for Blood Pressure States

Variable	Non-hypertensive→Hypertensive		Non-hypertensive→Death		Hypertensive→Death	
	HR (p-value)	95% CI	HR (p-value)	95% CI	HR (p-value)	95% CI
Age	1.00 (0.567)	(0.99–1.01)	1.02 (<0.001)*	(1.01–1.03)	1.03 (<0.001)*	(1.02–1.04)
Sex; male	1.03 (0.754)	(0.84–1.26)	0.78 (0.213)	(0.67–1.00)	1.14 (0.412)	(0.90–1.35)
BMI	1.04 (0.010)*	(1.01–1.04)	0.98 (0.383)	(0.97–1.01)	0.98 (0.276)	(0.97–1.01)
Comorbidity; yes	1.18 (0.241)	(0.90–1.35)	0.76 (0.270)	(0.55–1.22)	0.67 (0.073)	(0.45–1.00)
Cr	0.97 (0.226)	(0.96–1.00)	0.97 (0.437)	(0.91–1.03)	1.03 (0.420)	(0.96–1.08)
Na	0.97 (0.814)	(0.98–1.02)	0.99 (0.708)	(0.95–1.03)	1.02 (0.330)	(0.98–1.06)
FBS	0.99 (0.637)	(0.99–1.00)	1.03 (0.034)*	(1.01–1.05)	0.99 (0.586)	(0.99–1.00)
Trg	0.99 (0.643)	(0.99–1.00)	0.99 (0.923)	(0.99–1.00)	1.00 (0.148)	(0.99–1.00)
Albumin	1.02 (0.014)*	(1.01–1.49)	0.60 (0.015)*	(0.41–0.90)	0.66 (0.038)*	(0.55–0.82)
K	0.95 (0.486)	(0.83–1.11)	0.84 (0.238)	(0.74–1.10)	1.00 (0.960)	(0.82–1.23)
BUN	1.00 (0.299)	(0.99–1.00)	1.00 (0.344)	(0.99–1.00)	0.99 (0.014)*	(0.99–0.99)

Notes: CI = Confidence Interval, HR = Hazard Ratio

* = Statistical Significance, BMI = Body Mass Index, Cr = Creatinine, Na = Sodium, FBS = Fasting Blood Sugar, Trg = triglycerides, K = Potassium, BUN = Blood Urea Nitrogen.

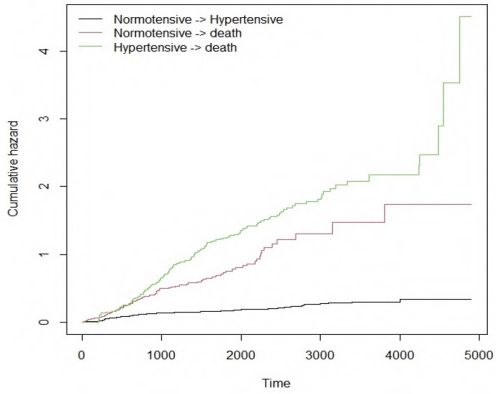

Figure 2. Cumulative Hazard for Three Transitions in Peritoneal Dialysis Patients

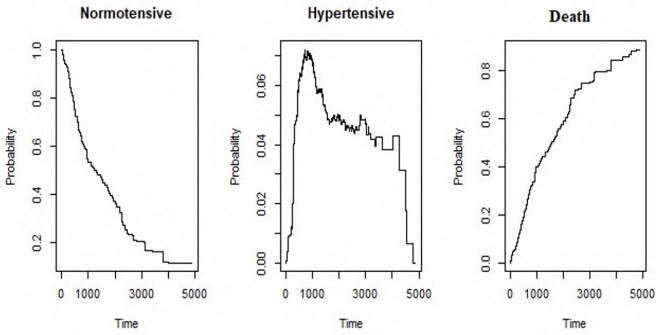

Figure 3. Patient-specific Transition Probability from State 1 in Peritoneal Dialysis Patients

Table 3. Expected Length of Stay in Each States

	In Normotensive	In Hypertensive
From normotensive	57.56 months	6.88 months
From hypertensive	-	49.92 months

from a non-hypertensive state to death. Also, the risk of these transitions is higher than the transition from a non-hypertensive state to a hypertensive state. According to Figure 3, the probability of remaining in a non-hypertensive state decreases over time. Moreover, the probability of transitioning to a hypertensive state increases up to 30 months and then decreases. The probability of death in a non-hypertensive state increases over time.

Duration of Remaining in Different Blood Pressure Status

The expected lengths of remaining in each defined blood pressure state are given in Table 3. According to this table, the time to remain in the normotensive state (57.56 months) is longer than that in the hypertensive state (49.92 months), which means that patients with hypertension experience a shorter life.

Discussion

Previous studies have shown that the prevalence of hypertension in Iran (48.2% in the adult population) is increasing.[22-23] In addition, blood pressure instability and the need to control it is a significant problem for kidney patients.[24] Therefore, paying attention to the pattern of a transition to a hypertensive state and its influential factors could be a basis for successful control of blood pressure and ultimately increase the survival of dialysis patients. In this study, a three-state survival model was used considering the blood pressure status to observe the influential factors to the Iranian PD patients' survival. Also, the probability of transitioning to a hypertensive state and the survival time with the hypertension experience were reported for the mentioned patients.

This study found some basic new points. The death risk of experiencing hypertension was higher than the risk of experiencing hypertension itself. Over time, the probability of high blood pressure increased until the first three years of dialysis and then decreased. Women were more likely to remain in their current blood pressure status (normotensive or hypertensive state) than men. The probability of death without high blood pressure experience was higher for women than men. In addition, the transition to hypertension, as well as the probability of death with the hypertension experience, was higher in men.

This study revealed that albumin and BMI were among the influential factors in the transition from normotension to hypertension status. The results on BMI were consistent with the study on the American working population,[25] and Chinese adults.[26] In the mentioned studies, the three-state model of blood pressure was used, considering hypertension as an absorbing state, but the death risk was not examined. Therefore, those studies were incomparable with the present study in terms of factors affecting death.

Previously, the role of obesity in causing kidney damage and increasing blood pressure has been proven.[27] Obesity, accompanied by increased visceral fat, is a major cause of high blood pressure. The cause of high blood pressure due to obesity is renal sodium reabsorption. Also, because of the compression of the kidney by the perineal fat, the plasma volume increases and leads to consequences, such as impaired baroreceptor and chemoreceptor reflexes and an increase in renal sympathetic nervous activity, and then blood pressure increases.[28]

Albumin is one of the most important blood plasma proteins, which plays an important role in maintaining blood oncotic pressure. Hypoalbuminemia increases the risk of cardiovascular diseases.[29] Few studies have been done on the relationship between serum albumin and blood pressure in PD patients. The permeability of the peritoneal membrane is an important factor in the exchange of fluids and solutes between the peritoneal and blood circulation in PD patients. Hypoalbuminemia might result from increased dialytic albumin loss and relative hemodilution for insufficient ultrafiltration caused by high dialysate glucose absorption.[30] The results of a study on the survival of PD patients showed that lower serum albumin leveled up the risk of patients' death.[31] The statistical model used, the follow-up time, and the amount of albumin and BUN in patients differed from this study.[31] In the mentioned study, the exact level of low serum albumin was also not determined in the analysis.[31]

This study observed the role of blood pressure before the possible occurrence of death. It showed that PD patients might experience increased serum albumin and blood pressure before death. Also, the serum albumin was analyzed as a continuous variable, and more studies are needed to determine a cut-off point for its high or low level. The difference in the results of this study from the previous studies might be due to differences in nutritional conditions, as serum albumin is a measure of the patient's nutritional status. Another important point was a systemic inflammation (e.g., C-Reactive Protein (CRP)) condition for CKD patients, as the low level of serum albumin might have interacted with CRP. The death risk evidently increased in kidney patients with low serum albumin who had high CRP, while the death risk did not increase for these patients with normal CRP.[32] However, this study did not examine this point due to a lack of information. The albumin level in kidney patients is possibly affected by other unknown factors. Therefore, more studies are needed to express an opinion on albumin.

In terms of influential factors to the PD patients' survival, in this study, the death risk with or without passing through the hypertensive state was examined. At the same time, this issue was not addressed in previous studies. Based on the findings of this study, increasing age and FBS increased the risk of death in patients with normal or high blood pressure status. In addition, in case of experiencing high blood pressure, increasing age leads to an increased risk of death.

While, the albumin and BUN indices had a protective role against death, although the role of BUN may be negligible due to its decreasing effect of one percent. Compared to previous studies, the finding of this study on the role of aging as an accelerating factor was in line with studies by Kang et al.[33] on the survival of PD patients and the protective role of albumin, as well as Cheng et al.[34] on the survival of diabetic PD patients.

Regarding the role of blood sugar levels, previous studies found that diabetes increased the risk of death in PD patients.[35-36] To examine the effects of aging in increasing the risk of death in PD patients, the weakening of kidney function in old age could be highlighted.[35] Moreover, elderly patients commonly have more comorbidities, which leads to a shorter life span.[36]

Prior studies have specifically focused on PD or hemodialysis diabetic patients; in this context, a study by Afghahi et al.[37] on the survival of diabetic patients receiving PD could be referred to, emphasizing that the HbA1c coefficient of variation >2.83 independently increased the risk of death threefold. This study had similar results to the previous study on FBS. One of the causes of an increase in the risk of death among diabetic and dialysis patients was glycemic change.[38] Such instability could occur for a change in the dialysis regime or absorption of a large amount of glucose from the dialysate. Glucose fluctuation might lead to oxidative stress and dysfunction of endothelial cells and damage to them, thereby enhancing the risk of death.[39]

A strength of this study was that it dealt with the survival of PD patients according to their blood pressure changes as a factor of interest. In other words, the risk of death and its influential factors were compared by passing through the high blood pressure condition and also without experiencing it. Also, using multistate survival and Markov models provided powerful data analysis and, subsequently, more accurate results. The limitation of this study was that although some patients might have comorbidities and were taking relevant medications, the effect of taking medication was not considered due to a lack of data.

Conclusion

In the patients receiving PD, the probability of high blood pressure and death is higher for men than women. The BMI and serum albumin are the predictors of hypertension. Increased blood sugar and age enhance the risk of death,

and albumin plays a protective role against death. If the hypertensive state is reached, serum albumin and BUN may play a protective role against death. The probability of experiencing hypertension decreases over time, which is lower compared to the probability of death without experiencing hypertension. The duration of remaining in a non-hypertensive state is longer than in a hypertensive state, and the risk of death rises when a hypertensive state is reached. Increasing age, blood sugar, and obesity can be a warning for the occurrence of hypertension and death. Therefore, it seems necessary to pay attention to these factors in addition to blood pressure control in PD management.

Abbreviations

ESRD: End-stage Renal Disease; PD: Peritoneal Dialysis; CKD: Chronic Kidney Disease; FBS: Fast Blood Sugar; BUN: Blood Urea Nitrogen; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; BMI: Body Mass Index; SD: Standard Deviation, HR: Hazard Ratio.

Ethics Approval and Consent to Participate

Participation in this study was voluntary, and participants were provided with informed written consent. Ethical approval was obtained from the Research Ethics Committee of the Faculty of Public Health, Tehran University of Medical Sciences (Ethical approval number: IR.TUMS.SPH.REC.1401.250).

Competing Interest

The authors declared that there are no significant competing financial, professional, or personal interests that might have affected the performance or presentation of the work described in this manuscript.

Availability of Data and Materials

Data used in this study are available from the corresponding author upon reasonable request.

Authors' Contribution

HN and MH were responsible for conceptualization and methodology. MY collected data and investigated. HN wrote the original draft. ARF, HN, and MSY critically reviewed the manuscript. MH supervised this study. All authors read and approved the final manuscript.

Acknowledgment

The authors thank all the patients participating in this study.

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Kesmas

Volume 19
Issue 1 *February*

Article 5

2-29-2024

The Structural Equation Modelling of First Level Health Facilities' Performance-Based Capitation Payment in National Health Service

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Recommended Citation

Aryani AD , Bachtiar A , Candi C , et al. The Structural Equation Modelling of First Level Health Facilities' Performance-Based Capitation Payment in National Health Service. *Kesmas*. 2024; 19(1): 35-41
DOI: 10.21109/kesmas.v19i1.7340
Available at: https://scholarhub.ui.ac.id/kesmas/vol19/iss1/5

Aryani et al. *Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*. 2024; 19 (1): 35-41
DOI: 10.21109/kesmas.v19i1.7340

Kesmas: Jurnal Kesehatan Masyarakat Nasional (Kesmas: National Public Health Journal)

The Structural Equation Modelling of First Level Health Facilities' Performance-Based Capitation Payment in National Health Service

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Abstract

The BPJS Healthcare Security implemented performance-based capitation/*Kapitasi Berbasis Kinerja* (KBK) payments to conduct structured and ongoing monitoring of the First Level Health Facilities/*Fasilitas Kesehatan Tingkat Pertama* (FKTP)'s performance throughout Indonesia. This study aimed to examine the direct and indirect effects of FKTP capacity on KBK and FKTP performance. This study was conducted in February 2023, and Structural Equation Modelling analysis was performed with secondary data from the BPJS Healthcare Security system database in 2021. Human resources were defined as the availability of doctors in FKTP, infrastructure as credentialing value, ownership and type of FKTP, and KBK, and performance as first contact, non-specialist outpatient referral ratios, and Chronic Disease Management Program/*Program Pengelolaan Penyakit Kronis* (Prolanis) participant ratio. The analytical results revealed that human resources directly and positively affected the KBK. The indirect effect analysis results suggested that only human resources impacted FKTP performance. In conclusion, human resources are critical in achieving the KBK and FKTP performance.

Keywords: First Level Health Facilities performance, human resources, Performance-based Capitation

Introduction

Equal access to health services is a challenge worldwide. Access to health services is one of the government's responsibilities of providing health insurance to the people in line with the primary objectives of the Sustainable Development Goals for Universal Health Coverage (UHC).[1] Unfortunately, half of the world's population is known to have no access to health services.[1] In implementing the UHC, equity is inherent and embodied in healthcare coverage, including access and use of services.[2] Studies show that First Level of Health Facilities/*Fasilitas Kesehatan Tingkat Pertama* (FKTP) services means crucial to reduce healthcare inequities.[3] The FKTP is the most accessible health service for insurance participants;[4] therefore, the future sustainability of healthcare system could be achieved through comprehensive first-level performance measures.[5]

To monitor the FKTP performance in a structured and continuous manner in Indonesia, BPJS Healthcare Security implemented performance-based capitation/*Kapitasi Berbasis Kinerja* (KBK) payment in 2016 aimed at improving the FKTP performance by monitoring and linking it to a monthly capitation payment.[6] The comparison of quality index values attained by KBK and non-KBK health facilities groups shows that applying KBK improves the FKTP quality.[4]

In Indonesia, policies providing incentives and disincentives to improve performance have been widely enforced but are more oriented toward motivating employees to improve performance. Providing incentives and disincentives has an impact on the sustainability and success of programs.[7] It is expected that by KBK payment, FKTP, as a gatekeeper, could meet such equity and efficiency aspects of health services and the responsiveness of health services provisions in fulfilling the rights and expectations of citizens for effective, quality, and needed health services. BPJS Healthcare Security, the National Health Insurance (NHI) organizer, implemented KBK payment in 2016 that was given to FKTP under the NHI scheme. Three indicators of KBK assessment include the number of contacts between FKTP and NHI participants, the ratio of non-specialized outpatient referrals, and the ratio of Chronic Disease Management Program/*Program Pengelolaan Penyakit Kronis* (Prolanis) participants.[8]

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Received : August 20, 2023
Accepted : February 16, 2024
Published : February 29, 2024

The FKTP performance was improving after implementing the KBK. The number of contacts between FKTP and NHI participants increased by 18.8% in 2019 compared to 2018 and 2% in 2020 despite the COVID-19 pandemic.[9] The referral system was also improving, as seen by the decrease in the ratio of referrals to hospitals by 2.3% from 2018 to 2020.[10] Moreover, the implementation of KBK payment can reach 56.85% of diabetes mellitus (DM) and hypertension patients registered with the Prolanis, as well as 19.2% in controlled blood sugar for DM patients and blood pressure for hypertension patients in 2020.[10]

The capitation amount is given based on FKTP performance achieved with two criteria: FKTP has cooperated with BPJS Healthcare Security for at least one year and/or has a minimum of 5,000 registered participants.[4] The assessment of KBK payment is based on performance indicators multiplied by scoring criteria rating of performance achievement. The amount of capitation payment per FKTP is based on the sum of achievement scores per each indicator. BPJS Healthcare Security Regulations Number 2 of 2015 stipulates that KBK payments will be deducted if FKTP performance does not reach 100%.[11] In particular, the capitation rate is set separately for remote areas. Such policy succeeded in achieving a positive performance of FKTP, and provided quite a deterrent effect for Primary Health Care (PHC) that did not make maximum efforts to achieve the 100% KBK indicators.[12]

The availability of human resources (HR), in this case, doctors, nurses, midwives, and pharmacists, means a factor affecting KBK achievement and dominantly in all indicator achievements.[12] The number of contacts is achieved through NHI participants' visit to FKTP, or vice versa. The limited availability of HR has led to a non-achievement in a contact rate indicator of 150 per mile. Such situation is a double burden for PHC staff to provide NHI services and the Public Health Efforts Program. They are responsible of delivering services at PHCs and in communities.[12] This condition that visits to the NHI participants' homes could not be carried out.[13]

The availability of general practitioners affects the achievement of non-specialized referral ratios.[13] General practitioners are the service providers diagnosing the disease and deciding whether participants are referred to the hospital. A total of 144 diagnoses of diseases included in non-specialized referrals are by the competence of general practitioners.[4] In addition to HR, the availability of other personnel, such as administrative and medical record staff, affects KBK achievement. Administrative staff input health services data into the BPJS Healthcare Security application named PCare.[15] The data entered would affect the FKTP performance measures.[16] While medical record staff are needed to organize referrals influenced by proper coding, selecting the wrong coding at the time of referral would affect achievement in the non-specialized referral ratio.[17]

Limited infrastructure affects the achievement of contact rate indicators.[15] After the service is provided, recording is taken in the PCare apps to reach the number of contacts indicator so that infrastructure is needed to support the process. The availability of facilities used for health checks and diagnostic support affects achievement in non-specialized referral ratio indicators.[14] Non-specialized referrals are made as any available facilities are unable to support patients' treatment according to the 144 diagnoses.[4]

Good FKTP governance and organization affect the achievement of performance indicators. Inadequate support from the local government and absent policies supporting KBK are influential factors in the achievement of KBK.[15] The FKTP staff's authority for the assigned tasks has a significant relationship with the achievement of KBK indicators. The authority given would make clear the division of tasks and the responsibility of each staff.[18] Apart from authority, another influential factor is the commitment of the leadership and all staff at FKTP.[14]

Activity planning affects the achievement of the number of contacts indicator. Activities by PHC, such as home visits in the *Indonesia Sehat* (Healthy Indonesia) Program, could be integrated as an effort to achieve the number of contacts.[14] This study aimed to analyze a relationship between implementing KBK on FKTP performance and influential factors on FKTP performance achievements. The outcomes of this study are expected to improve the FKTP performance for an optimal implementation of KBK in all FKTPs in Indonesia.

Method

This study was conducted in February 2023 and used secondary data from the BPJS Healthcare Security with a total of 28,301 FKTPs in Indonesia in 2021.[6] The Structural Equation Model-Partial Least Square (SEM-PLS) was applied to analyze a correlation between a FKTP capacity with KBK and the FKTP performance (Figure 1). This study aimed to assess the effects of KBK on FKTP performance, in which the KBK was influenced by FKTP's capacity.[19]

The following are the stages carried out in SEM-PLS:

a. Multicollinearity

In a multiple regression model, multicollinearity is defined as a significant correlation or link between two or more independent variables.[20] Several assumptions must be met for analyzing the inner model, including the multicollinearity assumption. If there is multicollinearity, the predictive power is unreliable and invalid. If the Variance Inflation Factor

(VIF) value of a regression model is lower than 9, it is considered to have no multicollinearity.[20]

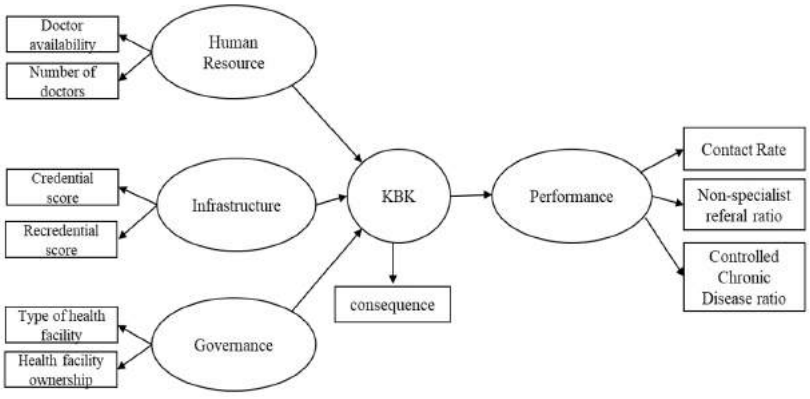
b. Model evaluation

Model evaluations are assessed through estimated validity and reliability to observe the relationship between indicators and constructs.[21] Validity analysis is a method to observe the relationship between indicators in a construct and between constructs that make up a model, as well as direct and indirect effects, by looking at the t-value (CR) of >1.96. The expected value of the Average Variance Extracted (AVE) is greater than 0.5, so each variable is considered to have good discriminant validity. Composite reliability measures how well variables underlying constructs served in structural equation modeling. It is allowed to have a build reliability coefficient greater than 0.70. A value of CR ≥ 0.7 is required to achieve construct reliability.[21]

Results

The test was conducted to examine whether a multicorrelation between variables was found in this model. Table 1 displays the results of the multicollinearity test of the study data. The value of collinearity diagnostics results shows that the coefficient is below the measurement limit. This value means that all indicators of KBK, performance, governance, and infrastructure variables were not strongly correlated or related to the variables studied.

After evaluating the loading factor value, the next step is to look at the value of Cronbatch's alpha, composite reliability, and AVE. Table 2 shows that the reliability test of two latent variables (KBK and infrastructure) was considered very good, while the other three latent variables (performance, HR, governance) were considered otherwise. The AVE value illustrated the variance or diversity of indicators that latent variables could own. Thus, the greater the variance or diversity of indicators that latent variables could contain, the greater the representation of indicators on latent variables. The AVE value is acceptable if the value is greater than 0.5, meaning that more than half of the diversity of the



Notes: Construct (Variable latent): Human Resouce, Infrastructure, Governance, KBK, and Performance. Indicator: Doctor availability (HR1), Number of doctors (HR2); Credential score (Inf1), Recredential Score (Inf2); Type of Health Facility (Gov1), Health Facility Ownership (Gov2); Consequence (Consq); Contact rate (Perf1), Non-specialist referral ration (Perf2), Controlled Chronic Disease ratio (Perf3).

Figure 1. Research Framework

Table 1. The Results of the Multicollinearity Test

Variable	Variance Inflation Factor
Number of doctors	1.118
Doctor availability	3.231
Credential score	2.412
Recredential score	1.112
Health facility type	2.374
Ownership	2.374
Consequence	1.000
Contact rate	1.115
Non-spesialist referal ratio	1.039
Controlled chronic disease ratio	1.089

Table 2. Model Evaluation

Variable	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
KBK	1.000	1.000	1.000
Performance	-0.014	0.313	0.319
HR	-0.963	0.473	0.406
Infrastructure	1.000	1.000	1.000
Governance	-6.360	0.002	0.880

Notes: KBK = Performance-based Capitation/*Kapitasi Berbasis Kinerja*, HR = Human Resources

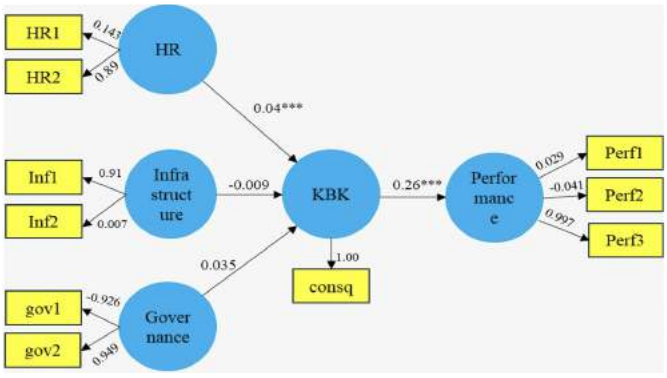


Figure 2. The Structural Equation Model-Partial Least Square Results

Table 3. Direct Effect of Latent Variables

	Coefficient	Mean	SD	t-value	p-value
KBK→Performance	0.268	0.269	0.017	15.447	<0.001
HR→KBK	0.040	0.041	0.004	11.121	<0.001
Infrastructure→KBK	-0.009	-0.009	0.006	1.499	0.135
Governance→KBK	0.035	0.026	0.025	1.400	0.162

Notes: SD = Standard Deviation, KBK = Performance-based Capitation/*Kapitasi Berbasis Kinerja*, HR = Human Resources

indicator could explain the latent variable.

Information obtained from Table 2 shows three variables having AVE values exceeding a minimum criterion of 0.5. This means that the three indicators of latent variable studied in this study could explain and measure the variable well. In contrast, the two construct indicators (performance and HR) belong to the poor category.

Figure 2 and Table 3 show the results of hypothesis testing as follows:

a. The Path Coefficients value on the KBK variable in hypothesis testing obtained a value of 0.268, which was >0 (positive effect), the t-value of 15.447, which was >1.96, and the significant value was <0.05. These results showed that the KBK positively and significantly affected performance.
b. The Path Coefficients value on the HR variable in hypothesis testing obtained a value of 0.040 (>0), a t-value of 11.121 (>1.96), and a significant value of <0.05. These results pointed out that HR positively and significantly affected the KBK.
c. The Path Coefficients value on the infrastructure variable in hypothesis testing obtained a value of -0.009 (<0), a t-value of 1.499 (>1.96), and a significant value of 0.135 (>0.05). These results showed that facilities and infrastructure had no negative and insignificant effect on the KBK.
d. The Path Coefficients value on the governance variable in hypothesis testing got a value of 0.035 (<0), a t-value of 1.400 (>1.96), and a significant value of 0.162 (>0.05). Based on these results, governance did not have a positive and significant effect on the KBK.

Table 4. Indirect Effect of Latent Variable

	Coefficient	Mean	SD	t-value	p-value
HR→Performance	0.011	0.011	0.001	8.265	<0.001
Infrastructure→Performance	-0.002	-0.002	0.002	1.444	0.149
Governance→Performance	0.009	0.007	0.007	1.388	0.166

Notes: SD = Standard Deviation, HR = Human Resources

Based on the Table 4, the results can be described as follows:

1. The KBK mediated the effect of HR on performance. The coefficient was 0.011, and the significance was 0.00 (p-value < 0.001). The KBK could strengthen the influence of HR on performance.
2. The KBK mediated the effect of facilities on performance. The coefficient was -0.002, and the significance was 0.149. The KBK was unable to strengthen the influence of facilities and infrastructure on performance.
3. The KBK mediated the effect of governance on performance. The coefficient was 0.009, and the significance was 0.166. The KBK could not strengthen the influence of governance on performance.

Discussion

Availability of Human Resources

The availability of HR means an influential factor to the KBK achievement.[22] The availability of HR (doctors, nurses, midwives, pharmacists) dominantly influenced all indicator outcomes.[12] The limited availability of HR led to the non-achievement of the contact rate indicator of 150 per mile. The number of contacts was achieved through visits, either made by participants to FKTP, or vice versa. However, it became a double burden for the PHC staff.

An issue attracting the most attention is the gap in the distribution of medical personnel in Indonesia.[23] The increasing proportion of medical personnel in the population has been considered insufficient to meet the demands.[23] In particular, the small and disparate distribution of health workers in the Eastern Indonesia, as well as the inadequate quality of services provided occur.[23] To reduce such service gap, the central government enforces the "Healthy Archipelago"/*Nusantara Sehat* (NS) program that spreads medical personnel to different regions. Unfortunately, NS workforce face various difficulties largely for the low well-being of theirs in rural areas. In the end, an equitable distribution of medical personnel in rural areas is not accomplished.

The digital transformation emerging in the health industry is also another issue affecting medical personnel that must follow any latest developments with their supporting skills and expertise. Data entry using the PCare apps is necessary to achieve the KBK. The absent documentation of the indicator achievement is a result of the lack education and expertise of health workers.[24] Therefore, to ensure that each achievement is properly documented, medical personnel need to acquire current knowledge and abilities.

Availability of Infrastructure Facilities

The limitation of infrastructure facilities affected the achievement of contact number indicator.[16] After providing the service, recording was done in the PCare apps to achieve the number of contact indicator; therefore, infrastructure is needed to support the process. The availability of facilities used for medical check-ups and diagnostic support affects the achievement of non-specialized referral ratio indicator.[14] The non-specialized referrals are made as the available facilities are unable to support patient treatment according to the 144 diagnoses.[5] The non-specialized referral indicator is an indicator showing the ability of FKTP to handle 144 diagnoses completely. In addition to general competent practitioners in completing the 144 diagnoses available at FKTP, limited facilities would make patients referred to hospitals. This condition results in the non-specialized referral ratio indicator not being achieved.

Conclusion

HR plays a crucial role in achieving the KBK and has an indirect impact on the FKTP performance. The government must significantly meet the HR needs in all health facilities in Indonesia and ensure the welfare of HR. The HR availability is not only limited to the number, but also equitable distribution of HR availability in each region in Indonesia to level up the KBK achievement and the FKTP performance. Furthermore, HR capabilities must be improved through seminars or workshops to meet expectations for achieving the most optimal KBK.

Abbreviations

UHC: Universal Health Coverage; FKTP: *Fasilitas Kesehatan Tingkat Pertama*/First Level Health Facilities; KBK: *Kapitasi Berbasis Kinerja*/Performance-based Capitation; NHI: National Health Insurance; Prolanis: *Program Pengelolaan Penyakit Kronis*/Chronic Disease Management Program; DM: Diabetes Mellitus; PHC: Primary Health Care; HR: Human Resources; SEM-PLS: Structural Equation Model-Partial Least Square; VFI: Variance Inflation Factor; AVE: Average Variance Extracted.

Ethics Approval and Consent to Participate

Ethical approval was obtained from the Research and Community Engagement Ethical Committee of the Faculty of Public Health Universitas Indonesia (Reference 31/UN2.F10.D11/PPM.00.02/2023).

Competing Interest

The authors declared that there are no significant competing financial, professional, or personal interests that might have affected the performance or presentation of the work described in this manuscript.

Availability of Data and Materials

As a source of data and information from ProQuest, Scopus, Science Direct and BPJS Healthcare Security database in 2021.

Authors' Contribution

ARA and AB contributed substantially to the concept and work design. ARA conducted data analysis and data interpretation. CC drafting of the manuscript. ARA and AB revised critically for the content and final approval of the version to be published.

Acknowledgment

Not Applicable.

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Kesmas

Volume 19
Issue 1 *February*

Article 6

2-29-2024

Road Traffic Noise Annoyance and Cardiovascular Disease Risk in Population: A Case Series Study in Kota Bharu, Malaysia

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Recommended Citation

Naim F , Nasir NH . Road Traffic Noise Annoyance and Cardiovascular Disease Risk in Population: A Case Series Study in Kota Bharu, Malaysia. *Kesmas*. 2024; 19(1): 42-50
DOI: 10.21109/kesmas.v19i1.7458
Available at: https://scholarhub.ui.ac.id/kesmas/vol19/iss1/6

Naim et al. *Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*. 2024; 19 (1): 42-50
DOI: 10.21109/kesmas.v19i1.7458

Kesmas: Jurnal Kesehatan Masyarakat Nasional (Kesmas: National Public Health Journal)

Road Traffic Noise Annoyance and Cardiovascular Disease Risk in Population: A Case Series Study in Kota Bharu, Malaysia

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Abstract

Noise pollution can cause annoyance, significantly threatening the population's health and well-being. This study aimed to find an association between road traffic noise exposure and cardiovascular disease (CVD) risk among residents in Kota Bharu, Malaysia. This descriptive study used a case series approach and surveyed 34 residents in selected residential areas near main roads. An adapted questionnaire was distributed to residents using a purposive sampling method. Questions related to sociodemographic information, self-reporting about CVD, and road traffic noise assessment were asked to investigate the underlying risk factors for CVD. The average score of CVD assessment was classified as moderate risk. No significant association between noise annoyance and CVD was found using multiple linear regression. However, the association between cardiovascular risk and sociodemographic variables, particularly the length of residency at the current address, was statistically significant. Although noise annoyance was not associated with CVD, the length of residency could mediate CVD risk as those living longer in residence might be less vulnerable to the noise. Future longitudinal studies are recommended, which include a noise exposure assessment with a larger sample.

Keywords: CVD, cardiovascular risk, noise annoyance, noise exposure, road traffic noise

Introduction

Environmental noise could be defined as unwanted or harmful outdoor sounds that human activities generate, which include noise from roads, railways, airports, and industrial sites.[1] Noise has been recognized as a pollutant by the World Health Organization since 1972.[2] A main agent resulting in environmental loss and degraded quality of life in a metropolis is noise pollution.[3] Europeans spend approximately 90% of their time indoors and almost 60% at home.[4] Similar to the Asia Pacific region, most of the population preferred to stay at home despite the lockdown measures had been lifted during the COVID-19 pandemic.[5] Over 70% of the Malaysian population preferred to stay at home compared to those who chose to go out.[5]

Road traffic noise is harmful to the health of urban residents, especially at night. The major concern of environmental noise exposure in cities is sleep disturbance as the nighttime noise is more pervasive in urban areas, which reduces the quality and quantity of sleep even at a low level of noise.[6] Outdoor road traffic noise exposure has affected many residents' sleep quality and convenience.[7] The nighttime road traffic noise, even at a level lower than daytime exposure, contributes to oxidative damage, elevated stress hormone levels, and fragmented sleep.[7] These variables may contribute to the development of high blood pressure and vascular malfunction (endothelial dysfunction).[8]

Besides, the misclassification of daytime noise exposure in residential areas is higher than nighttime noise as people are more likely not to be at home.[9] A prospective cohort study among 2,497 residents in the region of Basel, Switzerland, found that noise annoyance and sleep disturbance were strong mediators for the effects of road traffic noise on the health-related quality of life.[10] Any reaction to noise annoyance is mediated by sleep disturbance, communication, and activity, as well as associated emotional and cognitive reactions. These affect endocrine (e.g., increased concentrations of cortisol and catecholamine) and autonomic (sympathetic) systems.[11] This may lead to modifications in blood pressure regulation and glucose and lipid metabolism, all of which increase the risk of cardiovascular disease (CVD).[7]

Overall, exposure to road traffic noise could increase CVD risk for several influential factors: sociodemographic

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Received : September 18, 2023
Accepted : February 20, 2024
Published : February 29, 2024

characteristics (age, sex, and socioeconomic status), health status, and lifestyle.[12] Therefore, determining the noise annoyance of residents will serve as a proxy for the subjective assessment of road traffic noise exposure in the residential areas observed. This method has been applied in previous studies,[13-15] as annoyance is a symptom of emotional stress, which is a major risk factor for the development of atrial fibrillation with a strong association with other CVDs, including coronary artery disease and hypertension.[16] Furthermore, noise sensitivity is a sign of vulnerability to environmental stressors, and the highly-sensitive persons are more likely to develop illness when exposed to environmental noise.[17]

Kota Bharu, a capital city of Kelantan state on the East Coast of Peninsular Malaysia, may face critical noise pollution issues in the near future due to the growing population, rapid urbanization, improper road planning, and increasing traffic volume in the city. The problem may become worse for no proper integration between land use and road planning in Kota Bharu to reduce the impact of environmental noise pollution. Road traffic noise, particularly higher vehicular traffic and vehicle speeds, causes problems for local residents. This study aimed to assess the noise annoyance perceived by the residents as a proxy for road traffic noise exposure and its association with the CVD risk in Kota Bharu, Malaysia.

This study is the latest in determining the causal impact of noise annoyance on CVD risks in the small regions to add to the existing literature on the epidemiological relationship between noise and health in Malaysia rather than simply assessing the level of noise exposure level. Therefore, the outcomes would indicate whether safety measures or certain actions are adequate to deal with the problem of road traffic noise among the neighborhoods impacted, such as the monitoring of noise level, noise barriers, building sound insulation, the enforcement of noise regulations and policies, and the monitoring of speed limit around the residential area.

Method

This study applied descriptive research design with case series as the methodological approach. Residents living in a residential area in Kota Bharu near main roads were recruited to participate in this study that was conducted in January-July 2020. The residential area locations selected were Taman Seri Pengkalan Chepa, Taman Seri Tambahan Pengkalan Chepa, and Bandar Baru Kubang Kerian due to facilities near the residential areas (within 1 km). The commercial areas consist of many restaurants and a city airport at Pengkalan Chepa. At the same time, Universiti Sains Malaysia Hospital, schools, and shopping centers are located in Kubang Kerian, which could be considered a point of attraction in Kota Bharu. All of these activities might contribute to noise pollution in Kota Bharu.

The population in this study was residents living in the selected residential areas in Kota Bharu close to the main roads, approximately 100 meters away, as used in the previous study.[18] However, distance estimation was done using the Google Maps app and observation during the site survey. The inclusion criteria included those exposed to road traffic noise (living close to a main road within 100 meters) and individuals aged 18 years and older who understood Malay or English language. Based on the 2019 National Health and Morbidity Survey, Malaysians aged 18 years and older were estimated to have a high potential of getting CVD symptoms.[19]

More than one respondent or representative per household was allowed to participate in this study. Illiterate householders were excluded from the study. A priori power analysis determined the minimum sample size required for the study hypothesis testing. Results indicated the required sample size to achieve 80% power for detecting a medium effect, at a significance criterion of $\alpha = 0.05$, was $N = 55$ for linear regression. However, only 34 participants were obtained to participate in this study through purposive sampling.

This study applied an adapted questionnaire as an instrument to answer the aims of study. The questionnaire consisted of three parts. The first part consisted of self-developed questions to gather sociodemographic information, such as sex, race, household income, occupation, duration of living at current address (years), and current address. Household income and occupation would indicate the socioeconomic status of the respondents. A previous study found that deprived groups suffered a low economic status burden and were vulnerable to higher noise exposure.[20] The second part contained questions about the CVD risk factors and records. The third part comprised road traffic noise assessment-related questions. The modified questionnaire was reviewed by the field experts. In terms of the internal consistency of the questionnaire items, Cronbach's alpha value obtained was 0.811, thus indicating that the questionnaire was reliable.

Cardiovascular Risk Assessment Questionnaire (CRAQ)-related questions in the second part were adopted and modified from the prior study. The questionnaire originated from Australia and New Zealand Health World.[21] This CRAQ tool was used as it has a multiple-choice questionnaire designed to assess an individual's CVD risk, which is structured and easy to comprehend and respond to for the target local community. The questionnaire provided assignment of a "risk score," either positive, neutral, or negative to each potential support item, based on how each associated element contributed to or reduced CVD risk in this study. The questionnaire had two parts: the first part

must be filled in by a patient or subject, while the second part must be filled in by a physician.

However, this study only took the first section of the questionnaire. Only the patient's self-report section was used in this study, as not all participants had access to a doctor's or their medical records. The CRAQ part comprised seven subscales: risk associated with age younger than 30 years to older than 70 years (score range: 0 to 140), CVD records (score range: 0 to 250), CVD and diabetes in family (score range: 0 to 45), healthy or unhealthy lifestyle (score range: -35 to 150), including physical activity, smoking, alcohol abuse, passive smoking, and environment, stress and its management (score range: -19 to 330), sleep duration and its disorders (score range: 0 to 29), and healthy or unhealthy nutrition (score range from -23 to 48). The CVD outcome was measured based on the total cardiovascular risk score divided into four categories: low (-88 to 100), moderate (101 to 220), high (221 to 350), and severely high (351 and more). The higher the score, the higher the CVD risk. Negative scores indicated a reduced effect of CVD risk, such as due to a healthy lifestyle or diet.

Moreover, the last part of the questionnaire was road traffic noise assessment, adopted and modified from the International Commission on Biological Effects of Noise annoyance ratings.[22] The road traffic noise exposure measures used a 0-10 scale according to the magnitude of annoyance to the road traffic noise that the residents perceived while staying at home. 0 indicated "not all annoyed," and 10 was categorized as "extremely annoyed." The questions also included when the road traffic noise was annoying, disruptive, or disturbing at home during the morning, afternoon, and evening on weekdays and weekends.

Furthermore, the respondents were asked about the action taken and any suggestions to reduce the noise at home. Due to the unexpected COVID-19 pandemic, the road traffic noise measures could not be taken. Therefore, this study assessed the noise exposure among the residents through perceived noise annoyance. Although community activities were restricted during the COVID-19 pandemic, which indirectly reduced the road traffic noise level, this study required the residents to self-report their perceived annoyance based on overall (past and current) experiences living in their residential areas.

The questionnaire was distributed to the residents by hand in the selected residential areas to obtain the larger number of study participants. The surveys were distributed in the evening of weekdays after working hours. Respondents were asked to participate in this study if they were accessible and met the inclusion criteria. Respondents who needed some assistance to answer the questions were guided without trying to influence their answers. Each respondent had a participant code number recorded on the questionnaire form to ensure that the data were anonymized. In addition, the respondents provided and filled out the written consent form upon answering the questionnaire as their approval to join the study and to ensure the confidentiality of their personal information.

The data analysis used the SPSS version 24.0, licensed under the Universiti Sains Malaysia. The distribution of respondents for sociodemographic information was analyzed descriptively and presented in frequency and percentage, while CRAQ was in mean and standard deviation, and noise annoyance used a median and interquartile range. Data normality was checked using the Kolmogorov-Smirnov test. The Pearson correlation test was used to determine the relationship between cardiovascular risk, noise annoyance, and length of residency. Inter-relationships among variables could significantly influence the interpretation of regression model findings in reference to prior expectations, although not nearly as high as strong collinearity.

Multicollinearity might affect the size and the standard error of the regression coefficients related to those collinear variables, which could be difficult to interpret.[23] The association between the CVD and noise annoyance was explored using simple linear regression since the outcome of this study was analyzed as a mean score. The statistical relationship between CVD risk, sociodemographic, and other potential risk factors, such as age, CVD record, family history, lifestyle, stress, sleep, and diet risks, was analyzed through multiple linear regression tests.

Results and Discussion

Table 1 shows the distribution of respondents by demographic information, with a total of 34 respondents. Most participants were female (61.8%), Malay (88.2%), and under 30 and 50-69 years old, with an equal percentage (35%). The mean age of respondents was 37 years. However, most respondents were at the age of under 30 years, in which the percentage for this age group was the highest in this study. Most respondents were young residents for only one representative per household preferred by the occupants to answer the questionnaire, and most likely they were those who could read and write well.

In addition, the highest percentage (44%) for household income was obtained from respondents receiving worth Malaysian Ringgit (MYR)1,000-4,999 monthly, which fell under the first quartile. Based on the results, the respondents' household income mostly fell under the first quartile. For decades, socioeconomic status has shown a consistent inverse relationship with CVD in most industrialized countries in the West, in which disadvantaged groups experience a higher

Table 1. Distribution of Respondents Based on Demographic Information Characteristic (n = 34)

Variable	Category	n (%)
Sex	Male	13 (38.2)
	Female	21 (61.8)
Age (years)	Under 30	12 (35.3)
	30 – 34	4 (11.8)
	35 – 39	5 (14.7)
	40 – 44	-
	45 – 49	1 (2.9)
	50 – 54	4 (11.8)
	55 – 59	2 (5.9)
	60 – 64	5 (14.7)
	65 – 69	-
	70 – 74	1 (2.9)
	75 and over	
Race	Malay	30 (88.2)
	Chinese	4 (11.8)
Household income	Lower than MYR 100	6 (21.4)
	MYR 1,000 – MYR 1,999	6 (21.4)
	MYR 2,000 – MYR 2,999	5 (17.9)
	MYR 3,000 – MYR 3,999	3 (10.7)
	MYR 4,000 – MYR 4,999	1 (3.6)
	MYR 5,000 – MYR 5,999	2 (7.1)
	MYR 6,000 – MYR 6,999	1 (3.6)
	MYR 7,000 – MYR 7,999	1 (3.6)
	MYR 8,000 – MYR 8,999	1 (3.6)
	MYR 9,000 – MYR 9,999	1 (3.6)
	MYR 10,000 and greater	1 (3.6)
Length of residency	Less than 1 year	3 (9.1)
	1-10 years	8 (24.2)
	More than 10 years	22 (66.7)
Type of house	Semi-detached or townhouse or terrace or villa	17 (50.0)
	Other (Shophouse)	17 (50.0)

Note: MYR = Malaysian Ringgit

risk of CVDs.[24] Several studies have agreed that low-income individuals are at higher risk of developing CVD.[25,26] Rosengren et al.[27] studied 20 low-, middle- and high-income countries in total and found a high level of CVD risk in low social class associated with low education levels.

More than half (66.7%) of the residents had lived more than ten years at their current residence. Half of the them lived in a terrace house, and another half stayed at a shophouse. Based on the survey, most respondents were not exposed to occupational noise as their occupations had a low exposure to high noise levels. The respondents' occupations included retail businessmen, students, housewives, clerks, educators, and managers. This study revealed that most respondents lived in their current residence for more than ten years. Therefore, these respondents might be more resistant to noise in their surroundings.

Accordingly, the road traffic noise emission would no longer affect their daily basis since they had lived at their house for a long time. A previous study found that the population living close to high-traffic roads exceeding 70 dBA did not consider road traffic noise an annoying factor.[28] This might be due to such insensitivity of theirs to adverse road traffic noise conditions as they do not intend to change their residence.[28] However, some of them could also feel annoyed by road traffic noise since they had experienced gradual exposure to noise, which might be higher than before for the urban development in Kota Bharu.

Most respondents were annoyed by the road traffic noise, with a median of six on a ten-point scale. Due to study limitations, the road traffic noise measures could not be taken. Therefore, this study used the noise annoyance scale as an indicator for the residents' exposure to the road traffic noise. Most respondents preferred motorcycles (70.6%) as the primary source of road traffic noise around their residential area, followed by private cars (48.5%). A study in Indonesia shared the same findings.[29] Private cars were the second highest to be selected as the source of road traffic noise in the survey, as stated in several studies in Malaysia.[30-32] The respondents also felt disturbed by the engine revving and fast-moving vehicles; a previous study called this vehicle noise.[30]

On the other hand, the respondents did not think that road traffic noise interfered with home life, such as listening

to the music, having a conversation, reading, relaxing, studying, and spending time outdoors. A study in Shah Alam, Malaysia, also revealed that the nearby residents' daily activities and health conditions were not affected by the noise level from the traffic.[32] Several causes are determined to explain a variety of noise annoyance levels among individuals. The first is the degree of susceptibility to noise. Generally, everyone has their level of vulnerability to noise. Therefore, some people could stand at a high level of sound. Second, humans are immune to the noise around them. The third is the house location. If the house is surrounded by large trees, the noise from traffic might be reduced since trees serve as a natural sound barrier.[33] Therefore, indirectly, the occupants would have lesser exposure to the noise.

However, almost half of respondents admitted that they had difficulty hearing conversations during phone calls (41.2%), while 32.4% reported that their sleep had interfered. Most respondents stated that road traffic noise caused bothersome, annoyance, or disturbance at home and at night on weekends (61.8%) and weekdays (73.5%). The respondents managed to reduce the noise even though most (56.5%) claimed the action did not solve the problem. (Table S1).

The CVD risk assessment scores (mean±SD) are shown in Table 2. The mean total score of cardiovascular risk is 125.65±72.78. This result is categorized as moderate risk (101 to 220) according to CVD risk classification. Additionally, risks related to cardiovascular history and stress were moderate. The mean lifestyle score (17.71±21.76), including the residents' environment, was recorded as moderate risk based on the risk classification. The distribution of each CVD risk of the respondents is shown in Table S2 of the Supplementary Files.

Although the prevalence of noise annoyance was only moderate, some residents had initiatives to reduce the noise by modifying inside or outside their houses, soundproofing their bedrooms, blocking the noise by wearing earphones, asking for legal advice, filing a complaint or making a police report, and warning or giving an advice to the driver who made the noise. Awareness of such actions might also reduce the exposure to road traffic noise and indirectly lessen the perceived annoyance level. The awareness might also explain the moderate risk of CVD among the study population. Consequently, the CVD risk might be attributed to the noise exposure as a subfactor studied in the lifestyle aspect was the house location near the main road.

The relationships between age, CVD records, family records, lifestyle, stress, sleep, nutrition, total risk, noise annoyance, and length of residency using the Pearson correlation test. This test measured the strength of association between the exposure and outcome of interests, also potential confounding factors of CVD. However, based on the correlation matrix, only moderate correlations were found between age and nutrition (r = -0.52) and total CVD risk with CVD (r = 0.605) and family records (r = 0.569). The length of residency also has moderate correlations with age (r = 0.507), family records (r = 0.452), and total CVD risk (r = 0.699) (Table S3). Thus, the results indicated that only few predictors included in the study had moderate multicollinearity, and no covariate was correlated with noise annoyance.

Table 2. The Cardiovascular Disease Risk Assessment Score

Variable (Score Range)	Mean (SD)	Cardiovascular Disease Risk Category
Age risk (0 to 140)	37 (46.97)	Not a modifiable risk factor
Cardiovascular disease record risk (0 to 250)	25 (51.12)	Low: (0 to 30) Moderate: (31 to 50) High: (51 and above)
Family record risk (0 to 40)	15 (14.77)	Not a modifiable risk factor
Lifestyle risk (-35 to 150)	17.71 (21.76)	Low: (-35 to -10) Moderate: (-9 to 21) High: (22 and above)
Stress risk (-19 to 330)	25.53 (28.26)	Low: (-19 to 20) Moderate: (21 to 40) High: (41 and above)
Sleep risk (0 to 29)	4.97 (2.56)	Low: (0 to 5) Moderate: (6 to 11) High: (12 and above)
Nutrition risk (-23 to 48)	1.74 (6.91)	Low: (-19 to 6) Moderate: (7 to 13) High: (14 and above)
Total cardiovascular risk	125.65 (72.78)	Low: (-88 to 100) Moderate: (101 to 220) High: (221to 350) Very high: (351 and above)

Note: SD = Standard Deviation

Table 3. Association Between Noise Annoyance and Cardiovascular Disease Risk

Cardiovascular Disease Risk		Coefficient (95% CI)			
		Model I	Model II	Model III	Model IV
Noise annoyance		-0.038 (-9.640; 7.820)	-0.198 (-11.830; 2.690)	-0.005 (-0.800; 0.500)	-0.003 (-0.617; 0.464)
Sociodemographic	Age	-	-0.015 (-0.650; 0.610)	-	-0.016 (-5.420; 0.902)
	Sex	-	-0.084 (-60.100; 36.700)	-	-0.001 (-5.548; 5.108)
	Race	-	0.045 (-71.800; 89.400)	-	-0.002 (-0.630; 0.546)
	Household income	-	-0.145 (-11.100; 4.100)	-	0.016 (-1.960; 5.671)
	Length of residency	-	**90.313 (48.100; 132.500)	-	0.000 (-1.190; 1.183)
Cardiovascular risk factors	Age	-	-	**0.638 (0.937; 1.040)	**0.676 (0.922; 1.022)
	CVD record	-	-	**0.723 (0.987; 1.073)	**0.786 (0.960; 1.037)
	Family record	-	-	**0.201 (0.846; 1.130)	**0.187 (0.782; 1.053)
	Lifestyle	-	-	**0.275 (0.824; 1.013)	**0.307 (0.877; 1.016)
	Stress	-	-	**0.402 (0.961; 1.109)	**0.393 (0.945; 1.079)
	Sleep	-	-	*0.036 (0.180; 1.857)	**0.060 (1.146; 2.549)
	Nutrition	-	-	**0.069 (0.180; 1.857)	**0.076 (0.552; 0.995)
Adjusted R^2		-0.030	0.571	0.995	0.999

Notes: CI = Confidence Interval, CVD = Cardiovascural Disease, Significant at *p-value <0.05, **p-value <0.001, Statistical test: Multiple Linear Regression, Model I = Unadjusted Model, Model II = Adjusted with Sociodemographic Factors, Model III = Adjusted with Cardiovascular Risk Factors, Model IV (Fully Adjusted Models) = Adjusted with Sociodemographic and Cardiovascular Risk Factors.

Table 3 shows the association between noise annoyance and the CVD risk in the unadjusted (Model I, p-value = 0.833), partially adjusted (Model II, p-value = 0.204 and Model III, p-value = 0.700), and fully adjusted (Model IV, p-value = 0.766) models. No significant association was found between the noise annoyance of each model and the CVD risk. Model II was adjusted with the sociodemographic factors; only the duration of residence (years) at the current address (coefficient: 90.31, 95% CI = 48.1; 132.5, p-value<0.001) was significantly associated with the CVD risk. Generally, 57.1% of the CVD risk variance was explained in Model II (R^2 = 0.571; F = 7.307; p-value = 0.001).

While for the model adjusted with the CVD risk factors (Model III), all the risk factors included (age, CVD records, family records, lifestyle, stress, sleep, and nutrition) were strongly associated with cardiovascular risk. The explained variance was 99.5% (R^2 = 0.995; F = 1047.24; p-value<0.001). Similar to the fully-adjusted model (Model IV), all the CVD risk factors were associated with CVD (p-value<0.001). However, the length of residency was no longer significant. This model was able to explain 99.9% of the variance of the total CVD risk factors (R^2 = 0.999; F = 1332.57; p-value<0.001).

This study showed no significant association between noise annoyance and CVD risk in the unadjusted and adjusted models. Furthermore, sleep quality and noise annoyance might not be considered as adverse effects of noise since most residents were moderately annoyed and did not interfere with the road traffic noise. A study in Norway and the United Kingdom supported these results, stating that road traffic noise (mean Lden) was not associated with either incident cardiovascular, ischemic heart disease, or cerebrovascular disease.[34] However, a study in Taiwan found an association between the hypertension prevalence and road traffic noise exposure, even at low and mid-level frequencies.[35] This frequency level is reportedly sensitive to the human auditory system.[35] Non-significant association in this study might be due to selection bias (volunteer bias) in the recruitment of study participants, reflected in the variability of the exposure and the outcome measured.

The potential confounders for the CVD risks analyzed in this study were sex, race, household income, length of residency, and type of house. The CVD had a significant association with the length of residency (years) at the current address; however, no significant relationship was found with other sociodemographic factors. More than half of the residents had lived in their current residence for more than ten years. Besides, some participants had lived in their residences for one to ten years. This finding is similar to a previous study in Taichung, Taiwan,[35] but contradicts a study in Sweden that did not find an increased risk of hypertension among those with a length of residency period of greater than and equal to five years.[36]

Some circumstances limited the conduct and findings of this study. For the CRAQ, this study only used the first part of the questionnaire, which lowered the respondent's CVD risk score more than the total risk calculation and categories. The whole part of the questionnaire should be applied in future studies to provide more precise information on the CVD risk distribution. Besides, the sample size of this study was small, so it was really challenging to get a response from potential study participants through an email invitation approach. This study involved a limited number of

residential areas and respondents due to most residents' time constraints and unavailability during the walkthrough survey. However, the power analysis had been conducted for the acquired sample size (34 respondents). Thus, the obtained sample size suggested a ~60% and 30% probability of not encountering Type II errors in the simple and multiple linear regression analysis, respectively. Eventually, the exposure misclassification might occur since the current study used noise annoyance as a proxy for noise exposure level.

Conclusion

A significant association between noise annoyance and CVD cannot be determined in this study. However, the length of residency at current address significantly predicts noise annoyance among the residents. This indicates that the residents staying longer in the current residential area have been less sensitive to the noise and unaware of such invisible pollutant, which may silently result in some long-term health problems. Future studies, including noise exposure assessment with a larger population sample, are recommended to determine better causal relationships between noise and CVD.

Abbreviations

CVD: Cardiovascular Disease; CRAQ: Cardiovascular Risk Assessment Questionnaire; MYR: Malaysian Ringgit.

Ethics Approval and Consent to Participate

This study was assessed by the Human Research Ethics Committee of Universiti Sains Malaysia (number: USM/JEPeM/19110719). This study was conducted based on the specified criteria which include explaining the study benefits and the respondents' rights, protecting the privacy of respondents, as well as upholding aspects of fairness and the principle of openness by explaining research procedures and informed consent. Written informed consent was given to participate.

Competing Interest

The authors declared no significant competing financial, professional, or personal interests might have affected the performance or presentation of the work described in this manuscript.

Availability of Data and Materials

Data and materials are available for sharing according to procedures and regulations. The supplementary files can be accessed here.

Authors' Contribution

FN and NHMN designed the study, conducted quantitative data analyses, and drafted the manuscript. NHMN collected samples. FN gave feedback and revised the manuscript. All authors read and approved the final manuscript.

Acknowledgment

Special thanks to Universiti Sains Malaysia for the financial assistance through Short-term Grant Matching (304/PPSK/6315712). All authors express sincere gratitude to all respondents for their participation and assistance in completing this study. Many thanks to the Environmental and Occupational Health lecturers and lab staff for their valuable input and technical support.

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Kesmas

Volume 19
Issue 1 *February*

Article 7

2-29-2024

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Recommended Citation

Asri Y , Priasmoro DP , Muhtar MS , et al. Depression Among Islamic Boarding Schools Students During the COVID-19 Pandemic in East Java, Indonesia. *Kesmas*. 2024; 19(1): 51-58
DOI: 10.21109/kesmas.v19i1.7437
Available at: https://scholarhub.ui.ac.id/kesmas/vol19/iss1/7

Asri et al. *Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*. 2024; 19 (1): 51-58
DOI: 10.21109/kesmas.v19i1.7437

Kesmas: Jurnal Kesehatan Masyarakat Nasional (Kesmas: National Public Health Journal)

Depression Among Islamic Boarding Schools Students During the COVID-19 Pandemic in East Java, Indonesia

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Abstract

The COVID-19 pandemic significantly impacts many aspects of life, including health, economy, society, education, and mental well-being. The pandemic impact on mental health, in particular, leads to increased rates of depression, anxiety, and stress. This study aimed to determine the prevalence of depression among Islamic boarding school students in Indonesia and identify factors associated with depression symptoms. This cross-sectional study employed questionnaires for data collection. Assessment of depression levels used the DASS-21 tool. Descriptive statistics and multivariate logistic regression were applied to analyze relationships between variables. The study findings indicated that 62.4% of the students exhibited factors associated with depression. In general, education level, personality type, communication with peers, satisfaction with the living environment, and health status demonstrated significant associations with depression. In conclusion, recognizing and intervening at early stages are crucial for depression prevention and mitigation. This study serves as a key instrument for the policymakers in the field of education, providing insights to promptly take immediate actions, especially regarding the placement of students in Islamic boarding schools in Muslim-majority countries.

Keywords: depression, Indonesia, Islamic boarding school, policymakers, regulatory

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has significantly impacted people's lives physically and mentally. The rapid spread of COVID-19 worldwide has resulted in high rates of morbidity and mortality, as well as unexpected health, economic, social, educational, and psychological consequences.[1-2] Until October 2022, globally, over 6 million deaths from over 633 million COVID-19 cases were reported.[3-4] The pandemic has affected the social economy,[5-6] physical health,[7] mental health, such as depression, anxiety, and stress,[8-10] and high mortality rate.[11]

In a previous study, mental health has become a major serious issue among young people, in which almost 40.4% of the younger generation tends to have psychological problems.[12] The relationship between mental health problems and preventive behavior is essential for developing targeted interventions addressing both physical and mental health needs. Individual mental health status may help promote overall well-being and reduce the burden of disease in terms of mental health conditions and physical health issues.[13] Another study also found that 30.8% of the Indian general population reported depression, 26.6% had anxiety, and 24.5% reported stress.[8]

Furthermore, mental health issues among adults and the elderly were also reported to be still high.[14-15] Few studies revealed mental health issues among the young during the COVID-19 pandemic, especially in Islamic boarding schools.[16-17] A study in an Islamic boarding school in Malang City, East Java Province, Indonesia, reported 56% of students developing depression and 76% having anxiety.[18] Moreover, anxiety among adolescents in Indonesia was 54% during the COVID-19 pandemic.[19]

The Islamic boarding schools are inheritance of religious practice from the local community, the oldest type of Islamic education activity for acculturation to the local culture in Indonesia.[20] Islamic boarding schools' elements include dormitories for students to stay and mosques for worship. Islamic boarding schools have several weaknesses, including habits and culture, in which the students are used to doing some activities together, such as eating, studying, and sleeping, as well as the culture of greeting students and teachers with shaking and kissing hands.[20]

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Received : September 15, 2023
Accepted : February 28, 2024
Published : February 29, 2024

Most importantly, one dorm room is commonly occupied with 10-20 students, which could increase the risk of a student contracting COVID-19. Islamic boarding schools implement a rule prohibiting students from carrying their cell phones. This situation may cause a major mental health issue because the lack of information could worsen students' mental health. The Islamic boarding schools with closed spaces should consider the impacts of physical health and non-physical aspects. The uncertainty of the pandemic could affect the mental health status of Islamic boarding school students. Therefore, this study examined Islamic boarding school students' mental health status in Indonesia. In addition, this study aimed to assess the prevalence of depression among demographics and identify potential factors associated with depression symptoms.

Method

This descriptive-analytic study with a cross-sectional approach was conducted in March-April 2023. It should be noted that the estimated number of the Islamic boarding schools students' population in East Java Province, Indonesia, is approximately 970,541. The study utilized a significance level (alpha) of 0.05 to set a statistical power of 0.95. The 0.95 established a required sample size of 384, representing the precise number of responses needed to reach a specified level of precision. These parameters were based on prior study.[21-23] The sample size study collected 425 student participants meeting the criteria (p-value of 0.05) across Islamic boarding schools in four different regions in East Java Province (Malang, Mojokerto, Jombang, and Bojonegoro).

Convenience sampling methodology was applied. Inclusion criteria required participants to be at least 12 years old and currently reside within the confines of an Islamic boarding school. Preceding the questionnaire distribution to the student cohort, a comprehensive briefing outlining the study's objectives to all participants was conducted. Moreover, the participants were assured that their involvement would not affect their educational pursuits. Confidentiality was of the upmost importance, as all participants were guaranteed that their information would be kept confidential.

Data collection involved questionnaires covering participant sociodemographics, depression-related factors, and depression assessment. Sociodemographics included sex and education level. Depression factors included boarding school preference, parental support satisfaction, personality type, family visit frequency, stay duration, peer communications, satisfaction with the living environment, health status, socializing, sleep patterns, mask-wearing, distancing, and cough etiquette. The questionnaire's clarity was validated on 20 students from an Islamic boarding school.

The primary variable was depression, assessed using a 7-item depression scale from the Depression Anxiety Stress Scale-21 (DASS-21).[24] The validity of DASS-21 in the Indonesian version was previously used in the Indonesian population,[25-26] and the depression scale consisted of 7 items. Each item was scored on a 4-point Likert scale from 0 (never) to 3 (almost always). Scores of 0-9 were considered normal, and 10-42 indicated depression. All questionnaires were tested through linguistic validation before being implemented on the participants to assess items and clarify and identify whether responses were clear.

This study categorized sex as male or female; education level as junior or senior high school; boarding preference as self or parental; financial support from parents as satisfied or dissatisfied; personality as extrovert or introvert; family visit frequency as often, sometimes, or never; stay duration as one year or more than one year; peer communications as good, average, or poor; satisfaction of the living environment as satisfied, neutral, or dissatisfied; health status as good or poor; socializing as good or bad; sleep patterns as good, adequate, or poor; mask-wearing as yes or no; distancing as yes or no; and cough etiquette as yes or no. Data was analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Sociodemographics were described with frequencies and percentages. Bivariate analysis used the Chi-squared test. Multivariate logistic regression identified depression-related factors, generating odds ratio (OR) and 95% confidence interval (CI) for each variable in the final model.

Results

This study involved 425 students from Islamic boarding schools, and Table 1 presents the sociodemographic distribution and Chi-square analysis. The distribution of sex showed that 75.1% of participants were females, while 24.9% were male. For their educational background, 60.2% of students attained a senior high school level, and the remaining 39.8% had attended junior high school. Interestingly, 75.8% expressed their choice to stay at the boarding school, while 24.2% indicated their parents' preference.

A noteworthy finding showed that 90.8% of the students were content with the financial support they received from their parents, opposing the 9.2% showing their dissatisfaction. In term of personality, 56.5% of them identified as introverts, while 43.5% identified as extroverts. Family visit frequency varied, in which 27.8% experienced frequent visits, 68.2% had occasional visits, and 4.0% never had family visits. A substantial 82.6% of students stayed at Islamic

Table 1. Sociodemographic Distribution and Chi-squared Analysis Among Islamic Boarding School Students (n = 425)

Variable	Category	n (%)	Depression		p-value
			Normal (n (%))	Depression (n (%))	
Sex	Male	106 (24.9)	42 (9.9)	64 (15.1)	0.628
	Female	319 (75.1)	118 (27.8)	201 (47.3)	
Education level	Junior high school	169 (39.8)	52 (12.2)	117 (27.5)	0.017*
	Senior high school	256 (60.2)	108 (25.4)	148 (34.8)	
Preference to stay at a boarding school	Self-preferred	322 (75.8)	125 (29.4)	197 (46.4)	0.378
	Parents	103 (24.2)	35 (8.2)	68 (16.0)	
Satisfied financial support from parent	Satisfied	386 (90.8)	151 (35.5)	235 (55.3)	0.049*
	Dissatisfied	39 (9.2)	9 (2.1)	30 (7.1)	
Type of personality	Extrovert	185 (43.5)	81 (19.1)	104 (24.5)	0.022*
	Introvert	240 (56.5)	79 (18.6)	161 (37.9)	
Frequency of family visit	Often	118 (27.8)	43 (10.1)	75 (17.6)	0.917
	Sometimes	290 (68.2)	110 (25.9)	180 (42.4)	
	Never	17 (4.0)	7 (1.6)	10 (2.4)	
Duration of stay	≤1 year	74 (17.4)	27 (6.4)	47 (11.1)	0.821
	>1 year	351 (82.6)	133 (31.3)	218 (51.3)	
Peer communication	Good	324 (76.2)	139 (32.7)	185 (43.5)	<0.001*
	Average	89 (20.9)	17 (4.0)	72 (16.9)	
	Poor	12 (2.8)	4 (0.9)	8 (1.9)	
Satisfaction with the living environment	Satisfied	252 (59.3)	107 (25.2)	145 (34.1)	0.020*
	Neutral	163 (38.4)	48 (11.3)	115 (27.1)	
	Dissatisfied	10 (2.4)	5 (11.3)	5 (1.2)	
Health status	Good	395 (92.9)	156 (36.7)	239 (56.2)	0.004*
	Poor	30 (7.1)	4 (0.9)	26 (6.1)	
Interacting with friend	Good	404 (95.1)	157 (36.9)	247 (58.1)	0.023*
	Bad	21 (4.9)	3 (0.7)	18 (4.2)	
Sleep need	Good	254 (59.8)	107 (25.2)	147 (34.6)	0.025*
	Adequate	102 (24.0)	36 (15.5)	66 (15.5)	
	Poor	69 (16.2)	17 (4.0)	52 (12.2)	
Wearing a mask while doing activity	Yes	106 (24.9)	38 (8.9)	68 (16.0)	0.659
	No	319 (75.1)	122 (28.7)	197 (46.4)	
Keeping a safe distance	Yes	106 (24.9)	38 (8.95)	66 (15.5)	0.048*
	No	319 (75.5)	122 (28.7)	199 (46.8)	
Covering mouth with tissue or the inner arm while coughing	Yes	160 (37.6)	128 (30.1)	197 (46.4)	0.183
	No	265 (62.4)	32 (7.5)	68 (16.0)	
Depression	Normal	160 (37.6)	-	-	
	Depressed	265 (62.4)	-	-	

Note: *p-value <0.05

boarding schools for over a year.

Peer communications were generally positive, with 76.2% reporting good communication, 20.9% stating it average, and only 2.8% considering it poor. Furthermore, 59.3% expressed satisfaction with their living environment. Personal health was vital for their mental well-being, as 92.9% reported good health, while 7.1% indicated poor health. Furthermore, students overwhelmingly had good relationships with their friends (95.1%) and reported relatively positive sleep quality (59.8%).

However, a significant proportion (75.1%) did not wear masks during activities, and 62.4% did not adhere to hygiene practices, for example, not covering their mouth while coughing. Remarkably, 62.4% of the students reported indicated depression scores above nine on the DASS-21 scale, indicating a significant prevalence of depression among the study samples. These findings shed light on the diverse characteristics and well-being of students at the Islamic boarding school, highlighting areas of concern, such as mental health and hygiene practices, which may warrant further attention and support.

The study employed Chi-square analysis to explore potential associations between various variables and depression within the studied population. The corresponding p-values were utilized to evaluate the statistical significance of these associations. Notably, the analysis revealed no statistically significant association between sex and depression (p-value = 0.628), indicating that both males (9.9%) and females (15.1%) in the sample exhibited similar rates of depression.

Additionally, significant associations were found, particularly with educational level emerging as a noteworthy factor (p-value = 0.017). The findings suggested that individuals with senior high school levels were more likely to experience depression compared to those with junior high school levels. This underscores the importance of educational

background as a potential influencing factor in depression within the studied population. Similarly, the student's satisfaction with financial support from their families showed a statistical significance (p-value = 0.049). Those feeling dissatisfied with their financial support from parents were more likely to experience depression. This result underscored the importance of financial stability and support in mental well-being. Personality type also displayed significance, with introverted individuals showing a higher propensity for depression (p-value = 0.022). Introverted individuals were more susceptible to depression compared to extroverts, suggesting that one's temperament might play a role in their vulnerability to depression.

Poor peer communication, dissatisfaction with the living environment, poor health status, limited interaction with friends, and poor sleep quality were all associated with an elevated likelihood of depression. These factors highlighted the importance of social connections and relationships in physical and mental health. On the other hand, variables such as frequency of family visits, duration of stay, wearing masks during activities, and covering the mouth while coughing did not exhibit statistically significant associations with depression. Table 2 results provide valuable insights into the factors influencing depression in this population, offering potential avenues for targeted interventions and further research in mental health and well-being.

Table 2 provides comprehensive statistics of multivariate logistic regression analysis conducted to explore the intricate relationship between various factors and depression among students. The table provides the OR values for each variable without the crude odds ratio or adjusted odds ratio (AOR). These statistical findings offered a nuanced understanding of factors contributing to depression among this specific student population. First, the analysis revealed that introverted students were more likely to experience depression, with an OR of 1.65 (95% CI = 1.080–2.547). This result underscored the influence of personality traits on mental health. Similarly, students having only average communication with friends faced a significantly heightened risk of depression (OR = 2.47, 95% CI = 1.258–4.866), emphasizing the importance of social interactions in mental well-being.

Table 2. Logistic Regression Analysis on Depression Among Islamic Boarding School Students (n = 425)

Variable	Category	p-value	OR	95% CI
Sex	Male		1.00	–
	Female	0.359	1.29	0.749–2.223
Education level	Junior high school		1.00	–
	Senior high school	0.017	0.53*	0.325–0.895
Preference to stay in a boarding school	Self-preferred		1.00	–
	Parents	0.547	1.17	0.699–1.964
Satisfied financial support from parent	Satisfied		1.00	-
	Dissatisfied	0.182	1.87	0.747–4.691
Type of personality	Extrovert		1.00	–
	Introvert	0.021	1.65*	1.080–2.547
Frequency of family visit	Often		1.00	–
	Sometimes	0.594	0.87	0.542–1.421
	Never	0.704	0.79	0.250–2.552
Duration of stay	≤1 year		1.00	–
	>1 year	0.156	0.62	0.330–1.195
Communication with friend	Good		1.00	–
	Average	0.009	2.47*	1.258–4.866
	Poor	0.097	0.21	0.033–1.328
Satisfied with the living environment	Satisfied		1.00	–
	Neutral	0.971	1.01	0.597–1.708
	Dissatisfied	0.039	1.162*	1.029–1.908
Health status	Good		1.00	–
	Poor	0.005	10.77*	2.084–55.65
Interacting with friend	Good		1.00	–
	Bad	0.303	2.09	0.514–8.527
Sleep need	Good		1.00	–
	Adequate	0.820	1.06	0.617–1.840
	Poor	0.456	1.29	0.653–2.579
Wearing a mask while doing activity	Yes		1.00	–
	No	0.815	0.92	0.468–1.816
Keeping a safe distance	Yes		1.00	
	No	0.705	0.87	0.438–1.479
Covering mouth with tissue or the inner arm while coughing	Yes		1.00	–
	No	0.054	1.69	0.991–2.911

Notes: OR = Odds Ratio, CI = Confidence Interval, *p-value <0.05

Table 3. Classification Results Based on the Logistic Regression Model

Observed	Predicted		
	Normal	Depression	Correct (%)
Normal	55	105	34.4
Depression	36	229	86.4
Overall			66.8

Furthermore, dissatisfaction with living conditions was associated with an increased likelihood of depression, supported by a statistically significant OR of 1.162 (95% CI = 1.029–1.908). Conversely, students with poor health status had an exceptionally elevated risk of depression, as indicated by a strikingly high OR of 10.77 (95% CI = 2.084–55.65). These results underscored the critical role of environmental and health factors in shaping mental health outcomes. In contrast, higher levels of education were found to be protective against depression, with students attaining a senior high school education having an OR of 0.53 (95% CI = 0.325–0.895), signifying a lower likelihood of experiencing depression. Findings thus elucidated the potential buffering effect of education against depressive symptoms in this study population. These statistical findings provided a comprehensive and quantitative understanding of the complex interplay of personality traits, social interactions, living conditions, health status, and education with depression among Islamic boarding school students in Indonesia.

As displayed in Table 3, the model's classification table reveals an overall accuracy of 66.8%. While this accuracy rate falls below a high threshold, it is noteworthy that the model can identify students with depression, achieving an accuracy of 86.4%. It suggests that this has the potential to serve as a valuable tool for screening depression among students.

Discussion

The elevated depression within Islamic boarding schools presented a substantial and potentially pervasive concern. These findings ascertained that the prevalence of depression among Islamic boarding school students stood at 62.4%, a notably higher figure compared to prior studies among Malaysian students, in which depression rates were observed at 29.4% and 53.9%.[22,26] A similar pattern emerges in Morocco,[27] and Islamic boarding schools in Malang City, East Java Province, Indonesia, which recorded 56%.[18] While the exact reasons for this heightened prevalence of depression in Islamic boarding schools remain unclear, several plausible explanations can be posited.

The pandemic probably interrupted regular daily schedules, giving rise to sensations of uncertainty and isolation. Despite not adhering strictly to protocols, the data indicates that individuals did not completely sever their social connections. Situations such as lockdowns and social distancing measures may have restricted social interactions, amplifying feelings of loneliness and isolation, consequently exacerbating symptoms associated with depression. It is essential to recognize that the contributing factors to depression are multifaceted and context-dependent. This analysis provided a general overview rather than a definitive statement regarding the Indonesian situation, underscoring the necessity for further research to elucidate the underlying causes of this increased depression prevalence.

This study's findings disclosed no statistically significant sex-based differences in depression prevalence, mirroring findings from a previous study in Malaysia.[22] Moreover, a higher level of education was linked with a higher likelihood of depression, consistent with studies among Palestinian[28], Chinese[29], and Pakistan[30] students, in which older students exhibited a greater propensity for depression. In the context of Islamic boarding schools, no substantial discrepancy in depression prevalence was discerned between senior and junior high school students. This complex pattern might be attributed to individual variations. Having potentially remained at home during the pandemic, senior high school students may have grappled with the challenges of online learning and social distancing to a greater extent. Understanding precise reasons for the elevated depression rates within this context necessitates up-to-date studies and data.

Regarding personality types, introverted individuals were more prone to depression, aligning with earlier studies indicating that introverts experienced positive and negative emotional impacts.[29-30] Multiple factors may contribute to this heightened susceptibility among introverts, such as diminished social support and a smaller circle of close friends, potentially rendering them less inclined to seek help or openly discuss their struggles. It is crucial to emphasize that not all introverted personalities would encounter depression, as diverse factors influence mental health conditions, and the relationship between introversion and depression is merely a correlation.

The findings of this study demonstrated that strong peer communication was associated with a reduced likelihood of depression, corroborating findings from other studies.[31-32] This might be attributed to friends' supportive space, allowing students to express their thoughts and emotions openly. Sharing one's feelings could be therapeutic, aiding individuals in processing their emotions and alleviating emotional distress, possibly preventing the onset of depression.[33] During times of upheaval like the COVID-19 pandemic, maintaining peer communications offers a sense of continuity and normalcy in relationships, offering comfort amidst uncertainty.

Satisfaction with one's living environment was associated with lower rates of depression, in line with previous studies.[34-35] Many factors, including past experiences and environmental influences, could explain this phenomenon. Nonetheless, it is essential to acknowledge that satisfaction with the living environment represents only one facet of an individual's mental health.[36-37] Promoting a gratifying living environment is pivotal in supporting students' mental well-being and fostering a positive and supportive atmosphere, contributing to their overall welfare, academic performance, and personal growth.

Nonetheless, this study underscored a significant correlation between poor health status and elevated rates of depression, in line with a previous study in Bangladesh.[38] Students with compromised health were more prone to depression,[39] potentially attributable to the impact on health. The pandemic presented various health challenges, and students contracting the virus or enduring other health issues during this period might continue to grapple with physical and emotional repercussions, amplifying their susceptibility to depression.

This study represented the inaugural exploration of mental health among Islamic boarding school students in East Java Province, Indonesia. However, it is vital to acknowledge several limitations which necessitate consideration in interpreting these findings and guide future studies. The cross-sectional design provided a snapshot but did not establish causal relationships over time. Convenience sampling, prompted by movement restrictions, may limit result generalizability, as social desirability bias or concerns about stigma could influence symptom reporting.

Consequently, these results cannot be used as a generalization of depression among students at all Islamic boarding schools in East Java or Indonesia. Additionally, Islamic boarding schools possess unique cultural, religious, and social contexts that may influence depression prevalence and expression differently than in non-religious educational settings. The questionnaires to assess depression and associated factors may not fully capture the complexity of students' experiences, potentially affecting result accuracy. Furthermore, these findings highlighted that the standard DASS-21 measure could not capture the situation.

The study findings suggested several implications and recommendations, such as acknowledging the imbalance of sex, with 75.1% female and 24.9% male participants potentially impacting generalizability. Future studies should aim for a more balanced representation to enhance the external validity and provide a nuanced understanding of gender-specific influences on phenomena observed. Also, mental health classes integrating religious values alongside a comprehensive understanding of depression should be provided and implemented. Additionally, offering faith-based counseling services and conducting training sessions for caregivers and teachers on early recognition of depression signs, as well as guidance on providing emotional and spiritual support to students, are crucial. By these measures, Islamic boarding schools could deliver culturally and contextually relevant interventions to address and overcome depression among students effectively.

Conclusion

Introverted personality traits, moderate peer communications, dissatisfaction with their living environment, and poor health status significantly correlated with depression among Islamic boarding school students. Addressing the mental health requirements of students facing health issues in Islamic boarding schools is of the utmost importance. Establishing a supportive and empathetic environment, promoting mental health awareness, and providing accessible mental health resources are pivotal in bolstering the students' well-being during the arduous period. Timely recognition and intervention are essential in the prevention and management of depression among students grappling with health-related challenges, while nurturing a compassionate and understanding community may wield a profound impact on their overall mental health.

Abbreviations

COVID-19: Coronavirus Disease 2019; DASS-21: Depression Anxiety Stress Scale-21; OR: Odds Ratio; CI: Confidence Interval; AOR: Adjusted Odds Ratio.

Ethics Approval and Consent to Participate

This study was approved by the Health Research Ethics Committee of Politeknik Kesehatan Kemenkes Malang, with approval No. 088/III/KEPK

POLKESMA/2023.

Competing Interest

The authors declare that there are no significant competing financial, professional, or personal interests that might have affected the performance or presentation of the work described in this manuscript.

Availability of Data and Materials

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Authors' Contribution

Writing original draft manuscript: YA. Formal and statistical analysis: YA and MS. Data curation: YA and DP. Technical writing, proofreading, validating, reviewing, and editing: YBM. All authors contributed to the study design and interpretation of the analysis and approved the final draft of the manuscript.

Acknowledgment

The authors would like to thank all participants, Institut Teknologi Sains dan Kesehatan RS Dr. Soepraoen Malang, the head of the Islamic boarding schools in East Java and Directorate of Research, Technology and Community Engagement, Directorate General of Higher Education, Research and Technology, Indonesian Ministry of Education, Culture, Research and Technology for the opportunity to participate in the international workshop.

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Kesmas

Volume 19
Issue 1 *February*

Article 8

2-29-2024

Effects of Maternal Anthropometry on Infant Anthropometry: A Cross-sectional Study at Public Hospital X in Ternate, Indonesia

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Recommended Citation

Nurwati Y , Hardinsyah H , Marliyati SA , et al. Effects of Maternal Anthropometry on Infant Anthropometry: A Cross-sectional Study at Public Hospital X in Ternate, Indonesia. *Kesmas*. 2024; 19(1): 59-66
DOI: 10.21109/kesmas.v19i1.7336
Available at: https://scholarhub.ui.ac.id/kesmas/vol19/iss1/8

Nurwati et al. *Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*. 2024; 19 (1): 59-66
DOI: 10.21109/kesmas.v19i1.7336

Kesmas: Jurnal Kesehatan Masyarakat Nasional (Kesmas: National Public Health Journal)

Effects of Maternal Anthropometry on Infant Anthropometry: A Cross-sectional Study at Public Hospital X in Ternate, Indonesia

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Abstract

Infant anthropometry is an indicator of neonatal survival. This study aimed to determine the effects of maternal anthropometry on estimating infant anthropometry. This cross-sectional study on 173 pregnant women at Public Hospital X in Ternate, Indonesia, was conducted from August 2018 to March 2023. The eligible criteria were pregnant women aged ≥18 years, single pregnancy, and antenatal care (ANC) visits to the same hospital. The variables used included maternal anthropometric measurements (body weight, body height, third-trimester weight (TTW)), gestational weight gain (GWG), education, age, ANC visits, and gestational age at delivery (GAD). A logistic regression model was employed to estimate significant variables related to infant anthropometric measurements (birth weight, birth length, and head circumference). The results showed that TTW, GWG, ANC, and GAD had significantly affected birth weight. Body weight, height, and TTW also significantly affected birth length. In addition, only GAD significantly affected the head circumference. In multivariate analysis, TTW and GWG significantly affected birth weight. Furthermore, only body height and GAD affected the birth length. Maternal anthropometrics become important indicators for estimating birth weight and birth length.

Keywords: birth length, birth weight, head circumference, logistic regression, maternal anthropometry

Introduction

Fulfillment of nutrition should meet nutritional needs, especially for vulnerable groups, including pregnant women. During pregnancy, pregnant women should ensure their energy and nutrient intake are sufficient to support fetal growth and development, in which according to the 2019 Indonesian Dietary Recommendation, they should add 180 to 300 kcal of energy.[1] By ensuring adequate nutrition meets nutritional needs, pregnant women will achieve normal gestational weight gain (GWG), an indicator of nutritional fulfillment during pregnancy.[2]

Infant health could be determined by examining infant anthropometric measurements, such as birth weight, birth length, and head circumference, representing a significant predictor of child survival, growth patterns, long-term health, and psychosocial development.[3] It is also very helpful in classifying an individual as having subnormal, normal, or excessive uterine growth.[3] Both subnormal and excessive intrauterine growth have been associated with a high risk of neonatal morbidity and mortality, as well as chronic diseases later in life.[3] An outcome of intrauterine growth restriction is low birth weight (LBW).[3] In addition, low and middle-income countries, including Indonesia, still have high rates of LBW, stunting at birth, and small for gestational age.[4]

LBW is the most common cause of infant death in Indonesia by 2021, while other causes are asphyxia, congenital abnormalities, infection, COVID-19, neonatal tetanus, and so forth.[5] The infant mortality rate (IMR) trend shows a decrease of 25% from 32 to 24 per 1,000 live births based on data from the 2017 Indonesian Demographic and Health Survey.[6] While, the National Medium-Term Development Plan target is to attain an IMR of 16 per 1,000 live births by 2024.[7] To achieve the target, the LBW incidence should be reduced.

Maternal nutritional status is the most frequently identified risk factor for subnormal fetal growth in developing countries.[3] Maternal anthropometric measurements, including body weight, body height, body mass index (BMI), mid-upper arm circumference, third-trimester weight (TTW), and GWG, are useful for assessing pregnancy outcomes.[3,8-9]

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Received : September 19, 2023
Accepted : February 28, 2024
Published : February 29, 2024

Despite the fact that all of these maternal anthropometric measurements are routinely recorded during antenatal care (ANC) visits, such a crucial public health tool is frequently underused to ensure optimal pregnancy outcomes, particularly in rural areas where advanced technology is not accessible.[8]

Both early and late detections of pregnant women at risk of poor pregnancy outcomes are crucial. Early detection is essential since several interventions, such as energy and protein supplementation, have been shown to improve pregnancy outcomes.[3] While, late detection, in which most of the fetal organs have already developed, could still assist decision-making regarding prepartum referral to an appropriate facility for delivery and neonatal care.[3]

The Indonesian Government has implemented several programs to reduce the LBW incidence, such as integrated ANC, providing supplementary food to pregnant women with chronic energy deficiency, and detecting pregnant women at risk of giving birth to LBW infants by collaborating with primary health care.[10-11] However, the government still faces barriers while making efforts to prevent LBW, one of which is internal factors in pregnant women, such as illnesses suffered during pregnancy and inadequate nutritional knowledge.[12]

Unfortunately, only several studies have examined an association between maternal anthropometry, especially GWG, and birth outcomes in lower-income countries.[11,13-16] Given that maternal anthropometric measurements have many implications on maternal and child weight, this cross-sectional study aimed to evaluate maternal anthropometric measurements (body weight, body height, GWG, TTW, and gestational age at delivery (GAD)) and maternal factor (ANC visit) to estimate infant anthropometric measurements, such as birth weight, birth length, and head circumference. The findings obtained would support the early detection of pregnant women at risk for potential prenatal or perinatal intervention. Furthermore, this study contributes to improving the quality of ANC and neonatal outcomes in Indonesia.

Method

This study was conducted at Public Hospital X in Ternate City, North Maluku Province, Indonesia. Secondary data from hospital medical records were collected and analyzed. Of 478 pregnant women receiving ANC services and giving birth at the hospital from 2018-2023, only 173 (36.2%) met the inclusion criteria after the cleaning process. Public Hospital X was selected as it is the only hospital with complete data for analysis (all the maternal and infant anthropometric data needed for this study was available in the hospital's medical record database).

Pregnancy data were sourced primarily from the hospital's medical record database and the Maternal and Child Health Booklet for pregnant women receiving ANC services and giving birth at the same hospital. This study's protocol was reviewed correctly and granted by the Ethics Committee of the Faculty of Medicine, Hasanuddin University. Permission was also obtained from the head of Public Hospital X. The Ethics Committee ruled out the need for informed consent for no direct intervention with patients.

Data collection used consecutive sampling techniques from August 2018 to March 2023. The inclusion criteria were pregnant women aged ≥18 years, single pregnancy, taking ANC visits, and giving birth at the same hospital. Pregnant women with comorbidities, such as preeclampsia, gestational diabetes, and bleeding, were excluded from the study. All the comorbidities' data were available in the medical records.

The independent variables were maternal anthropometric measurements (body weight, body height, TTW), education, age, ANC visit, GWG, and GAD. The dependent variables were infant anthropometric measurements (birth weight, birth length, and head circumference). The instrument for measuring birth weight used a baby scale. Measurements of body length and birth head circumference were carried out within 24 hours after birth using a non-stretchable measuring tape to an accuracy of 0.5 cm.

There are 478 pregnant women receiving ANC services and giving birth at Public Hospital X from August 2018 to March 2023. After pre-processing data, 173 (36.2%) of 478 women met the study criteria. Of these women, 15.02% delivered LBW babies, and the remaining 84.98% delivered babies with normal weight. This study excluded 305 (63.8%) pregnant women due to incomplete information on the required characteristics.

Maternal characteristics were summarized using frequency distribution. Percentage was used to describe the study population characteristics. Bivariate analysis using the Chi-square test was conducted to analyze a correlation between maternal factors and infant anthropometry. Statistical significance was set at the 95% confidence level (p-value < 0.05). By using a binary logistic regression analysis, an estimation model was developed using infant anthropometry as outcomes. Maternal body weight (≥46 kg), body height (≥150 cm), TTW (≥60 kg), GWG (kg), ANC visits, and GAD (weeks) were estimators added to the regression model.

Results

Maternal and infant characteristics are presented in Table 1. The infant anthropometric measurement was taken within 24 hours after delivery. Based on frequency distribution in Table 1, most pregnant women had a body weight of

Table 1. Maternal and Infant Characteristics Among 173 Mother-Infant Pairs

Variable	Category	n	%
Body weight (kg)	<46	51	29.5
	≥46	122	70.5
Body height (cm)	<150	19	11
	≥150	154	89
Pre-pregnancy body mass index (kg/m^2)	Underweight	37	21.4
	Normal	118	68.2
	Overweight	9	5.2
	Obese	9	5.2
Third-trimester weight (kg)	<60	84	48.6
	≥60	89	51.4
Gestational weight gain (kg)	Inadequate	46	26.6
	Adequate	108	63
	Excessive	19	11
Education	High school	82	47.4
	Higher education	91	52.6
Maternal age (years)	≤19	5	2.9
	20–24	44	25.4
	25–29	71	41
	30–35	49	28.3
	>35	4	2.3
Antenatal care visit (times)	<4	45	26
	≥4	128	74
Gestational age at delivery (weeks)	<37	15	8.7
	37–41	154	89
	>41	4	2.3
Infant characteristic			
Birth weight (gram)	<2,500	25	14.5
	≥2,500	148	85.5
Birth length (cm)	<48	55	31.8
	≥48	118	68.2
Head circumference (cm)	<33	19	11
	≥33	154	89

Table 2. Association of Gestational Weight Gain with Infant Anthropometric

Variable	Category	Infant Anthropometric					
		Birth Weight (g)		Birth Length (cm)		Head Circumference (cm)	
		<2,500	≥2,500	<48	≥48	<33	≥33
Gestasional weight gain	Insufficient	12 (26.7)	33 (73.3)	31(68.9)	14 (31.1)	6 (13)	40(87)
	Adequate	10 (9.2)	99 (90.8)	18 (16.5)	91 (83.5)	8 (7.4)	100 (92.6)
	Excessive	3 (15.8)	16 (84.2)	6 (31.6)	13 (68.4)	5 (26.3)	14 (73.7)
	p-value	0.019*		<0.001*		0.045*	

Note: *Statistical significance set at 5%

≥46 kg (70.5%) and a body height of ≥150 cm (89%). Almost 70% of pregnant women had normal weight. Above 50% of pregnant women had 60 kg of TTW and adequate GWG (62.4%) during pregnancy. Most pregnant women graduated from university and were at the age group of 25-29 years. Above two-thirds (74%) had attended at least four ANC visits during their pregnancy.

Most infants had a birth weight of ≥2,500 grams (85.5%) and a birth length of ≥48 cm (68.2%). Almost 90% of infants had a head circumference of ≥33 cm. As much as 89% of infants were delivered at 37-41 weeks of gestational age. The relationship of GWG with maternal and infant anthropometry is shown in Table 2. Almost 91% of pregnant women had delivered infants with ≥2,500 grams. In contrast, pregnant women with GWG below the Institute of Medicine (IOM) recommendation levels gradually were more likely to deliver LBW infants (26.7%) compared to those with adequate GWG (9.2%). Maternal GWG was also significantly related to birth length (p-value <0.001). Almost 70% of mothers with inadequate GWG had delivered infants with a birth length of <48 cm.

In addition, most mothers with adequate GWG had delivered infants with a birth length of ≥48 cm (83.5%). Table

Table 3. Association of Maternal Characteristics with Infant Anthropometry

Variable	Category	Birth Weight (g)			Birth Length (cm)			Head Circumference (cm)		
		<2,500	≥2,500	p-value	<48	≥48	p-value	<33	≥33	p-value
		n (%)	n (%)		n (%)	n (%)		n (%)	n (%)	
Body weight (kg)	<46	11 (21.6)	40 (78.4)	0.085	22 (43.1)	29 (56.9)	0.038*	8 (15.7)	43 (84.3)	0.201
	≥46	14 (11.5)	108 (88.5)		33 (27)	89 (73)		11 (9)	111 (91)	
Body height (cm)	<150	4 (21.1)	15 (78.9)	0.485	12 (63.2)	7 (36.8)	0.002*	3 (15.8)	16 (84.2)	0.478
	≥155	21 (13.6)	133 (86.4)		43 (27.9)	111 (72.1)		16 (10.4)	138 (89.6)	
Pre-pregnancy BMI (kg/m^2)	Underweight, overweight, and obese	6 (11.3)	47 (88.7)	0.425	16 (30.2)	37 (69.8)	0.737	4 (7.5)	49 (92.5)	0.329
	Normal	19 (16)	100 (84)		39 (32.8)	80 (67.2)		15 (12.6)	104 (87.4)	
Third-trimester weight (kg)	<60	18 (21.4)	66 (78.6)	0.011*	33 (39.3)	51 (60.7)	0.040*	10 (11.9)	74 (88.1)	0.706
	≥60	7 (7.9)	82 (92.1)		22 (24.7)	67 (75.3)		9 (47.4)	80 (89.9)	
Gestational weight gain (kg)					21 (38.2)	34 (61.8)	0.232			
	Inadequate or excessive	16 (29.1)	39 (70.9)	0.001*	34 (29.1)	83 (70.9)		8 (14.5)	47 (85.5)	0.316
	Adequate	9 (7.7)	108 (92.3)					11 (9.4)	106 (90.6)	
Education	High school	10 (12.2)	72 (87.8)	0.423	28 (34.1)	54 (65.9)	0.528	11 (13.4)	71 (86.6)	0.331
	Higher education	15 (16.5)	76 (83.5)		27 (29.7)	64 (70.3)		8 (8.8)	83 (91.2)	
Maternal age (years)	≤19 or >35	1 (12.5)	7 (87.5)	0.867	2 (25)	6 (75)	0.665	1 (12.5)	7 (87.5)	0.893
	20-35	24 (14.6)	140 (85.4)		53 (32.3)	111 (67.7)		18 (11)	146 (89)	
Antenatal care visit (times)	<4	13 (28.9)	32 (71.1)	0.001*	19 (42.2)	26 (57.8)	0.081	7 (15.6)	38 (84.4)	0.254
	≥4	12 (9.4)	116 (90.6)		36 (28.1)	92 (71.9)		12 (63.2)	116 (90.6)	
Gestational age at delivery (weeks)	<37	8 (44.4)	10 (55.6)	<0.001*	8 (44.4)	110 (55.6)	0.231	5 (27.8)	13 (72.2)	0.017*
	≥37	17 (11)	137 (89)		47 (30.5)	107 (69.5)		14 (73.7)	140 (90.9)	

Notes: BMI = Body Mass Index, *Statistical significance set at 5%

Table 4. Association of Maternal Anthropometric Measurements and Antenatal Care Visit with Infant Anthropometric Measurements

Variable	Birth Weight			Birth Length			Head Circumference		
	p-value	AOR	95% CI	p-value	AOR	95% CI	p-value	AOR	95% CI
Body weight (kg)	0.451	0.6	0.2–2.1	0.968	0.9	0.4–2.5	-	-	-
Body height (cm)	0.370	1.9	0.5–7.9	0.006*	4.4	1.5–12.5	-	-	-
Third-trimester weight (kg)	0.043*	3.6	1.0–12.1	0.226	1.7	0.7–4.1	-	-	-
Gestational weight gain (kg)	0.001*	5.4	2.0–14.3	0.192	1.6	0.8–3.4	-	-	-
ANC visits	0.135	2.2	0.8–6.4	0.858	1.1	0.5–2.5	-	-	-
Gestational age at delivery (weeks)	0.243	2.2	0.6–8.2	0.035*	3.4	1.1–10.7	0.183	2.4	0.7–8.5

Notes: AOR = Adjusted Odds Ratio, CI = Confidence Interval, ANC = Antenatal Care, *Statistical significance set at 5%

2 also shows that maternal GWG is significantly related to the infant's head circumference (p-value = 0.045). Mothers with inadequate GWG had more infants with a head circumference of <33 cm (13%).

The association for all maternal anthropometric measurements with infant anthropometrics is shown in Table 3. The TTW, GWG, ANC visits during pregnancy, and GAD were significantly associated with birth weight. A significant association was also detected between body weight, body height, and TTW with birth length. Additionally, there was also a significant relationship between GAD and head circumference.

The next analysis was multivariate logistic regression on the relation between maternal anthropometry and infant anthropometry. Independent variables in bivariate analysis with a p-value of <0.25 were included in the multivariate analysis. Based on the final results of binary logistic regression in Table 4, pregnant women with a TTW of ≥60 kg gave birth to significantly normal infants compared to pregnant women with a TTW of <60 kg.

This study found that pregnant women with adequate GWG gave birth to neonates with a mean birth weight of 2,500 grams (Table 4). The results of this study also revealed that taller pregnant women (body height ≥150 cm) gave birth to significantly higher birth-length infants than shorter pregnant women. In addition, pregnant women delivering their babies at 37-41 weeks of gestation were significantly associated with normal infant length (>48 cm) compared to those delivering a baby below 37 weeks. On the other hand, there was no correlation between maternal characteristics and the head circumference of infants.

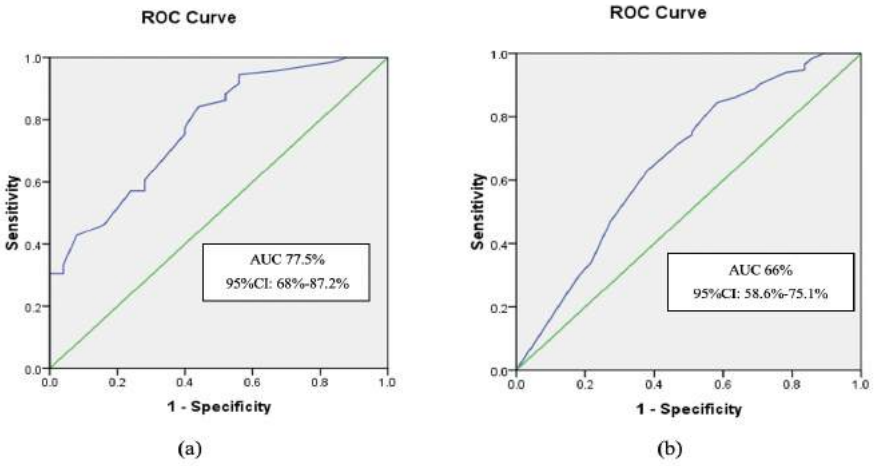

Figure 1. The Area Under the ROC Curve for Estimation Model (a) Birth Weight and (b) Birth Length

Discussion

This study found that both maternal anthropometry and ANC visits during pregnancy were associated with infant anthropometry, particularly birth weight and birth length. The association of maternal TTW of ≥60 kg and higher birth weight was similar to the previous studies.[8-9] In rural areas, most pregnant women usually visit their ANC during the third trimester. Therefore, early third-trimester weight could be an indicator of birth weight of 59.8 kg to 60.5 kg.

The optimal combination of maternal anthropometry to estimate weight was TTW and GWG. The combination of TTW and GWG to estimate birth weight resulted in an area under the ROC curve (AUC) of 77.5% (Figure 1a), which was moderate accuracy according to diagnostic accuracy classification.[16] Inadequate or excessive GWG has an impact on the mother and fetus.

A study by Abide et al.[17] with a retrospective study design at Zeyneb Kamil's Maternity and Children's Diseases Education and Research Hospital from 2014-2017 showed that GWG below the IOM recommendation was related to membrane rupture, LBW infants, intrauterine growth restriction, and admission to the neonatal intensive care unit. In addition, excessive GWG increases the risk of macrosomia in infants. Several studies also indicated that GWG has a significant relationship with birth weight.[17-19]

Moreover, an excessive GWG is also related to higher BMI during childhood and adolescence.[20-22] This is because pre-pregnancy BMI and excessive weight gain increased adipocytes in the fetus.[21-23] The fetal overnutrition hypothesis stated that increased transfer of nutrients from the placenta to the fetus would affect development, fat deposition, and development of the hypothalamic-endocrine system of fetus, controlling hunger and energy metabolism.[24]

In contrast, inadequate weight gain was related to the LBW infants as the increased nutritional intake during pregnancy for both mother and fetus is inadequate; therefore, the fetus does not receive the maximum nutrient transfer as needed.[25] As a consequence, this affects the birth weight of fetus.[25]

This study showed that birth length was affected by maternal body height and GAD. This combination resulted in an AUC of 66% (Figure 1b), which was a weak classifier accuracy according to diagnostic accuracy classification.[16] Previous studies also showed that maternal body height was associated with birth length.[26-28] The relationship between maternal height and birth length has been explained by a mechanism in which maternal height sets a physical constraint in the intrauterine environment (shorter women may have a smaller uterine, restricting fetal growth) and a reflection of cumulative social and nutritional conditions throughout life is an indicator of the biological and environmental factors that impact the growth and development of offspring in the uterus.[29]

Furthermore, genetic polymorphisms affecting maternal height may also have an immediate functional impact on the pregnancy outcomes in the fetus.[29] A study by Qurani et al.[30] showed that maternal height is the only factor significantly associated with the incidence of stunting. There is a cycle of intergenerational malnutrition in the future; stunted children will become short mothers who will also give birth to stunted children.[31]

Body height is affected by various factors such as genetics, nutrition, and infectious diseases.[32] If both mother and father are short in height because of certain infectious diseases or inadequate nutrients during adolescence, the stunting

risk of their offspring could be avoided. It could be explained that the risk of stunting could be avoided if the children get adequate nutrition and are not exposed to other risk factors.[32] The risk of growth faltering is greater in the fetus with the suffering of falter in uterus.[32]

Maternal height and age at delivery (weeks) were the combination affecting the birth length. A study by Derraik et al.[33] showed that decreased gestational age was linked to a shorter final height, and this correlation was especially marked in women who were born very preterm. Pregnant women delivering their babies before 37 weeks of gestational age were at greater risk of delivering an infant with a birth length of <48 cm.

This study found that nutrition was important for the process of growth and bone formation from the beginning of fetal life until the end of pregnancy. A systematic review conducted by Nurwati et al.[34] showed that several maternal risk factors contributing to LBW were maternal nutritional status and education. Krismanita et al.[35] indicated that maternal height was the dominant factor in the prevalence of a dual form of malnutrition. Therefore, it is recommended to improve nutrition in adolescence, especially for girls in their role as future mothers, for example, through intervention by nutrition education, micronutrient supplementation, and treatment of comorbidities.

The maternal nutritional status will determine the nutrient reserves required for fetal organogenesis, including bone development.[36] Mothers who are unable to supply the protein needs of fetuses will alter chondrocyte cell proliferation in the proliferation zone so that the thickness of proliferation zone is reduced.[36] Furthermore, if pregnant women are unable to supply the fetal calcium and zinc needs, the development of hydroxy acid crystals in maturation zone decreases, eventually limiting the process of mineralization and bone calcification in the cartilage zone.[36] Moreover, inadequate intake of calcium, phosphorous, and magnesium in the mineralized zone will cause the thickness of the mineralized zone to decrease.[37] Overall, inadequate nutrients cause the thickness of the epiphyseal plate thickness.[37] The lack of epiphyseal plate thickness will reduce the fetal length and reduce the potential fetal length after birth.[37]

In the multivariate analysis estimation model, there is an easily accessible estimate variable to be used in Integrated Health Care (IHC). The maternal variables significantly affecting the birth weight were TTW and GWG, with an AUC of 77.5% (95%CI = 68-87.2%). While, variables significantly affecting the birth length were maternal body height and gestational age at delivery, with an AUC of 66% (95% CI = 58.6-75.1%). The strength of this study is that all the estimator variables could be easily found from physical measurements. Therefore, it could be simply applied at the IHC or in rural areas where advanced technology is unavailable. This study's limitation is that the samples were taken from only one hospital.

Conclusion

Pregnancy outcomes can be determined through maternal anthropometric factors: body weight, body height, TTW, GWG, and GAD. All of these factors can be gained during ANC visits. Variables such as lower body weight and shorter body height can be potential risk factors for LBW and shorter birth length. To improve pregnancy outcomes, a collaboration between health workers and pregnant women is important so that intervention can be given from early pregnancy. Further studies can continuously validate the estimation tool using new studies with more variables, preferably using a prospective study design.

Abbreviations

GWG: Gestational Weight Gain; LBW: Low Birth Weight; IMR: Infant Mortality Rate; BMI: Body Mass Index; TTW: Third-trimester Weight; ANC: antenatal Care; GAD: Gestational Age at Delivery; IOM: Institute of Medicine; AUC: Area Under the ROC Curve; IHC: Integrated Health Care.

Ethics Approval and Consent to Participate

This study was approved by the Ethical Committee of the Faculty of Medicine, Hasanuddin University, ref: 785/UN4.6.4.5.31/PP36/2022. Permission was also obtained from the head of the Public Hospital X.

Competing Interest

The authors declare that no significant competing financial, professional, or personal interests might have affected the performance or presentation of the work described in this manuscript.

Availability of Data and Materials

Data were obtained from the hospital medical record database and the Maternal and Child Health Booklet.

Authors' Contribution

YN, HH, and SAM considered the study, interpreted the results, and co-wrote the manuscript. YN, SAM, BIS, and DA collected the data, assisted

with information interpretation, and co-wrote the manuscript. All the authors read and accepted the last manuscript.

Acknowledgment

The authors thank the Directorate of Higher Education, Indonesian Ministry of Education, Culture, Research, and Technology, for granting a scholarship for the Master-to-Doctorate Program for Superior Scholars (No. 077/SP2H/LT/DRPM/2021). The authors also thank the research team, Public Hospital X in Ternate, hospital staff, dr. Ummu Hani, SpOG and Fatma B. Malik, Amd. Keb., and pregnant women for their cooperation and support.

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Kesmas

Volume 19
Issue 1 *February*

Article 9

2-29-2024

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Recommended Citation

Napirah MR , Vidyanto V , Rahman N , et al. Implementation of National Movement for the Acceleration of Nutrition Improvement Policy for the First 1,000 Days of Life in Indonesia. *Kesmas*. 2024; 19(1): 67-73
DOI: 10.21109/kesmas.v19i1.8045
Available at: https://scholarhub.ui.ac.id/kesmas/vol19/iss1/9

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Napirah et al. *Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*. 2024; 19 (1): 67-73
DOI: 10.21109/kesmas.v19i1.8045

Kesmas: Jurnal Kesehatan Masyarakat Nasional
(Kesmas: National Public Health Journal)

Implementation of National Movement for the Acceleration of Nutrition Improvement Policy for the First 1,000 Days of Life in Indonesia

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Abstract

The national movement for accelerating nutrition improvement in the first 1,000 days of life is an effort to strengthen the Indonesian Government's commitment to the national strategic agenda and tackling stunting. This study aimed to determine communication, resources, disposition, and bureaucratic structure in implementing the movement at the Biromaru Primary Health Care (PHC) and Loru Village, Sigi District, Indonesia. The mixed method approach was carried out with informants consisting of several parties from the PHC, health cadres, and the local community through triangulation and questionnaires. The results showed poor communication was inhibited by a lack of community outreach, the attitude of the community's lack of participation, and the PHC staff's perceptions (85.14%). There was still insufficient number of health workers as resources (79.73%) who could cover all work areas. While, 75.68% of the health workers considered the disposition to be unfavorable because the incentive budget functioned as an operational budget. Only the bureaucratic structure has been running well, according to 82.43% of PHC staff. Standard operating procedure is required to make the movement run well.

Keywords: acceleration of nutrition improvement, first 1,000 days of life, national movement, policy implementation

Introduction

The national movement for accelerating nutrition improvement is pivotal to reduce nutritional problems and create healthy, intelligent, and productive human resources by focusing on the first 1,000 days of life (270 days during pregnancy and 730 days from birth to two years of age) of mothers, pregnant women, nursing mothers, and children aged 0-23 months. The movement indicator is a decrease in low birth weight (LBW) babies, stunting, wasting, underweight, and overweight children.[1] Stunting experienced by children can be caused by not receiving special attention in the first 1,000 days of life as it determines a person's physical growth, intelligence, and productivity in the future.[2] During this period, nutrition that a baby receives while in the womb and breast milk have a long-term impact on life as an adult.[2] Critical periods that need to be considered during the first 1,000 days of life are the period in the womb (280 days) and the age periods of 0-6 months (180 days), 6-8 months (60 days), 8-12 months (120 days), and 12-24 months (360 days).[2]

The under-five children with a score of lower than two standard divisions are considered stunting.[3] The condition of stunting appears in children aged two years with an inappropriate height or body length for their age.[3] Globally, in 2020, the prevalence of stunting was 32.4% (30.9-34.0) in African, Asian, and American countries. The lowest average percentage in Africa was in the North Africa at 24.2% (18.1-31.6); while, the highest was in the East Africa at 45.8% (41.2-50.5). For Asian countries, the highest prevalence was in the South Asia at 49.7% (45.6-53.9), and the lowest was in the East Asia at 19.2% (17.8-20.6). The prevalence of stunting in America with the lowest average percentage was in the South America at 13.8% (10.4-18.0), and the highest was in the Central America at 223.7% (16.6-32.8).[4]

Based on child malnutrition reports by the World Health Organization, the United Nations Children's Fund, and the World Bank Group in 2020, the estimated prevalence of stunting in the under-five children reached 21.3% globally (19.7-22.8). This data is divided into two groups: developing and developed countries. The group of developing countries consists of those countries in African and Asian continents, as well as the South American, Croatian Islands, and

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Received : January 12, 2024
Accepted : February 29, 2024
Published : February 29, 2024

Oceania regions. The African continent has the highest prevalence of stunting, reaching 29.1%. Then, the next data group is developed countries consisting of Australia and New Zealand, the European continent, and North American region. For this group, the prevalence of stunting was found only in North America at 2.6%.[4]

The prevalence of stunting in Indonesia is quite high. Based on the Indonesian Basic Health Research reports, the prevalence of stunting from 2007, 2010, 2013, and 2018 were 36.8%, 34.6%, 37.3%, and 30.8%, respectively.[5-8] The results of Nutrition Status Monitoring by the Indonesian Ministry of Health in 2017 showed a 30.6% prevalence of stunting in the under-five children.[9] Stunting represents a combination of nutritional problems focusing on results of measuring height/weight based on very short and shortages (height/age <-2 SD).[4]

The stunting occurring in Indonesia is not only experienced by the poor and underprivileged households/families, but also by those whose level of social and economic welfare is greater than 40%.[3] However, based on data from the Central Sulawesi Provincial Health Office, it has decreased. Data in 2013 showed that the prevalence of stunting was 41%, decreasing to 32.2% in 2018.[10-11] While, according to Nutrition Status Monitoring, the prevalence of stunting in the Central Sulawesi Province was 32% in 2016 and increased to 36.1% in 2017.[12] Furthermore, the Sigi District Health Office data showed that the prevalence of the under-five children stated undernourished or below the red line on the Kartu Menuju Sehat, the records functioning to monitor a child's growth from birth to five years old, was 1,052 out of 16,042 children in 2016, and 718 out of 19,554 children in 2017.[9] In 2020, the prevalence of stunted toddlers was 1,192 cases.

Efforts were made for nutrition improvement, one of which is through the issuance of Presidential Regulation Number 42 of 2013 concerning the National Movement for the Acceleration of Nutrition Improvement within the Framework of the First 1,000 Days of Life.[1] Such movement is implemented through community outreach at the national and regional levels, mobilizing funding sources in the state and regional budgets, preparing planning guidelines, and improving the daily food consumption through balanced nutrition education.[1] Also, pregnant women who are thin, measured by arm circumference, are given food supplements as a source of energy and protein, which are made using fortified food ingredients, such as salt (iodine), wheat flour (iron, zinc, folic acid, and vitamins B1 and B2), and cooking oil (vitamin A).[1]

To achieve goals, a public policy could be implemented through possible steps composing a program or formulating a derivative policy.[13] Four influential factors to policy implementation, which work simultaneously and interact with each other to assist and hinder policy implementation, are communication, resources, dispositions or attitudes, and bureaucratic structure.[14-15]

A preliminary study on program managers for the first 1,000 days of life in Loru Village, Sigi District, Indonesia highlighted some obstacles in implementing the Presidential Regulation No. 42 of 2013 concerning the National Movement for the Acceleration of Nutrition Improvement at the Biromaru Primary Health Care (PHC) working area. Loru Village has the second-highest stunting case with a total of 70 cases at the Biromaru PHC. The problem is on ineffectiveness of community and cross-sector outreach regarding regulations, also inadequate human resources.

Therefore, this study aimed to determine communication, resources, disposition, and bureaucratic structure in implementing the first 1,000 days of life at the Biromaru PHC and Loru Village. The study outcomes would provide insight into new parameters in evaluating the implementation of the first 1,000 days of life to achieve a reduction in stunting nationally.

Method

This study used mixed method with qualitative and quantitative descriptive survey approaches at the Biromaru PHC and Loru Village, Sigi District, Central Sulawesi Province, Indonesia, from May to June 2023. Qualitatively, subjects were selected by non-probability or purposive sampling according to study objectives. There were 11 informants consisting of the PHC head as the key informant, regular informants: the head of the PHC Nutrition Management Division and Nutrition Management staff, and additional informants: health cadres and Loru Village residents. While, this study obtained a sample of 74 PHC staff.

Data collection was conducted through technical triangulation: in-depth interviews, observation, documentation using interview guidelines, and interviews using questionnaires. Triangulation was the validity proxy for qualitative approach. In quantitative, both parameter estimation and point through all the PHC staff (n = 74) showed that internal validity was obtainable.

Content analysis was used as the qualitative-oriented technique, a standard parameter set by certain units usually used to determine and compare documents. Each respondent's statement propensity was identified through quote transcription and matched it with each variable's book code. Ultimately, all of it was described into a consensus theme under the definition of study variables. While, the results of the descriptive quantitative approach described in a fre-

quency distribution manner underpinned the obtained evidence.

Results

Communication

The results of in-depth interviews on the informants' understanding of the national movement of the first 1,000 days of life were considered good enough.

> *"It is just a few obstacles in conveying information and consistency of information."* (Respondent 1)

In the communication stage of policy implementation concerning the national movement of the first 1,000 days of life in the Biromaru PHC work area, three parameters used for measuring success were transmission, consistency, and clarity.

a) Transmission
   Efforts made through message transmission have not been maximized. This was obtained based on the results of interviews with regular informants. Common informants stated that the media for communication channels were in the forms of poster and brochure, also nutritional counseling to the community at a Post for Stunting Prevention, which means it could not be considered optimally in communication.
b) Consistency
   In an interview regarding consistency, respondents said that communication had been already well implemented through inter-sectoral coordination efforts. The communication process in the stunting prevention program was always carried out in an effort to cooperate between fields with the suitability of each main task.
   > *"As the efforts made aimed at reducing stunting cases, each field performs training in accordance with its duties and functions, and reports and evaluation meetings are always held to see some progress."* (Respondent 2)
c) Clarity
   For clarity, the national movement of the first 1,000 days of life was good, but inhibited by the process of channeling the communication itself. Health workers reached out to all the present residents as much as possible, but problems arose from the community itself. Some of them chose not to participate in the activity for different reasons. However, health workers still tried to visit the targets individually through home visits.

Resource

a) Staff
   In the in-depth interviews regarding human resources or staff, they stated that they had done well their job. However, they were constricted by a fairly wide area coverage.
   > *"Human resources were available, but we need more…."* (Respondent 1)

   The Biromaru PHC experienced insufficient health workers. This occurred for a quite wide working area, and the PHC only had one staff in the nutrition sector and one staff as a service officer handling the implementation of policies on stunting issues. According to a regular informant, the PHC had three staff consisting of two nutrition workers and one nurse.
b) Information
   The resource on information was being distributed quite well. All officers, executors, and activity supervisors were well-trained. Educational background also followed their respective field; hence, the duties and functions were implemented without problems. Regeneration in the community had also been carried out, however, not all cadres understood the related program.
   > *"All of the officers have been trained, and the cadres have also been given training, but not all of the cadres have been trained because there are still those who do not understand the program…."* (Respondent 3)

   This means that the information obtained by officers was nonoptimal. Less sustainable training related to the Presidential Regulation Number 42 of 2013 concerning the national movement within the framework of the first 1,000 days of life was the major cause of limited information.

Disposition

a) Bureaucratic Removal
   Regarding bureaucratic appointment, respondents indicated that it was done by the structure in the coordination process and program managers to appoint field officers. This could be seen from the bureaucratic attitude, which was to be fully responsible for implementing the movement, which was already good. The results of in-depth interviews with regular informants obtained information.
   > *"The bureaucratic appointment was left entirely to the program manager. There is no legal determination but rather*

Table 1. Perceptions of the Biromaru Primary Health Care Regarding the Movement (n = 74)

Variable	Category	n	%
Communication	Poor	63	85.14
	Good	11	14.86
Resource	Poor	59	79.73
	Good	15	20.27
Disposition	Poor	56	75.68
	Good	18	24.32
Bureaucratic structure	Poor	13	17.57
	Good	61	82.43

a direct appointment by the leadership of the primary health care for related fields such as nutrition. Then, the nutrition sector coordinates with other fields, and the cadre selection in each village is left entirely to the village. Usually, the village [office] appoints Human Development Cadres." (Respondent 4)

b) Incentive

The incentives, functioned as operational budget, were not used the way it should be. The results of in-depth interviews with the key informant stated that the budgeting for the movement implementation was taken from the budget for health operational costs, following the rules set by the health service.

"Align with that (incentive), there is an incentive in form of an honorarium received by those health workers going out to the field, but this is only calculated for one health worker, and the village office provides fees for such program activity." (Key informant)

Bureaucratic Structure

Related interviews regarding the bureaucratic structure dimensions in the movement implementation revealed that the bureaucratic structure had been carried out properly according to the standard operating procedures (SOP), duties, and functions. Based on Table 1, for the Biromaru PHC staff's perceptions, 85.14% of them thought the communication was poor, 79.73% thought the resources were poor, 75.68% thought the disposition was poor, and 82.43% considered the bureaucratic structure good regarding the movement implementation.

Discussion

The implementation of the national movement on the first 1,000 days of life in Pasaman District, Indonesia, in 2017 was not performed well for several obstacles: any absent written regulations, vision, mission, and specific program objectives.[16] There was also a maximum involvement of stakeholders, unavailable budget, lack of human resources, facilities, and infrastructure.[16] Communication is crucial in policy, in which in the implementation means a success parameter for a public policy.[17] Good transmission would greatly affect the policy implementation, thus no miscommunication occurs in the bureaucrats implementing the policy. However, the communication that exists must also be consistent, or not change, and be clear to avoid ambiguous communications between the bureaucracies.[17]

Communication transmission is channeling information, ideas, or opinions, which would also be well implemented. However, in the practice of communication transmission, misunderstandings often occur because communication stages pass through several bureaucratic levels, resulting in a distortion in the information distribution process.[18-20] An important point in communication is consistency. Orders given in performing a communication must be consistent and clear, not frequently changed, so that implementers in the field are not confused.[18]

In a prior study in the South Central Timor District, efforts were made to carry out the mandate in Indonesian Law Number 52 of 2009 concerning Population Development and Family Development.[19] However, the stunting problem in society has been considered not a critical problem and not requiring serious treatment. A mystical side involvement is still rooted in local culture, in which people consider stunting to be part of the mystical world. Therefore, the implementation of stunting prevention policy by the District Occupation Control and Family Planning Office run from a communication perspective. However, several obstacles were still found in terms of consistency of information provided and community's participation.[19]

Clarity of communication received by the policy implementers (street-level bureaucrats) must not ambiguous. Although sometimes any unclear message from a policy still remains, it does not hinder the implementation process. A thing needed is a flexibility from the policy implementers. However, the lack of clarity becomes a vessel for diverting

goals to be achieved.[18-19] Edward III stated that the primary resource in policy implementation is staff or human resources.[14] One of most important factors in the failure to implement a policy is the insufficient quantity and incompetent quality of staff in the field. Raising the number of staff is not enough without being balanced by increasing the quality of the staff's ability and expertise in carrying out their respective duties.[16]

The quality of human resources is not only determined by their expertise, but also accompanied by a controlled and commendable mental attitude in achieving policy goals. One of parameters for the success of a policy is the availability of adequate human resources, both in terms of quantity and quality. Human resources are active actors who will carry out activities such as implementing policies.[16,21] Two forms of information in policy implementation include 1) information related to how to implement the policy. Implementers must know what to do when they get an order; 2) information on any compliance data from implementers with applicable government rules and regulations. The implementers must know whether other people involved in implementing the policy are complying with it.[18,21]

The results of this study are not aligned with Megawati's study.[22] Generally, most cadres already had adequate knowledge of prevention and early detection of stunting. They felt that such training was useful in elevating their knowledge and capacity regarding balanced nutrition and stunting prevention.[22] All cadres received a thorough explanation of questions related to inaccurate understanding of nutrition so far. Through the training, cadres also had a better understanding of an optimal nutrition in the first 1,000 days of life to prevent stunting. In addition, the cadres also learned the way to identify risk factors of stunting incidence in their working areas. The cadres hoped the training would be provided sustainably and periodically and be much better programmed to make their knowledge and skills honed and improved.[22]

Other than communication and resources, disposition or attitude of policy implementers also determined the implementation of policy for their important role in running activities or programs. In addition, it requires ability to observe and comprehend conditions occurring in the community. Effectiveness and efficiency are needed in this case so that it becomes the policy implementers' responsibility. In disposition variable, considerable aspects in the implementation included the bureaucratic appointment and incentives.[18]

The disposition or attitude of implementers might generate real obstacles for the policy implementation if individuals involved could not carry out any policies expected by the higher-ups.[18] Hence, in the process of appointing executors, they must review not only their personal abilities, but also their dedication to the policies made. More specifically, they are people who care about the general interest, not the interests of certain groups or individuals,[18] which means that a concept of appointing a bureaucrat has been carried out well, continuously every month.[23]

Edward III suggested the way to overcome the policy implementers' tendency problem was by granting incentives.[14] In principle, people would act according to their own interests, therefore, available incentives would affect their attitude. Incentive means an effort that might be a supporting factor for policy implementers to perform their duties and mandates properly.[14,18,24] The fourth variable affecting the success rate of public policy implementation is bureaucratic structure. Highly complex policies require a cooperation of many people. The bureaucratic structure which is not conducive to available policies would result in various resources to be ineffective and hinder the implementation of policies. As the implementer of a policy, a bureaucrat is required to have an ability to support any politically-made policy by making a good coordination.

Therefore, two characteristics boosting a better performance of bureaucratic or organizational structure are implementing SOP and fragmentation. The SOP is a routine activity allowing the policy implementers/administrators/bureaucrats to do various daily activities according to predetermined or minimum standards required by residents. While, what is meant by implementing fragmentation is an effort to divide responsibility for activities or employee activities among several work units.[24-25] Through adequate SOPs, the bureaucratic or organizational structure could accompany performance with additional policies, including breastfeeding and early childhood cognitive development.[26-27]

Conclusion

The only factor that has been running well in the national movement for the first 1,000 days of life is the bureaucratic structure. The communication and resources are good enough, yet still nonoptimal. There is still a lack of transmission and clarity in communications and inadequate PHC staff in term of resources. However, the disposition is in poor condition since it has not been done legally. The SOP is needed to make the movement run well, and further efforts are needed to support the continuity to strengthen cross-sector communications and cooperation, reach all targets, and improve training. Special incentives for the PHC staff are expected.

Abbreviations

LBW: Low Birth Weight; PHC: Primary Health Care; SOP: Standard Operational Procedure.

Ethics Approval and Consent to Participate

All informants and subjects approved the informed consent before participating in the study. Their written approval was witnessed by independent bystanders. This study also passed ethical consideration and was granted ethical clearance from the Ethics Commission for Medicine and Health Research, Faculty of Medicine, Tadulako University, No. 3413/UN28.1.30/KL/2023.

Competing Interest

The authors declare that no significant competing financial, professional, or personal interests might have affected the performance or presentation of the work described in this manuscript.

Availability of Data and Materials

All qualitative and quantitative datasets belong to Tadulako University and can be accessed with the institution's permission.

Authors' Contribution

MV, MRN, V, NR, ASN, and A contribute equally to this study.

Acknowledgment

The authors thank all parties, including the Biromaru Health Center, the Loru Village, and Sigi District officers who were well-cooperated in this study.

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