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Spatial Durbin Model on the Utilization of Delivery at Health Facilities: A 2017 Indonesian Demographic and Health Survey Analysis

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Abstract

The utilization of delivery at health facilities is a major intervention in reducing 16 to 33% of deaths. This study aimed to determine the model of utilization of delivery at health facilities in Indonesia in 2017 and its influential factors. This study used secondary data from the 2017 Indonesian Demographic and Health Survey using a Spatial Durbin Model (SDM) approach. The population was mothers aged 15 – 49 years, spread across 34 provinces of Indonesia, and had 15,321 samples. The results showed that the Moran's I value was positive (0.146) and significant at p-value = 0.007, indicating clustered regions with similar characteristics. The SDM modeling estimation results (R2 = 91.61%) presented those dependent and independent variables that influenced the utilization of delivery at health facilities and its influential factors. The significant and most dominant direct factor that influenced the utilization of delivery at health facilities was pregnancy visits, while the most dominant indirect factor was socioeconomic status. Therefore, further policy planning is expected to be based on regional specificities, and effective intervention programs should be designed based on these factors.

Keywords: delivery, health facilities, Spatial Durbin Model, utilization

Introduction

Pregnancy and childbirth are momentous times in a woman's life. The World Health Organization (WHO) estimates that 287,000 women died during and after pregnancy and childbirth in 2020.[1] Maternal mortality is a priority on the Sustainable Development Goals (SDGs) agenda. The global maternal mortality rate (MMR) in 2000-2020 decreased from 339 deaths to 223 deaths per 100,000 live births worldwide, according to the WHO.[1] In Southeast Asia, Indonesia ranked the third highest MMR in 2023 at 173 deaths per 100,000 live births after Cambodia and Myanmar.[2] As a developing country, not only does Indonesia have the largest population among Southeast Asian countries, but it is also an archipelagic country with natural resources that vary between regions. This is characterized by people living in urban and rural areas working in various sectors. Indonesia is a large and diverse country. Diversity is a valuable asset but has the potential to precipitate inequality and polarization that would trigger social instability. Therefore, an appropriate policy design is needed; in this case, information support from various dimensions is needed to see the phenomenon as a whole.[3]

Major interventions to reduce maternal mortality include the utilization of skilled birth attendance (SBA) at health facilities by providing safe delivery, reducing actual and potential complications, and improving the survival of most mothers and newborns.[4] It is estimated that utilization of delivery facilities could reduce maternal mortality by 16 to 33%.[5] The 2012 Indonesian Demographic and Health Survey (IDHS) data figured that delivery coverage at health facilities in Indonesia was 56%, increasing to 73.6% in 2017. This increase still leaves a gap, in which the achievement is higher in urban areas (88.1%) than in rural areas (60%). Apart from the area of residence, the delivery coverage in health facilities for women in the lowest quintile economic group (45%) is also still below the national average (73.6%).[6]

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The phenomenon of low delivery coverage in health facilities among women in rural areas is due to barriers to accessing health facilities where women from middle to lower economic groups have the lowest health insurance coverage, so they prefer to deliver to traditional birth attendants rather than health facilities. This needs attention for maternal health and safety reasons.[6] The 2022 delivery trend at health facilities demonstrated a slight decrease in the proportion of women who gave birth assisted by the SBA from 95.93% (2021) to 95.79% in 2022.[7] However, disparities in such achievement still occur. Research shows significant differences between regions,[8] where most provinces in Indonesia already have SBA-assisted delivery outcomes of more than 90%, which is still not evenly distributed. In contrast, Papua and Maluku, two provinces with achievements below 80%, need to be prioritized to achieve maximum coverage.[9]

Previous studies have explored factors associated with the utilization of delivery at health facilities,[10–14] but few studies have explored them using spatial analysis.[15,16] Spatial analysis is deemed more accurate as it is capable of addressing phenomena based on geographical aspects. Spatial analysis can also show the distribution of an object on a location map and explain the distribution type.[17] The Spatial Durbin Model (SDM) is a spatial regression analysis model that analyzes influential factors in social, economic, and health issues. The SDM functions to produce regression estimates to determine a relationship between variable X and variable Y based on the presence of spatial effects or dependencies in it.[18] Hence, this study applied the SDM to determine a relationship between spatial dependencies and influential factors to the utilization of delivery at health facilities, which could support further policies and strengthen existing studies in Indonesia.[19]

Method

This study used secondary data from the 2017 IDHS that was part of an international survey in a series of demographic and health survey programs organized by the Inner City Fund. The 2017 IDHS is a big data at provincial level, including data on giving-birth women aged 15-49 years spread across all provinces in Indonesia and factors thought to influence the extent of utilization of delivery at health facilities in 2017. The location of the study was in 34 provinces in Indonesia based on the 2017 IDHS report.[6] The sample size was 15,321 people spread across 34 provinces in Indonesia, obtained by examining all the mothers who used health services from their first to sixth child.

Variables for the SDM analysis consisted of a dependent variable (the rate of mothers using health facilities for delivery/Y) and independent variables: rates of mothers aged 20-35 years (X1), working mothers (X2), mothers with lower socioeconomic status (X3), mothers with insurance (X4), mothers in urban areas (X5), mothers with antenatal care (ANC) visits ≥4 (X6), women with complications (X7), and women with a planned pregnancy (X8) utilizing health facilities for delivery.

The analysis in this study used a survey data analysis with complex sample design, so that the results obtained could represent the population in which each unit had its own weight in each region. The stages of analysis included describing the rate of utilization of delivery at health facilities and its influential factors from a territorial point of view by using thematic maps and testing effects of spatial dependency between locations. Different methods of testing were taken to determine the existence of spatial effects: spatial dependence and heterogeneity in the data. The spatial dependence or autocorrelation between locations was tested using Moran's I method. The hypothesis used was H_1: $I_M \neq 0$ (i.e. there were dependencies between locations).

The final stage was a modeling using HR regression. Regression analysis is a statistical analysis to model the relationship between dependent variables (Y) and independent variables (X). This relationship can be expressed in a linear regression model. The model developed by Anselin uses a cross-sectional spatial data. The general model of the General Spatial Model is shown below: [20]

$$\mathbf{y} = \rho \boldsymbol{W_1 y} + \mathbf{X\beta}$$

$$\text{where } \mathbf{u} = \lambda \mathbf{W_2 u} + \boldsymbol{\varepsilon}, \text{and } \boldsymbol{\varepsilon} \sim \mathrm{N}(0.\sigma^2 \mathbf{I}) \text{ [20]}$$

The matrices of W_1 and W_2 were weights indicating a proximity between locations. The diagonal was zero or $w_{ij} = 0$ for i = j and $w_{ij} \neq 0$ for I ≠ j where i (i = 1,2,., n) and j (j = 1,2, n) were observations or locations. While the SDM is characterized by the addition of spatial lags in the independent variable. The SDM model was expressed in the following equation:[20]

$$\mathbf{y} = \rho\mathbf{W_1 y} + \mathbf{\beta_0} + \mathbf{X\beta_1} + \mathbf{W_1 X\beta_2} + \boldsymbol{\varepsilon}$$
$$\text{where } \boldsymbol{\varepsilon} \sim \mathrm{N}(0.\sigma^2\mathbf{I})^{20}$$

Results

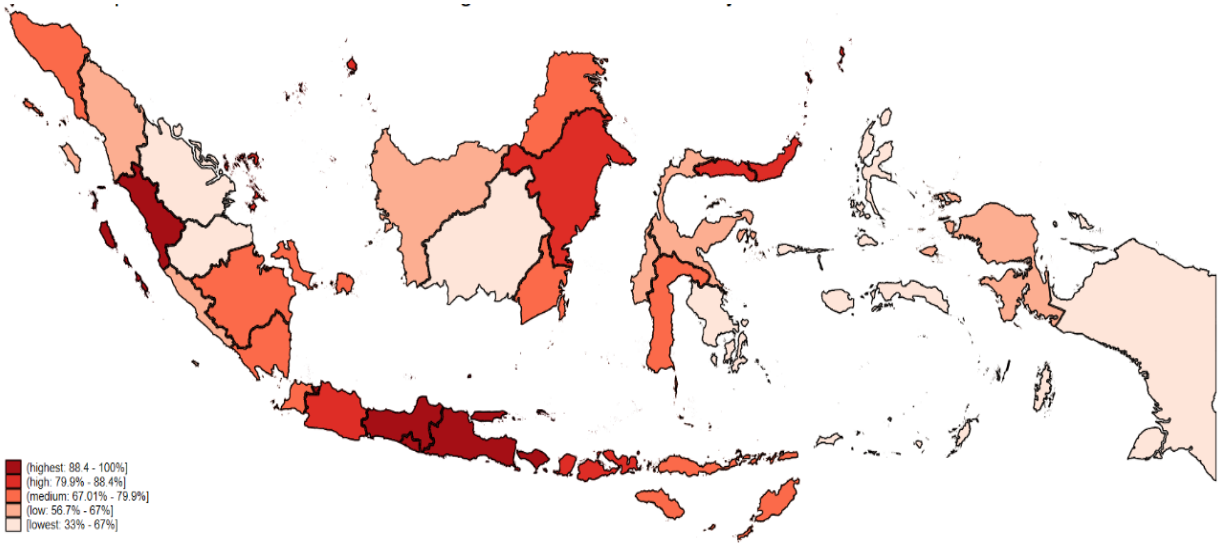

Figure 1. Spatial Distribution of the Percentage of the Utilization of Delivery at Indonesian Health Facilities, 2017 (Source: Personal Data Analysis Result by using STATA 15)

The average rate of mothers utilizing health facilities for delivery in Indonesia was 72.5%. It was categorized as high if a province reached the rate at greater than 72.5% and as low if less than or equal to 72.5%. Five provinces with highest rates were the Special Region of Yogyakarta (100%), Bali (98.8%), the Special Capital Region of Jakarta (97.6), Central Java (96.4%), and West Sumatra (93.9%). In contrast, seven provinces representing each of Indonesian islands were at lowest rates: Maluku Island (Maluku Province at 33% and North Maluku Province at 38.1%), Kalimantan Island (South Kalimantan Province at 41.8%), Papua Island (Papua Province at 48.4%), Sulawesi Island (Southeast Sulawesi Province at 51.6%), and Sumatra Island (Riau Province at 55.5% and Jambi Province at 56%).

Table 1. The Results of Linear Regression Analysis of Delivery Utilization in Health Facilities in Indonesia

Variable (Proportion)	Coef.	SE	T	p-value	[95% Conf.]	
Age	-0.352	0.793	-0.45	0.658	-2.011	1.299
Education	0.218	0.467	0.47	0.645	-0.756	1.193
Parity	0.005	0.626	0.01	0.993	-1.300	1.311
Knowledge	0.166	0.324	0.51	0.613	-0.509	0.843
Occupation	0.204	0.266	0.76	0.453	-0.352	0.761
Socioeconomic	0.130	0.727	0.18	0.860	-1.387	1.647
Insurance	0.390	0.222	1.75	0.095	-0.073	0.854
Decision	-0.143	0.296	-0.48	0.635	-0.761	0.475
Region	0.195	0.159	1.23	0.235	-0.137	0.528
Distance	-0.324	0.624	-0.52	0.610	-1.627	0.979
Visit	1.278	0.499	2.56	0.019	0.237	2.319
Complication	0.678	0.864	0.78	0.442	-1.124	2.481
Planning	0.127	0.208	0.61	0.546	-0.306	0.561

Table 2. Classic Assumption Test on the utilization of delivery at health facilities in Indonesia

Assumption Test	Test Name	Estimation	Criteria	Conclusion
Error Normality	Shapiro-Wilk W	0.951	p-value = 0.3175	Not fit
Homogeneity	Breusch-Pagan	0.420	p-value = 0.515	Fit
Multicollinearity	VIF	<10	<10	Fit
Autocorrelation	Durbin Watson	2.270	<-2 < DW <2	Not fit

Notes: VIF = Variance Inflation Factors, DW = Durbin Watson.

Based on the results of classical regression analysis at the initial stage above, all risk factors do not have a significant effect on the utilization of health facilities for delivery. However, this result was influenced by several assumptions that have not been met, such as normality and autocorrelation; therefore, the above results become biased and invalid. The next stage was detecting the existence of spatial influence on the utilization of health facilities for delivery. One way to determine a spatial dependency between locations was to perform spatial autocorrelation, in this case, by using Moran's I, Geary's C, and Getis & Ord G test statistics.

Hypothesis:

H0: No spatial autocorrelation between locations

H1: There is spatial auto-correlation between locations

Table 3. Spatial Autocorrelation Test on the Utilization of Delivery at Health Facilities in Indonesia

Variable	Moran's I		Geary's C		Getis & Ord's G	
	I	p-value*	C	p-value	G	p-value
Benefit	0.146	0.007	0.708	0.002	0.263	0.014

*): significant at p-value of ≤0.05

Based on the three criteria using Moran's I, Geary's C, and Getis & Ord G test statistics, the benefit variable was found consistently identified as having significant spatial autocorrelation with values of I = 0.146 (p-value = 0.007), C = 0.708 (p-value = 0.002), and G = 0.263 (p-value = 0.014). This indicated that the utilization of delivery at health facilities was interrelated between regions. The Moran's I value was positive, indicating clustered regions with similar characteristics. Hence, provinces with a high rate of utilization would also influence mothers aged 15-49 years to highly utilize health facilities in their nearby areas for their deliveries, and vice versa. The following table presents the results of spatial diagnostic test to determine appropriate spatial regression model where spatial effects are inherent in this study.

Table 4. Spatial Diagnostic Test on the utilization of delivery at health facilities in Indonesia

Test	Statistic	p-value
Spatial error:		
Moran's I	0.675	0.49
Lagrange multiplier	0.207	0.64
Robust Lagrange multiplier	0.000	0.98
Spatial lag:		
Lagrange multiplier	3.560	0.05*
Robust Lagrange multiplier	3.353	0.06

*): significant at p-value of ≤0.05

Based on the diagnostic test above, the selection of the spatial regression model to be carried out was spatial lag using the Lagrange multiplier function, in which the area approach calculates the influence of spatial lag weighted on the dependent variable, which was the utilization delivery at health facilities. Spatial modelling applied in this study was the SDM with the maximum likelihood estimation method because using the usual ordinary least square method estimation method would produce biased and inconsistent parameters. This spatial regression model was a development of the Spatial Autoregressive Model (SAR) in which the spatial lag was not only weighted on the benefit variable, but also had the characteristic of a spatial lag on the factor variable (X) in this study. The SDM concerned is as follows:

$$Y_i = \rho \sum_{j=1}^{n} W_{ij} Y_j + \alpha + \sum_{k=1}^{p} \beta_k X_{ik} + \theta_k \sum_{j=1}^{n} (W_{ij} X_{kj}) + \varepsilon_i$$

Notes:

ρ = spatial lag parameter of variable Y
W = weight matrix, size n x n
Y = vector of response variables, of size n x l
α = constant
β = regression parameter
X = risk factor variable matrix, size n x p
θ = spatial lag parameter of variable X
ε = error vector, of size n x l

The determinants for the utilization of delivery at health facilities with the Spatial Durbin equation obtained are as follows:

$$Utilization_i = 26.61 \sum_{j=1}^{34} w_{ij} Utilization_j - 174.56 + 0.02 * Age + 0.03 * Jobs + 0.18 * Socioeconomic + 0.6 * Insurance + 0.35 * Region + 1.84 * ANC\ Visit + 0.65 * Complication + 0.19 * Pregnancy\ Planning + \theta_k \sum_{j=1}^{34} (w_{ij} x_{kj})$$

So, the details of the final spatial Durbin model (pseudo R2 = 91.61) obtained are as follows:

Table 5. The Final Spatial Durbin Model on the Utilization of Delivery in Health Facilities in Indonesia

Variables	Coef	Direct				Indirect			
		dy/dx	95% CI		p-value	dy/dx	95% CI		p-value
Age	0.020	0.020	0.013	0.027	<0.001*	0.000	-0.010	0.011	0.934
Occupation	0.034	0.039	-0.261	0.340	0.796	0.409	-0.319	1.138	0.271
Socioeconomic	0.179	0.217	-0.516	0.951	0.562	2.821	1.202	4.439	0.001*
Insurance	0.609	0.608	0.403	0.813	0.000*	-0.017	-0.297	0.262	0.902
Region	<0.001	0.355	0.209	0.502	0.000*	0.394	0.006	0.783	0.046*
ANC visit	0.350	1.822	1.325	2.319	0.000*	-1.723	-2.378	-1.068	<0.001*
Complication	0.654	0.655	-0.110	1.421	0.093	0.058	-1.054	1.170	0.918
Planning	0.197	0.205	-0.043	0.455	0.106	0.643	0.154	1.131	0.010*

Notes: ANC = antenatal care; *): significant at p-value of ≤0.05

The most dominant and positive variable directly affecting the utilization of delivery at health facilities was ANC visit, while socioeconomic had the most dominant indirect effect among women aged 15-49 years in Indonesia. Indirectly, a pregnant woman's socioeconomic status influenced the utilization of delivery at health facilities with a p-value of 0.001. For every 1% increase in the socioeconomic status of pregnant women, the indirect effect of thr utilization of delivery at health facilities increased by 2.8%.

The age and insurance status of a pregnant woman had a significant direct effect on the utilization of delivery at a health facility with a p-value of <5% (<0.001). By region, pregnant women residing in urban areas had a significant effect on the utilization of delivery at health facilities in Indonesia with a p-value of <5% (<0.001). For every 1% increase in pregnant women residing in urban areas, the utilization of delivery at health facilities increased by 0.35%. ANC visits were the most dominant factor influencing the utilization of delivery at health facilities with a p-value of <0.001. For every 1% increase in pregnant women with a minimum of four ANC visits during pregnancy, the rate of the utilization of delivery at health facilities increased by 1.82%.

Discussion

Studies conducted in developing countries had also shown significant regional variations in the utilization of delivery at health facilities.[15,21-22] This may be due to inaccessible health facilities and inequality in the distribution of skilled resources (health workers) in remote areas. It may also be due to sociocultural and socioeconomic differences among women in different regions and limited access to information on maternal health services. When delivery at health facilities is low, possible causes include unsupportive societal traditions and unavailable funds, in addition to considerations of the location and maximum carrying capacity of each health facility, the geographical distribution of

the population, the landscape that the patient must traverse to reach the health facility, and the mode of transport.[22] Hence, if a gap was found in factors such as geographical variations in the topography of the region (for example. mountainous areas, uneven land contours, large areas of the forest) with an impact on transportation barriers, it would further lower the interest of mothers to give birth at health facilities.[23] Furthermore, the spatial study is pivotal due to the spatial influence where the location of province is separated between regions.

The utilization of delivery at health facilities in the Western Indonesia is likely better than in the Eastern Indonesia.[19] This condition is in line with the development process in Indonesia, which also tends to show disparities between the Western and Eastern regions. This situation is motivated by an archipelagic state of Indonesia. Economic movements and development between regions make the development gap between regions continue. Such gap also affected people's accessibility to health facilities, including the utilization of delivery at health facilities.[24] The development process in the West compared to the East could be observed,[3,25] specifically the Java Island that is the centers of Indonesian Government and various activities in the economy, education, transportation, technology, and so forth compared to other Indonesian islands.[26] Another study in the West Africa also found similar results.[27] This proves that spatially, geographical conditions in a region contribute to creating disparities, including the utilization of delivery at health facilities.

Many factors are associated with the utilization of facility-based delivery in Indonesia. The most direct determinant is ANC visit. This finding is in line with previous studies in Ghana[28] and Zambia.[29] This suggests that the process of interaction during ANC is a determinant factor in the subsequent utilization of maternal services. This is related to the expectations and satisfaction with the health services received by patients,[30] including their perspectives on the services received. In addition, women having more of ANC visits were more likely to receive information on complications associated with home delivery, thus motivating them to utilize delivery at health facilities with SBA.[29]

The indirect factor is socioeconomic, in which this finding is consistent with studies in Ghana[31] and Zambia.[29] This is likely because higher socioeconomic status could help women pay all the costs charged for delivery at a health facility. A better economic status may further improve health-seeking behavior and autonomy in healthcare decision-making, thus having an indirect positive influence on overall health service utilization. This reinforces the idea that socioeconomic influences the preference to deliver at a health facility.

Conclusion

The distribution pattern of the utilization of delivery at health facilities shows the existence of regional groupings based on their characteristics. Five provinces with the highest number of utilization presentations are the Special Region of Yogyakarta, Bali, the Special Capital Region of Jakarta, Central Java, and West Sumatra; while, the lowest ones are Maluku, North Maluku, South Kalimantan, Papua, Southeast Sulawesi, Riau, and Jambi Provinces. Based on the results of estimating parameters of the SDM modelling, the lag of dependent and independent variables affects the modelling of childbirth utilization and its influential factors. Directly influential variables are age, insurance ownership, region, and ANC visits; while indirectly influential variables are socioeconomic and pregnancy planning.

Abbreviations

WHO: World Health Organization; MMR: maternal mortality rate; SBA: skilled birth attendance, IDHS: Indonesian Demographic and Health Survey; SDM: Spatial Durbin Model; ANC: antenatal car; VIF: Variance Inflation Factors; DW: Durbin Watson.

Ethics Approval and Consent to Participate

The 2017 IDHS has obtained ethical approval from the Health Research and Development Agency of the Indonesian Ministry of Health. Respondents' identities have all been removed from the dataset. Respondents have provided written consent for their involvement in this study. The use of the 2017 IDHS data for this study has received permission from ICF International for analysis: https://dhsprogram.com/data/new-user-registration.cfm

Competing Interest

The authors declare that there are no competing interests, financial or otherwise that might influence the presentation of the work described in this manuscript.

Availability of Data and Materials

The data is available online and can be accessed on https://dhsprogram.com/.

Authors' Contribution

ISW, IG, MRM, and TR were equally participated in the conceptualization of the study design and interpretation of the data, critically revised the manuscript, and approved the final manuscript.

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Mapping for Tracking Sexually Transmitted Infections by Subdistricts in Surabaya, Indonesia

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Mapping for Tracking Sexually Transmitted Infections by Subdistricts in Surabaya, Indonesia

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Abstract

The 2014 shutdown localization of prostitution in Surabaya City, East Java Province, Indonesia, has given rise to an illegal prostitution industry, resulting in the spread of uncontrolled sexually transmitted infections (STIs). Mapping needs to be done to track the spread of the disease. This study used secondary data on STIs in 2020 from the Surabaya City Health Office. By using biplot analysis, this study sought to offer a detailed understanding of the distribution and dynamics of STI cases in different parts of Surabaya. The early-stage syphilis was found in Tegalsari and Krembangan Subdistricts; then, gonorrheal urethritis was found in Tandes, Karang Pilang, and Pabean Cantian Subdistricts. Meanwhile, gonorrhea was typically found in Tandes, Gunung Anyar, Sawahan, and Karang Pilang Subdistricts. On the other hand, Tegalsari, Krembangan, and Pabean Cantian Subdistricts also had cases of advanced syphilis. This study enables relevant parties, specifically the Surabaya City Health Office, to monitor the method's rapid spread and respond to each case according to the predominant type of STI.

Keywords: biplot, mapping, monitoring, sexually transmitted infections, subdistricts

Introduction

Sexually transmitted infections (STIs) are a group of diseases primarily transmitted through sexual contact, often colloquially referred to as venereal diseases.[1] The primary mode of disease transmission involves the exchange of body fluids and, in some cases, through medical equipment, from mother to fetus, via blood products, or through the transfer of contaminated tissues.[2] The causal agents of STIs encompass a diverse array of microorganisms, including bacteria, viruses, parasites, and genital lice. A noteworthy aspect of STIs is that many infections may not manifest noticeable symptoms, particularly in the early stages, or may exhibit indirect symptoms within the reproductive organs.[1] After being infected with STIs, particularly gonorrhea, the incubation period until clinical symptoms appear is very short, typically between 2-5 days. In addition to affecting the genitals, the bacteria can also infect other parts of the body, including the anus, eyes, throat, and joints.[3]

The latency in symptom manifestation underscores the urgency of regular screening and early detection for effective management. The diagnosis of some STIs could be made through physical examination or microscopic analysis of sores or discharge from the genital area or anus.[4] According to the Surabaya City Health Office, each of the eight distinct types of STIs presents its unique characteristics and potential health implications. These include early-stage syphilis, advanced syphilis, gonorrhea, gonorrhea urethritis, non-gonorrhea urethritis, cervicitis, lymphogranuloma venereum (LGV), trichomoniasis, and genital herpes.[5] The identification and understanding of these various types are crucial for effective prevention, diagnosis, and treatment strategies aimed at curbing the prevalence and impact of STIs within the community.

In East Java, a province inhabited by a population of 39,886,288 people, Surabaya City stands out as the most populous, serving as the capital of the province. This bustling city accommodates 2,904,751 individuals, resulting in a population density of 8,286.5 people per square kilometer.[6] As an illustration, around 8,287 people inhabit every square kilometer of Surabaya. Despite Dolly, once the largest center of prostitution in Surabaya and Southeast Asia, being shut down in 2014 and the crackdown on illegal activities in certain areas, Surabaya continues to grapple with a large number

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of STI cases. The East Java Provincial Health Office recorded a total of 2,526 individuals infected with the HIV/AIDS virus in 2021.[7] According to the data, Surabaya City is the area with the highest number of HIV/AIDS cases, with 323 individuals affected.[7]

This persistent issue accentuates the complex challenges associated with illegal prostitution and its impacts on public health. By using biplot analysis, this study aimed to provide a nuanced understanding of the distribution and dynamics of STI cases across various areas within the city. Findings from this mapping endeavor are crucial for devising targeted interventions and strategies to address the prevailing public health concerns related to STIs in Surabaya.[8]

In light of the information provided, a comprehensive study was undertaken to analyze the patterns of trends of STI cases across various subdistricts in Surabaya in 2020. This investigation employed the biplot analysis[9] to visually represent the data and ascertain the relationship between STI occurrences and the subdistricts in Surabaya. With a total of 13 subdistricts recorded, this study revealed the presence of individuals affected by four distinct types of STIs: gonorrhea, gonorrhea urethritis, early-stage syphilis, and advanced syphilis.

The primary objective of this study was to determine the trend pattern of STI cases within subdistricts of Surabaya. The visualization provided by the biplot analysis would facilitate a more comprehensive relationship of STI occurrences with specific subdistricts. The outcomes of this study would further furnish valuable information, enabling the Surabaya City Health Office to effectively manage and address the prevalence and distribution of STI cases. This, in turn, will contribute to enhancing targeted healthcare interventions and strategies to curb the impact of STIs in the city.

Method

The ground of this study relied on the use of secondary data from the Surabaya City Health Office, specifically focusing on the incidence of STIs in 2020.[10] The variables encompassed two key elements: subdistricts in Surabaya and certain types of STIs prevalent in those subdistricts. Notably, this study identified four distinct types of STIs and considered 13 subdistricts known to have reported STI cases. Data organization was systematically presented through structured tables that delineated the distribution of STI cases across different subdistricts and the prevalence of each particular type of STIs. The subdistricts in Surabaya City examined in this study were Benowo, Gubeng, Gunung Anyar, Karangpilang, Krembangan, Mulyorejo, Pabean Cantian, Sawahan, Semampir, Tambaksari, Tandes, Tegalsari, and Wonocolo. The STIs identified in these areas were categorized into gonorrhea (G), urethritis gonorrhea (UG), early-stage syphilis (ES), and advanced syphilis (AS).

A biplot served as an insightful graphical representation employed in multivariate data analysis, offering a unique perspective by integrating variables, subjects, and principal components onto a single graph.[11] While various types of biplots exist, the most prevalent was rooted in principal components analysis. This statistical technique transforms correlated variables into a set of uncorrelated variables called principal components.[12] The beauty of a biplot lies in its ability to encapsulate complex multivariate information in a comprehensible visual format.

As one of the few graphical methods capable of handling highly multivariate data, biplot analysis plays a crucial role in elucidating relationships within datasets. It accomplishes this by concurrently illustrating both the vector rows and columns on a two-dimensional plane, thereby facilitating a holistic understanding of the interplay between variables and subjects.[10] In essence, a biplot unfolds as a visual synthesis in which variables or attributes and the corresponding objects are cohesively depicted on the same graph. This dual representation enables researchers and analysts to discern patterns, trends, and associations in the data, providing a powerful tool for interpretation and exploration. By showcasing relationships between variables and subjects in a single, accessible visual framework, biplots contribute significantly to elucidating intricate multivariate structures.

This analysis was first introduced by Gabriel in 1971. Suppose a matrix n**Y**p is a matrix of data and n**X**p is A matrix of data corrected with their average scores, **X** = **Y** – **(JY)**/n, which n**J**n is a matrix with the elements of one. The singular value decomposition is as follows:

$$n\mathbf{Y}p = n\mathbf{U}r\ r\mathbf{D}r\ p\mathbf{V}r \quad (1)$$

Where **U** dan **V** are matrices with orthonormal colom ($\mathbf{U}^T\mathbf{U} = \mathbf{V}^T\mathbf{V} = r\mathbf{I}r$), and if **D** is a diagonal matrix with its diagonal element is eigen values, then $\mathbf{U} = \mathbf{D}w^{-1/2}\mathbf{U}$ and $\mathbf{V} = \mathbf{D}q^{-1/2}$ The equation (1) can be expressed as:

$$\hat{\mathbf{Y}} = \tilde{\mathbf{U}}\mathbf{D}_{\beta}\tilde{\mathbf{V}}^{\mathrm{T}} \tag{2}$$

then $\mathbf{G} = \mathbf{I}^{\frac{1}{2}}\mathbf{U}\mathbf{D}_{\beta}$ and $\mathbf{H} = \mathbf{J}^{\frac{1}{2}}\mathbf{V}$

The biplot analysis yielded a graph illustrating the link between the variables by measuring the angle between them. The correlation between the two variable vectors was shown by the angle produced between them; the smaller the angle formed, the stronger the correlation. The matrix of the square approach would provide a better presentation of the information contained in the original data.

The efficacy of biplot analysis in capturing and characterizing the overall variance present in the original data matrix was contingent upon the precision of its representation. In this context, the accuracy level served as a critical metric that gauged how faithfully the biplot encapsulates the intricacies and variability inherent in the multivariate dataset.[9]

$$\eta = \frac{\lambda_1 + \lambda_2}{\sum_{i=1}^{p}\lambda_i} \; ; \; 0 \leq \eta \leq 1 \tag{3}$$

λ_1 = The first largest eigenvalue
λ_2 = The second largest eigenvalue
λ_i = The ith largest eigenvalue, i = 1, 2, …, p

The success of a biplot analysis is often determined by the proximity of the η value to 1. A η value approaching 1 signifies that the information variation encapsulated by the biplot is nearly equivalent to 100% of the total information present in the dataset. In essence, a higher η value indicates a more successful representation of the dataset's variability, emphasizing the effectiveness of the biplot in capturing and conveying a comprehensive portrayal of the underlying data structure.

Results

The initial analysis conducted pertained to the examination of data characteristics. Data characteristics were instrumental in gaining insights into the overall profile of STIs data, encompassing the types of STIs, the distribution of STI types based on subdistricts, and characteristics of ES, AS, G, and UG by subdistricts. The analysis delved into understanding the landscape of STIs data in Surabaya in 2020.

The ES accounted for the highest percentage of cases (31.58%). The following were UG (28.95%), G (24.56%), and the last were AS (14.91%) out of 114 STI cases in Surabaya in 2020. It was quite concerning that the percentages exceeded 10%, in particular since the shutdown of the localization in 2014. Therefore, the Surabaya City Government should be aware of the occurrence and spread of STIs in the city.

Following the initial examination of overall disease characteristics, a more detailed analysis was conducted to explore the specific distribution patterns of each type of disease across the 13 subdistricts of Surabaya. This granular investigation delved into the nuances of disease prevalence and incidence in each subdistrict, shedding light on localized variations. In particular, the characteristics of ES, UG, G, and AS were scrutinized based on subdistrict-level data in Surabaya in 2020. The attributes of STIs across the 13 subdistricts in Surabaya, each of which reported cases of this ailment in 2020, were visually depicted through a bar chart in Figure 1.

The presented Figure 1 aims to offer a comprehensive overview of the distribution and prevalence of different types of STIs, providing a visual snapshot of the landscape of STIs in Surabaya during the specified year. This initial phase of analysis sets the stage for a more in-depth exploration of the intricate patterns and trends within the STIs data, paving the way for a nuanced understanding of the public health scenario related to STIs in the city.

Figure 1 reveals that the Tegalsari Subdistrict experienced the highest incidence of STI cases in 2020, with a total of 36 reported instances. Among the various types of STIs, ES emerged as the predominant ailment in the Tegalsari Subdistrict, contributing to 26 cases. In contrast, Mulyorejo and Tambaksari Subdistricts recorded the lowest occurrences of STI cases in Surabaya City during the same period. Specifically, the Mulyorejo Subdistrict reported only one case, identified as G case, while the Tambaksari Subdistrict documented a singular case of ES.

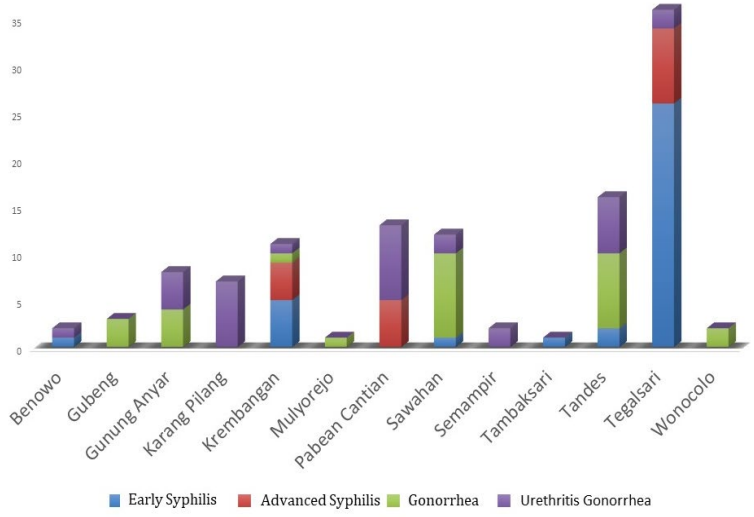


Figure 1. Characteristics of Sexually Transmitted Infections Based on Subdistricts[10]

Out of the total 114 STI cases reported in Surabaya City in 2020, the Tegalsari Subdistrict exhibited the highest percentage of ES cases, constituting a significant 72.22%. Conversely, Benowo, Sawahan, and Tambaksari Subdistricts reported the lowest percentages of ES cases, each accounting for a mere 2.78%. Notably, other subdistricts in Surabaya City did not report any instances of ES throughout the entirety of 2020.

For the AS cases, the Tegalsari Subdistrict maintained its prominence, reporting the highest percentage at 47.06%. In contrast, Krembangan Subdistrict documented the lowest percentage of AS cases, standing at 23.53%. Similar to ES, several subdistricts of Surabaya City did not report any cases of AS in 2020. Shifting the focus to G cases, Sawahan Subdistricts emerged with the highest percentage at 32.14%. In contrast, Krembangan and Mulyorejo Subdistricts reported the lowest percentages, each at 3.57%. Remarkably, several other subdistricts did not record any instances of G cases during the observed year.

Finally, when examining UG cases among the 114 reported STI cases in Surabaya City in 2020, the Pabean Cantian Subdistrict documented the highest percentage at 24.24%. In contrast, Benowo and Krembangan Subdistricts reported the lowest percentages, each at 3.03%. Similar to other STI types, certain subdistricts did not report any instances of UG cases during the specified period.

To monitor the spread of STIs in Surabaya, a mapping needs to be conducted in each subdistrict. The mapping employed biplot analysis, in which the proximity of STI types to subdistricts was depicted based on the angles formed between them. The magnitude of these angles reflected the correlation between them; the smaller the angle formed, the higher the correlation. This implied a close relationship between STI occurrences and the respective subdistrict areas. The accuracy level of a two-dimensional biplot was measured by $\eta = \frac{\lambda_1 + \lambda_2}{\sum_{i=1}^{p} \lambda_i}$ where λ_i was the eigenvalue of i = 1, 2, 3, 4.

$$\eta = \frac{(1{,}94667 + 1{,}08564)}{(1{,}94667 + 1{,}08564 + 0{,}84029 + 0{,}12741)} = 0{,}758 \sim 0{,}76$$

The first two main components contributed 76% of the total correlation information among variables, specifically in the context of STIs. This implied that the analysis could explain 76% of the information related to STIs in Surabaya.

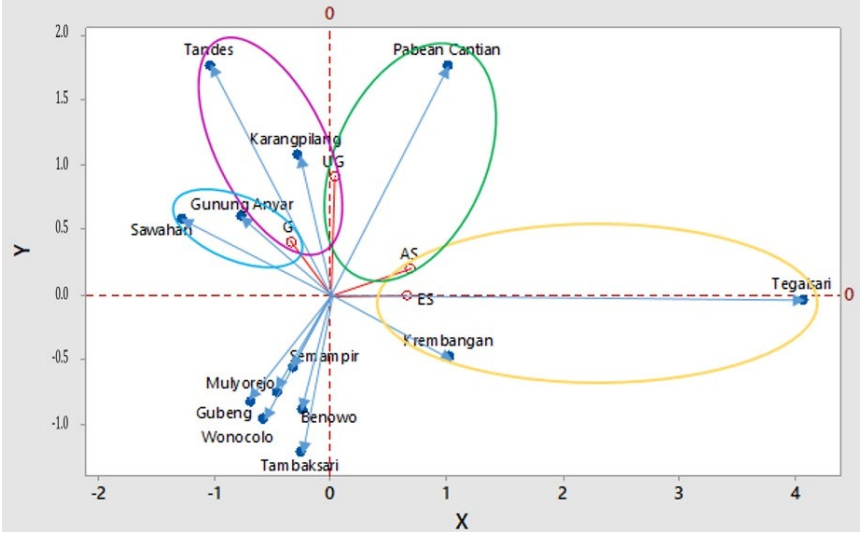
This substantial value exceeded 50%, making it sufficient for marking and serving as an indicator for subdistricts with high correlations that should be monitored cautiously. Figure 2 and Table 1 provide a visual and tabular representation of the subdistrict's position in relation to various types of STIs. The smaller the angle formed between STIs and the subdistrict, the closer the relationship between disease incidence in the subdistrict was concerned. The degrees of the angle formed are shown in Table 1.

Table 1. The Angular Measurements (in Degrees)

Subdistrict	ES	AS	G	UG
Benowo	105.00	122.19	121.30	165.10
Gubeng	128.83	146.02	97.47	141.27
Gunung Anyar	144.28	127.09	**10.58**	54.38
Karangpilang	107.15	89.96	**26.55**	**17.25**
Krembangan	**24.00**	**41.19**	157.70	113.90
Mulyorejo	120.13	137.32	106.17	149.97
Pabean Cantian	61.88	**44.69**	71.82	**28.03**
Sawahan	157.40	140.21	**23.70**	67.50
Semampir	120.03	137.23	106.27	150.06
Tambaksari	101.14	118.33	125.16	168.96
Tandes	122.39	105.19	**11.32**	**32.48**
Tegalsari	**0.88**	**16.31**	132.82	89.02
Wonocolo	120.18	137.38	106.11	149.91

Notes: ES = early-stage syphilis, AS = advanced syphilis, G = gonorrhea, UG = urethritis gonorrhea

The spatial arrangement in Figure 2 is delineated by the angles formed between individual subdistricts and the occurrences of specific STIs. The significance of these angles lies in their ability to convey the degree of correlation or association between each subdistrict and the prevalence of STIs. In this context, a smaller angle signifies a more pronounced correlation or interconnectedness between a given subdistrict and the incidence of STIs. Essentially, the angular measurements in Table 1 serve as a quantitative indicator, with a diminishing angle suggesting an increasingly substantial relationship between the subdistrict and the occurrence of STIs within that specific area.



Notes: G = gonorrhea, UG = urethritis gonorrhea, ES = early-stage syphilis, AS = advanced syphilis

Figure 2. The Biplot of Sexually Transmitted Infections in Surabaya[10]

The angular representations in Figure 2 and Table 1 unveil noteworthy correlations between subdistricts and various types of STIs. The discerned patterns indicate:

- Tandes and Karangpilang Subdistricts: These areas notably correlate with G and UG. The angular measurements signify a robust association between the geographical positioning of these subdistricts and the prevalence of these specific STIs.
- Krembangan, Tegalsari, and Pabean Cantian Subdistricts: These regions are intricately linked with both ES and AS.

Furthermore, Pabean Cantian demonstrates a distinct correlation with UG. The angles formed underscore the geographical significance of these subdistricts in relation to the prevalence of specific STIs.

- Gunung Anyar and Sawahan Subdistricts: These areas are singularly associated with G. The angles formed reflect the geographical specificity of these subdistricts concerning the incidence of G.

Conversely, a distinct group comprising Semampir, Gubeng, Wonocolo, Mulyorejo, Benowo, and Tambaksari Subdistricts does not display a pronounced correlation with the types of STIs, despite the documented cases within these regions. With a commendable accuracy rate of 76%, this analysis demonstrates a robust capability to elucidate the prevailing conditions of STIs in the urban landscape of Surabaya.

Discussion

The analysis conducted using the biplot method for mapping and visually tracking STIs offers a more informative approach, as it provides a direct depiction of the proximity between regions and the prevalence of diseases. A previous study on mapping and trend analysis of STIs in Surabaya City merely provided an overview of the total incidence rates of STIs from year to year. It primarily focused on mapping the subdistricts with the highest total cases of STIs without delving into the specific relationships between types of STIs and subdistricts.[13] In contrast, this study delved into the intricate associations between different types of STIs and specific subdistricts in Surabaya City. This approach significantly contributes to a nuanced understanding of the distribution and potential determinants of STIs in the surveyed area.

By focusing on the relationships between specific types of STIs and subdistricts, this study offers a more targeted and precise analysis to inform public health interventions more effectively. This comprehensive understanding serves as a foundation for developing targeted interventions and public health initiatives to reduce the incidence of STIs in Surabaya City. The comprehensive depiction generated from this study serves as a potent tool for ongoing monitoring of the spatial distribution of STI cases in Surabaya. Government entities and relevant stakeholders can leverage these insights to prioritize vigilant attention and meticulous intervention in subdistricts exhibiting high correlations with STIs. Additionally, a continuous vigilance strategy should be maintained for areas with lower correlations to ensure a controlled and monitored incidence rate.

Conclusion

This study reveals compelling patterns in the distribution of STIs across various subdistricts in Surabaya. The Sawahan and Gunung Anyar Subdistricts exhibit a strong correlation with gonorrhea. Conversely, the Tandes and Karangpilang Subdistricts are closely associated with both gonorrhea and urethritis gonorrhea, while the Pabean Cantian Subdistrict is linked to urethritis gonorrhea and advanced syphilis. Additionally, Tegalsari and Krembangan Subdistricts show a stronger correlation with both early-stage and advanced syphilis. These findings offer valuable insights into the spatial dynamics of STIs, serving as critical indicators for targeted interventions and public health initiatives and providing a foundation for ongoing monitoring and strategic planning by government entities and stakeholders.

Abbreviations

STIs: sexually transmitted infections; ES: early syphilis; AS: advanced syphilis; G: gonorrhea; UG: urethritis gonorrhea.

Ethics Approval and Consent to Participate

This study is based on a research project approved by the Directorate of Research and Community Service at Institut Teknologi Sepuluh Nopember, with Research Implementation Agreement Letter No.2430/PKS/ITS/2023.

Competing Interest

The authors assert that no noteworthy competing financial, professional, or personal interests could have influenced the execution or presentation of the research outlined in this manuscript.

Availability of Data and Materials

This study utilized secondary data from the Surabaya City Health Office, consisting of the number of STI cases based on subdistricts in Surabaya in 2020.

Authors' Contribution

DS provided supervision throughout the project. DSA was responsible for data collection and entry, while BSU and FH conducted the data analysis. Additionally, DS, BSU, FH, and DSA collaborated on manuscript preparation, content refinement, and administrative tasks. All authors participated in result discussions and contributed to the final manuscript.

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The Influences of Medical Students' Consent to Participate in Thalassemia Research

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The Influences of Medical Students' Consent to Participate in Thalassemia Research

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Abstract

An effective way of learning about thalassemia, a complex public health issue with multiple perspectives, is through participating in research. This study used an inductive approach to presume the influencing factors of students' consent to participate in thalassemia research voluntarily. Nested in the preliminary stage of a research series on thalassemia, this study used a consecutive sampling to recruit 140 medical undergraduates. Their knowledge, experience, and attitude to thalassemia and the perception of self-quality life were assessed using self-administered questionnaires. Blood samples were drawn for carrier screening. Students' GPAs were collected from faculty records. Of 140 participants, only 123 had at least heard of thalassemia, and their data was used in the analysis. Most participants had fairly good but incomplete knowledge of inheritance patterns, antenatal screening, and thalassemia management. Premarital screening was known and received the most positive attitudes from participants. Inductively, academic performance and carrier status curiosity were presumed to influence students' consent to participate. With the limitation of an inductive approach, further study with a specific design is needed to closely investigate student perspectives on research and their drives to get involved.

Keywords: consent, influence, knowledge, medical student, thalassemia

Introduction

In Southeast Asia, thalassemia is known to be the most common manifestation of hemoglobinopathy.[1] Historically, this inherited blood disorder was frequently found in malarial enclaves and assumed to confer a benefit of selective survival on thalassemia heterozygotes from the severe adverse effects of malaria. This natural selection may have also placed Indonesia, the second-largest malaria endemic area in Southeast Asia, into the thalassemia belt. Until now, the magnitude of the thalassemia problem in Indonesia remains a public health concern, with the number of cases expected is expected to continue to increase from time to time.[2]

Indonesia has had a strategic plan for thalassemia prevention since 2010[3], which primarily translated into various program activities such as health promotion, formal education, carrier screening, premarital counseling, and prenatal diagnosis.[4-6] However, these efforts have not yet been able to significantly suppress new emerging cases since health service inequality is still a challenge triggered by geographic differences, socioeconomic discrepancies, and inequitable distribution of health providers and required facilities within the country.[2,7]

Approximately 2,500 babies are born with beta-thalassemia (ß-TM) mayor yearly.[8] In 2019, the annual average cost to get optimal treatment for a thalassemic patient reaches up to IDR 300-400 million (USD 1,8642.72 – 2,4856.96), and this cost will increase as the patient ages and the complications they experience.[9] Such spending burdens the individual patient or their family and causes an enormous financial burden within the government health insurance scheme, estimated at IDR 900 billion (USD 559,281.6) per year.[10]

To date, information on the magnitude of thalassemia-related public health burdens has not received proportionate public attention in Indonesia. Efforts to work on thalassemia as a type of anemia have not yet been part of the health promotion to reduce anemia cases. That being concerned, the campaign for anemia due to iron deficiency is much more intensive, far surpassing the slow outreach of the other common variants of anemia, such as thalassemia.

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In other words, public ignorance is also a major obstacle in the efforts to control thalassemia thus far.[2]

The lack of public awareness of thalassemia in Indonesia is allegedly due to inadequate general knowledge, even among prospective health workers, about what thalassemia is and how to deal with it. Within the last decade, linkages between knowledge, awareness, attitude, and behaviors related to thalassemia have been studied among different respondents in various settings in Indonesia.[11-16] Trials to elevate knowledge of thalassemia among respondents with multiple characteristics have consistently proven effective in creating awareness or adherence to certain positive attitudes and behaviors.[17-20] The act of providing relevant information could also lend psychological support,[21] reduce anxiety,[22-23] improve self-esteem,[24] and increase resilience for both thalassemia patients and those closest to them.[21]

It is fundamental to do effective promotional education activities to disseminate information on thalassemia.[25] For this purpose, the public health system needs capable, trustworthy, and easy-to-consult resource persons. There is a high expectation for a medical doctor to at least be a competent resource person to deliver education on thalassemia or even provide quality healthcare for people with thalassemia. To build up such relevant knowledge and skills during their study time, the institution should organize various teaching and learning methods, one of which is through research activities. Although it is knowledge-dense, the involvement of students in research activities is optional, especially for undergraduates; hence, it requires their consent to participate, which could sometimes be very minimal. Meanwhile, factors which could motivate medical students to participate in research, particularly those requiring somewhat invasive procedures,[26] such as blood sampling, have yet to be studied.

In 2021, the Faculty of Medicine at a university in Jakarta initiated a research series on thalassemia. In phase I of this study, participants were selected from the university medical students who voluntarily enrolled after the outreach of research. The outreach conveyed to the attendants the need for blood sampling from all participants for carrier screening. As part of the research series, this study aimed to comprehend students' knowledge and attitudes to issues related to thalassemia. An additional analysis of their profiles was also carried out to determine influential factors to the students' consent to volunteer using an inductive approach.

Method

To find out more about thalassemia from various perspectives, a series of research was planned. Carried out as a cross-sectional descriptive study in May-June 2021, this was the preliminary stage of the series. This study included undergraduate students from the 2016-2020 batches of the Faculty of Medicine of a private university in Jakarta, Indonesia, who registered voluntarily online or offline. A consecutive sampling technique was applied to correspond with the study objectives. Recruiting participants began with the outreach directly to the students, both through online and offline.

The online session was delivered on May 24, 2021, followed by consecutive offline sessions from June 23-29, 2021. These sessions allowed dialogue between the attendants and the research team members on the study objectives, methodology, and data collection process. Participants in this study must be active undergraduate medical students; domiciled in Jakarta; not suffering from chronic diseases and/or not having blood transfusion within three months prior to blood collection; healthy during data collection; had heard of thalassemia; and not having an increase in leukocytes greater than 20% of the normal value range.

A formula to estimate a single proportion of the degree of participation was applied to calculate the sample size. With a total of 619 students from batch 2016-2020, a finite population correction (FPC) was applied to adjust the final sample size. The sample size calculation formula with an FPC was:

$$n = \frac{\frac{Z^2.(1-p)}{e^2}}{1 + \left(\frac{Z^2.(1-p)}{e^2 N}\right)}$$

For estimating 90% of the participation level with a 95% confidence level ($Z\alpha/2$ = 1.96) and a 5% margin of error (e), the minimum sample size required after the correction was 113 participants. Voluntary participation in medical-related studies that include invasive procedures might be low, even among medical students. This study showed that of 619 active students, 60.6% (n=375) attended the study outreach. Of the 375 students attending the outreach sessions, 140 voluntarily registered in the study. Of these 140 students, 17 (12.1%) had never heard of thalassemia; thus, their responses were considered irrelevant and excluded from the analysis. Yet, using non-probability sampling

technique, the composition of participants still resembled the composition of the 2016-2020 student population with a male/female ratio of 1 to 2 and slightly fewer participants from the earlier batches (the year 2016-2018: 45%) than from the latest batches (the year 2019-2020: 55%).

As illustrated in Figure 1, the presumed influential factors to students' participation in research were regarded as variables under study whose indicators were collected using three different methods. Knowledge, attitude, and experience related to thalassemia, perception of quality of life, sociodemographic status, and participants' economic status were assessed using self-administered online (Google Forms) questionnaires (as coded with Q1 – Q4). The data on students' grade point average (GPA) was obtained from the faculty record. A 7 ml venous blood sample was also collected from each participant in two 3 ml etilena diamina tetra asetat (EDTA) tubes for three levels of carrier screening.

The blood sampling was done by skilled analysts from Laboratory X in six batches from June 23 to 29, 2023. The first level screening was done using a Complete Blood Count (CBC), which comprises Hb, MCV, and MCH. The CBC was assessed using the Flow Cytometry Method Using a Semiconductor Laser (Sysmex-XN®). These biochemical assessments were carried out by Laboratory X in compliance with ISO Standards (SNI ISO 15189 has been accredited by the National Accrediation Committee with certificate no LM-013- IDN). The procedures of the second and third level screening would be reported elsewhere (in progress) because only the results of the first level screening were presented here.

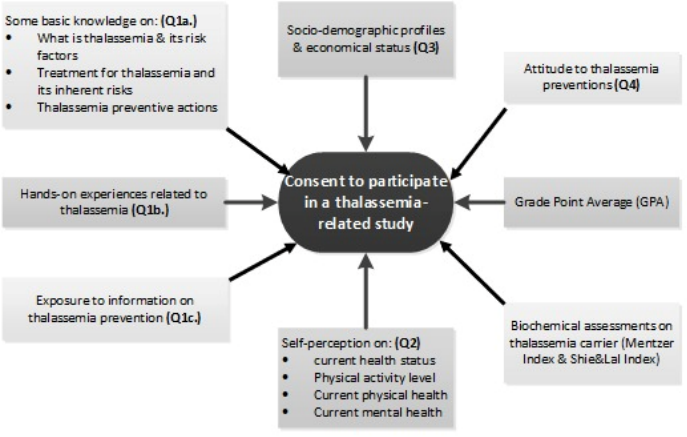


Figure 1. Conceptual Framework of the Preliminary Study

This study collected two types of data, categorical and continuous data, analyzed using SPSS Statistics for Windows version 26.0 (licensed until 2032). Responses from questionnaires were mostly categorical and presented as proportions. For responses on Q1.a, Q2, and Q4 were transformed into scores so that they could be treated as continuous data as well as regrouped into ordinal data (i.e., low, medium, and high scores). All continuous data were checked for their data distribution graphically using eye-ball observations and statistically using the Kolmogorov-Smirnov test combined to further determine the statistical tests for more analytical purposes.

The results of blood biochemical tests were used to detect the participant's pathophysiological conditions, such as anemia and/or suspected thalassemia carriers. The sex-specific World Health Organization's standards were applied to determine an anemic condition based on Hb level with <13 g/dL for anemic men and <12 g/dL for anemic women.[27] For those with anemia, further examinations were also carried out to determine whether the person concerned was suspected of thalassemia carrier. Following the national guidelines for medicine services management of thalassemia,[5] those with MCV<80 fl and/or MCH <27 pg were initially (1st level) suspected of thalassemia. A combination of the Mentzer index (MCV/RBC) and the Shine&Lal index (MCV^2*MCH/100) could also be utilized to sort out those with suspected thalassemia carriers.[28,29] Participants with Mentzer index <13 and Shine&Lal index <1530 were considered suspected Beta-thalassemia carriers.

Results

Analyses were performed based on only 123 datasets. The participants were 18-26 years old, with an average age of 20. None of them were married or had children. Most were Muslims (78.6%; n=97) and Christians (18.6%; n=23).

Based on the World Bank categories,[30] 22.9% (n=28) of participants came from the lower middle-income group, while more than half (77.1%; n=95) came from the upper middle to high-income group. Most students (79.7%; n=98) had been exposed to relevant information from lectures at the faculty, 13.8% (n=17) from TV, and very few (6.5%; n=8) from unspecified sources. Based on their experience, only 11.4% (n=14) have ever met a child with thalassemia or even donated blood to a child with thalassemia (3.3%; n=4). Although it could not be determined which happened first, experience or exposure to information, it was noticed that among those with backgrounds (14.6%; n=18), all had been exposed to some information, whether it be from lectures (11.4%; n=14) or news on TV (3.3%; n=4). Most participants (95.9%; n=118) also expected the government to raise public awareness of thalassemia through printed and electronic media.

The participants were dominated by those with optimal academic achievement (GPA 2.5-3.5: 69.9%; n=86), some from a less academic group (GPA <2.5: 20.3%; n=25), and even fewer from the high achievers (GPA >3.5: 9.8%; n=12). Only the 2020 batch had the number of participants equally divided between low and optimal achievers. The number of low achievers then decreased drastically in earlier batches. A significant difference in knowledge related to thalassemia prevention could only be detected between those with GPA <3.0 and those with GPA ≥3.0. Within the range of minimal and maximum scores of 0-4, the median score (4) of students with high GPAs was statistically higher than the median score (3) of those with low GPAs (p-value <0.05; Mann-Whitney U test). Besides, no other statistical differences were found between groups related to all aspects (knowledge, experience, attitude, and self-perception), including those between batches. Therefore, the overall analysis was then carried out using combined data, and the results were presented descriptively without any segregation between those with different batches or levels of GPA.

None of the participants knew whether they were thalassemia carriers or not. Of 123 participants, 13.8% (n=17)—all female—were anemic. Based on the first screening level, more than half of these anemic cases (n=10) were also suspected of thalassemia. While using MI and SLI combined, two anemic female participants were also suspected of beta-thalassemia. Three domains of knowledge were tested on the participants: a) what thalassemia is and its inherited pattern; b) prevention of thalassemia; and c) treatment for thalassemia. Overall, the participants' knowledge was high, with a median score of 10 (min-max: 1-15). As seen from Table 1, knowledge of what thalassemia is could be answered correctly by most participants (>90%). Still, the proportion sharply decreased when being asked about the roots of this condition (<60%). Only 60.2% (n=74) answered that thalassemia could be prevented, yet most participants (95.9%; n=118) answered correctly that premarital screening was equally crucial for males and females.

However, 33.5% (n=41) did not know that antenatal screening could work effectively. Compared to the first two knowledge domains, knowledge related to thalassemia treatment appeared to be much less, with the most significant proportion being 72.4% (n=89) for non-specific knowledge of thalassemia, repeating blood transfusion carries a risk. The participants could provide correct answers (60.2%; n=74) at most for 8-11 of 15 knowledge-related questions (Figure 2). This proportion was dominated by participants' correct responses on 2-5 questions on thalassemia and its causes (93.5%; n=115), 2-4 questions for thalassemia prevention (92.7%; n=114), and 2-4 questions for thalassemia treatment (61%; n=75).

Coherent with participants' knowledge of the methods to prevent thalassemia, premarital screening received the most positive attitude (98.4%; n=120) compared to the other preventive ways (Table 2). More than half of the participants were willing to undergo this kind of screening voluntarily, even though it was not mandatory. While, positive attitudes for other preventive ways only came from about two-thirds of the participants, and the proportion was even smaller (26.2%; n=32) when it related to the termination of pregnancy with a thalassemia major fetus. Most participants (81.3%; n=99) gave only one to two reasons that a pregnancy with a thalassemia major fetus would cause difficulties to the child (71.5%; n=87) or his family (33.3%; n=41) if maintained. Yet, the majority (64.8%; n=79) gave no opinion about pregnancy termination.

In this study, eight features were used to describe the quality of life as a whole, including self-assessment of the overall health (1 set of questions), physical conditions (3 sets of questions), vitality (1 set of questions), mental conditions (2 sets of questions), and even social functions (1 set of questions). As seen in Table 3, the participants' responses generally tended to be positively skewed as they valued themselves as healthy and normally functioning physically, mentally, and socially. Yet, when it comes to the self-perceived on broader or more abstract features like overall health, vitality, and mental health, their responses tended to be diverse and represented more the picture of a population's normal distribution.

Table 1. Participants' Knowledge of Thalassemia (N=123*)

Knowledge	Correct answer n (%)
What thalassemia is	
1. Thalassemia is a genetic disease	120 (97.6)
2. Thalassemia originates from a blood disorder	122 (99.2)
3. There are two types of thalassemia	71 (57.7)
4. A normal person could genetically have thalassemia minor	67 (54.5)
5. A child will not suffer from thalassemia if only one of the parents genetically has thalassemia minor	14 (11.4)
6. A normal person could marry a thalassemia carrier	86 (69.9)
Prevention of thalassemia	
1. Thalassemia could not be transmitted from food	105 (85.4)
2. Thalassemia could be detected during pregnancy	83 (67.5)
3. Thalassemia is preventable	74 (60.2)
4. Premarital screening for thalassemia needs to be done on both men and women	118 (95.9)
Treatment of thalassemia and its inherent risks	
1. Repeated blood transfusion is the way children with thalassemia can survive	69 (56.1)
2. There is a permanent solution for thalassemia	48 (39.0)
3. Repeated blood transfusion carries a risk	89 (72.4)
4. Therapy using iron chelating agents can be recommended for children with thalassemia	40 (32.5)
5. There are precautions/prohibitions for certain types of food for those with thalassemia	39 (31.7)

Table 2. Attitude to Thalassemia Prevention (N=122*)

	Attitude (%)		
Pregnancy with **a fetus detected as a carrier of thalassemia major**		**Reason**:	
• Kept it	9.0 (n=11)	Difficulties to the child (n=3); burden to the family (n=3); ethical issue (n=4) **gave no reason at all (n=1); gave only one reason (n=10)**	
• Terminated it	26.2 (n=32)	Difficulties to the child (n=30); burden to the family (n=12); burden to the country (n=3); death risk (n=1) **gave only one reason (n=21); gave more than one reasons (n=11)**	
• Do not know	64.8 (n=79)	Difficulties to the child (n=55); burden to the family (n=26); burden to the country (n=6); ethical issues (n=3); break the chain of disease (n=1) **gave no reason at all (n=12); gave only one reason (n=49); gave more than one reasons (n=18)**	
Premarital screening for thalassemia is **necessary**		M**arriage between** couples who are **both thalassemia carriers**	
• Yes	98.4	• Just fine	32.8
• No	1.6	• Should not	67.2
Want to have a premarital screening independently although it is not yet mandatory in Indonesia		**Carriers couples for getting pregnant**	
		• Just fine	33.6
		• Should not	66.4
• Yes	54.9		
• Maybe	41.8		
• No	3.3		

*one respondent gave no responses to this set of questions

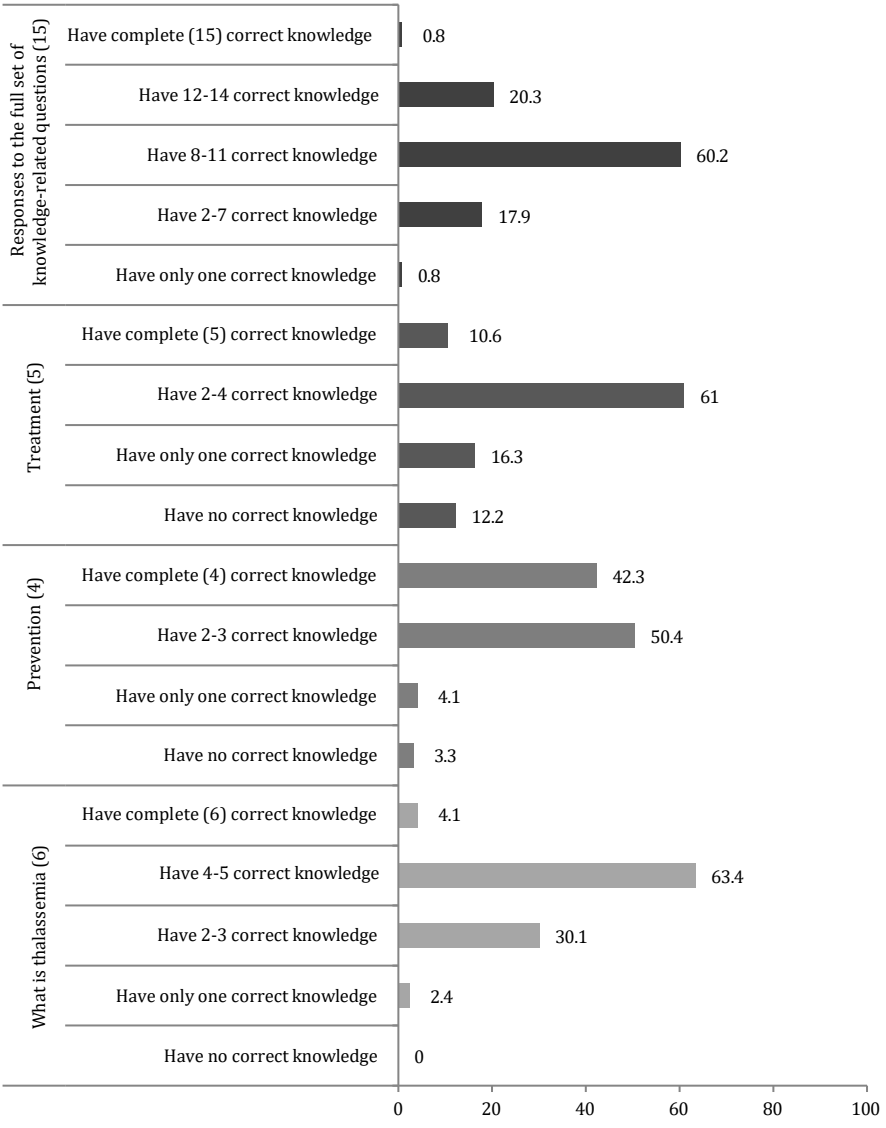
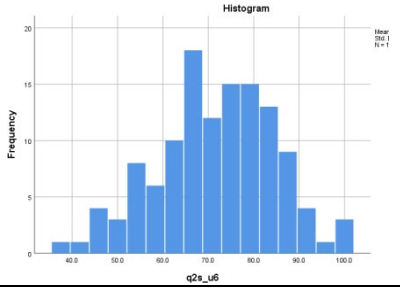
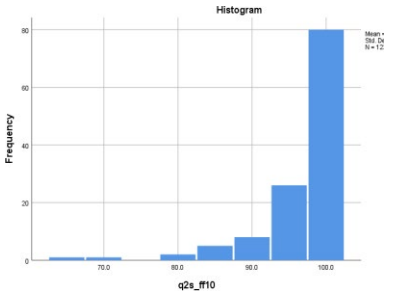
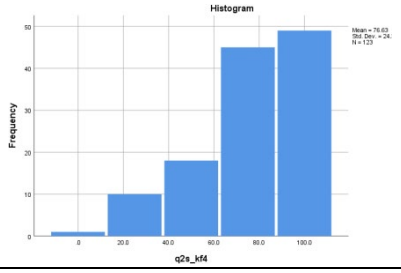
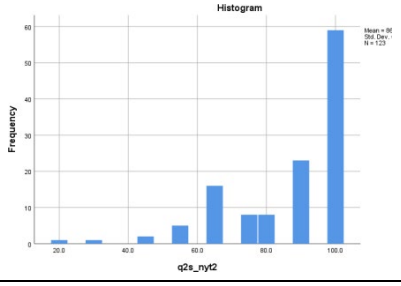
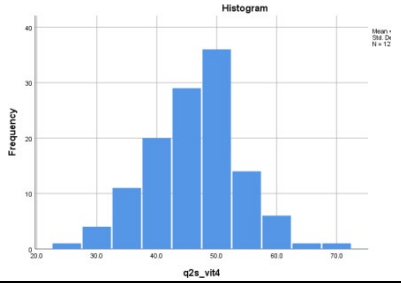
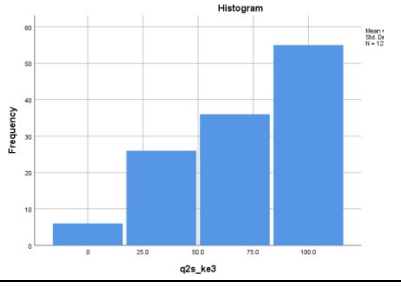
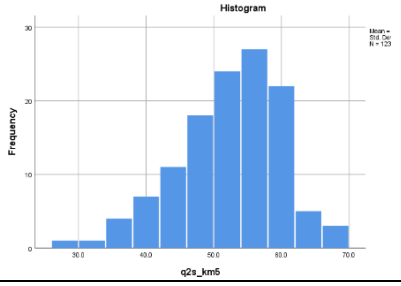
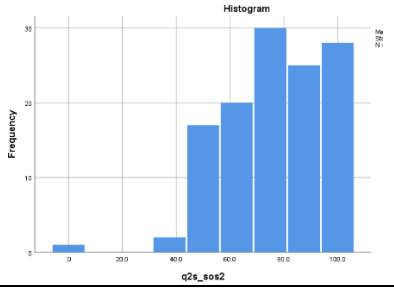


Figure 2. Proportion Distribution of Participants with Correct Knowledge of Thalassemia (N=123)

Table 3. Perception of the Self-Quality of Life (N=123)

Sub-variable	Statistics*	Score distribution
General health (6 questions) 1. How would you describe your current health condition? 2. How is your health now compared to one year ago? 3. I feel like I get sick a little easily 4. I am as healthy as anyone else 5. I feel my health is getting worse 6. My health is very good	70.8 (37.5 - 100.0)	

	Physical functions (10 questions) 1. Activities that require a lot of energy, lifting heavy objects, doing strenuous exercise 2. Light activities such as moving tables, sweeping, jogging/leisurely walking 3. Lifting or carrying light items (e.g. groceries, bags) 4. Climb some stairs 5. Climb one stair 6. Bending the neck/hands/legs, prostrating or bowing 7. Walk more than 1.5 km 8. Walk through several alleys/1km 9. Walk through one alley/0.5 km 10. Take a shower or wear your own clothes	100.0 (65.0 - 100.0)	
	Physical limitations (4 questions) 1. Spending all your time doing work or other activities. 2. Finishing work not on time. 3. Limited to some work or other activities. 4. Experiencing difficulty in doing work or other activities (for example those that require extra energy such as jacking/carpentry, washing)	75.0 (0.0 - 100.0)	
	Body soreness (2 questions) 1. How much pain have you felt in your body during the last 4 weeks? 2. In the last 4 weeks, how much did the pain interfere with your daily work (including work outside the home and work inside the home)?	87.5 (20.0 - 100.0)	
	Vitality (4 questions) 1. Do you feel full of enthusiasm? 2. Do you have a lot of energy? 3. Do you feel bored? 4. Do you feel tired quickly?	45.0 (25.0 - 75.0)	
	Emotional limitations (3 questions) 1. Spending all your time doing work or other activities 2. Finishing the job takes less time than usual 3. When carrying out work or other activities, you are not as careful as usual	66.7 (0.0 - 100.0)	

Mental health (5 questions) 1. Are you a very nervous person? 2. Do you feel very depressed and nothing cheers you up? 3. Do you feel calm and peaceful? 4. Do you feel hopeless and sad? 5. Are you a cheerful person?	52.0 (28.0 - 68.0)	
Social function (2 questions) 1. In the last 4 weeks, how much did your physical health or emotional problems interfere with your usual social activities with family, friends, neighbors or your group? 2. In the last 4 weeks, how often did your physical health or emotional problems affect your social activities (such as visiting friends, relatives, etc.)?	75.0 (0.0 - 100.0)	

***Median (min-max)**

Discussion

Delivering education on thalassemia takes a challenging and complex process. With the gene inheritance pattern from parents to offspring, carrier screening might create a fear of stigmatization.[25] Several prevention methods, such as avoiding or terminating a pregnancy, may arouse serious controversy and even outright rejection because they conflict with existing norms, or are invasive.[31,32] Moreover, efforts to convince thalassemia major patients or their families to strictly adhere to lifelong treatment could be hampered by many issues, such as financial problems, time constraints, resistance to pain, and mental depression.[33] In this context, more than just relevant medical knowledge is needed to enable a doctor to carry out the function of a health educator.

Solid medical knowledge may enable one to select and construct supportive fundamental messages precisely. However, concordance should be pursued regarding more delicate or sensitive issues, not just adherence or compliance.[34] Specific skills must also be mastered to verbally communicate (ideally in an understandable lay language) on thalassemia, its consequences, or the reasons for recommending a way out or solution. Also, it is a proper attitude that must objectively underlay specific medical advice whenever considered the best option.[35] Only then would the patients probably comprehend better the basis of their decision-making less clouded by incorrect or irrelevant perspectives.

That being said, only some of the participants could meet the above criteria, even just assessed by their levels of knowledge and attitude. Although their overall knowledge was good, it was patchy in some specific issues: inheritance patterns, antenatal screening, and treatment of thalassemia. However, the coherence of knowledge and attitude was noticed in this study, just like premarital screening, which was known by and received a positive attitude from most participants (>90%). This attitude might be predisposed by students' understanding that thalassemia is an inherited disorder and their unmarried status. However, the pattern of inheritance following Mendel's law for recessive genes was unknown by the majority (88.6%). Perhaps a positive attitude to premarital screening was also driven by considerations that other options, such as termination of pregnancy, were too risky, against the existing norms, conflict with their personal views or beliefs, or might give rise to ethical controversy.[31]

Age, sex, and years of education did not determine differences in knowledge and attitude on thalassemia among these undergraduate participants. A study in Semarang, Central Java, among medical students also reported similar findings, except that the year of education was significantly associated with knowledge and attitude.[13] Other studies among similar target groups reported significant associations between sex and knowledge,[36] age and attitude,[35] or age and knowledge.[37] Their educational performance, as indicated by the GPA, seemed only to differentiate the elementary level of knowledge of thalassemia prevention, but not about attitude or even experience. This association between GPA and knowledge somewhat aligned with their response that the faculty's lecture was their primary information channel on thalassemia. As a caveat, the topic of thalassemia given through lectures was very short in duration and not repetitive

(2 x 50 minutes in only one semester). Much detailed information might be forgotten when piled up with other course materials. The experience of thalassemia among the participants was too minimal to be associated with any factor aside from their rare exposure to thalassemia cases, direct or indirect. Perhaps it was because the participants were still students with no intense exposure to specific cases, including thalassemia, on top of their patchy knowledge.

One effective way to build positive attitudes and gain hands-on experience simultaneously with knowledge for medical students is through volunteering,[36] including in research. Therefore, understanding the underlying factors of students' interest in research to the point that they were willing to participate was just as important as exploring an engaging teaching method. However, this study has shown that student's willingness to participate voluntarily in research could be low regardless of their high attendance in the outreach session. There was also an indication that their interest was not necessarily driven by the proximity of their educational background to the scientific field of a given research.

An interesting finding was the dominance of students with optimal academic performance as this study participant, also found among undergraduate medical students in Dubai.[36] It was assumed that the optimal achievers' group may have different motives and attributes in viewing or responding to any existing opportunities compared to other groups. The phenomenon of the number of participants with low and optimal GPAs being equal only in the latest batch might indicate that students initially had similar attributes, which then became diverse in corresponding to the changes in learning demands and patterns in line with their studying period.

Even though it was known that a small number of participants were carriers of thalassemia, none of them knew about their condition because they had never been independently screened before, and most perceived themselves to be in reasonably good health. Curiosity to see whether they are carriers could be the driving factor for their participation in this research, even though their blood samples must be taken. However, on the other hand, it is yet to be known whether the lack of consent among non-participants was due to objections to blood sampling.

Using an inductive approach to identify influencing factors of consent to volunteers based on participants' characteristics has a limited scope of interpretation because there is no comparative data on the features of the non-participant group. Since factors such as age, sex, marital status, economic group, years of education, and perceived self-quality of life of the participants resembled the profile of the 2016-2020 students' population, no underlying factor of students' consent could be presumed within this cluster of variables as another limitation of an inductive approach.

Conclusion

In general, knowledge of thalassemia among the study participants is quite good, even though they are patchy on issues regarding inheritance patterns, antenatal screening, and treatment for thalassemia. The attitude to premarital screening is mostly positive, supported by the knowledge that thalassemia is an inherited disorder. The limitation of the inductive approach and the absence of a comparison group (non-participants) become constraints in identifying the influencing factors for student consent to participate. Academic performance and curiosity about career status are presumed to be the influential factors. Further studies must be specifically designed to analyze determinants for medical students' consent to participate, particularly in a study with complex subjects that must be understood from multiple public health perspectives, such as thalassemia.

Abbreviations

FPC: finite population correction; GPA: grade point average; CBC = complete blood count.

Ethics Approval and Consent to Participate

This research was ethically approved by the Research Ethics Committee of the Faculty of Medicine, Universitas Trisakti, Indonesia (Ethical Clearance no 011/KER/FK/IV/2021). The participation of students in the research was voluntary. All potential candidates who had met the inclusion criteria were exposed to detailed information on the research objectives and data collection procedures through outreach activities before signing consent to participate.

Competing Interest

The author declares that no significant competing financial, professional, or personal interests might have affected the performance or presentation of the work described in this article.

Availability of Data and Materials

The data used in this study is primary data taken directly from the results of filling out online questionnaires and laboratory examinations.

Authors' Contribution

RW had initiated the conception of the research, and all the other authors contributed to constructing the research plan. EXT and AK managed the data collection, DA and AK performed the statistical analysis, and RW drafted the manuscript. All authors took part in compiling references, giving insight into research implications for the near future study and policy, and finalizing the draft manuscript.

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Exploring the Implementation of Safety Resilience Assessment in Industries: A Systematic Literature Review

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Abstract

Safety Resilience discusses how a work process can run properly not only aims at preventing adverse events, but also increasing work productivity and effectiveness by increasing resilience. The concept of resilience has been widely suggested as safety management due to its ability to support organizations to continue operating even when facing unexpected demands or scale disruptions by improving their day-to-day performance. This study used a systematic literature review to explore the implementation of safety resilience in various industries. The results showed that 50% of articles used the Resilience Assessment Grid instrument to measure safety resilience in the workplace. In brief, increased safety resilience positively improves work performance and organizational safety.

Keywords: assessment, resilience, resilience engineering, resilience assessment grid, safety resilience

Introduction

Along with time, safety science has developed from Safety I to Safety II. In Safety I, an accident or near miss is regarded as an incident that occurs due to workers not completing work according to applicable procedures; hence, the focus of Safety I is to develop preventive measures through rules made for controlling humans to work without human error.[1,2] The basis of this perspective, particularly in terms of patient safety, for a safety improvement, is less precise, and several experts argued that such efforts might inadvertently create more confounding, which could ultimately hinder the safety improvement.[3–5] In Safety II, safety management focuses on assisting people to deal with complex conditions that arise while under pressure. This concept was introduced to clarify the distinction between two perspectives on safety (Safety I and Safety II) and their underlying assumptions.[2] Safety II discusses how a work process could run properly to prevent adverse events and boost productivity and effectiveness by uplifting resilience.[6,7] The paradigm shift from Safety-I to Safety-II would also help improve safety practices in a company.[8]

The resilience concept was introduced by Hollnagel, Woods, and Levenson in their book entitled Resilience Engineering: Concept and Receipt in 2006. The resilience concept has been widely suggested as safety management because it supports organizations in continuing to operate even when facing demands or scaling unexpected disruptions by improving their daily performance.[9,10] This improvement in performance includes four potential aspects: the ability to respond to changes and disturbances, monitor conditions that may affect organizational performance, learn the rights and wrongs of a condition, and take anticipatory action.[6] The resilience term is widely applied across multiple disciplines. However, the development of quantitative metrics for sociotechnical systems and establishing standards and processes are still in their infancy.[11,12] To ensure an effective implementation of resilience engineering, a rigorous methodology is essential. This necessitates a transdisciplinary approach to resilience engineering, drawing on expertise from diverse sectors, including industrial sectors, to enhance resilience.[12,13]

For the industrial sectors, especially those with a high risk of accidents, good safety management is the key to production sustainability. In addition, much complexity in terms of technology and business development exists in the 4.0

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industrial era. Companies are required to develop following such complexity in order to continue to run productively. Applying the safety resilience concept could help companies demonstrate their flexibility in adapting to various changes that occur; thus, outcomes or products produced remain in line with the company's goals.[14] Several industries which have implemented the resilience concept are aviation, health services, chemical and petrochemical industries, nuclear power plants, and railroads.[15] Therefore, this study aimed to explore safety resilience measurement methods in various industries.

Method

A systematic literature review (SLR) was applied to explore safety resilience measurement methods in various industries. The SLR aims to identify, evaluate, and assess the results of prior studies which are relevant to a particular research question or topic.[16] The SLR must use methodological and transparent steps, one of which is the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) method, which is comprehensive for conducting SLRs in various research fields. Therefore, this study applied the PRISMA method, which comprises of four stages: identification, screening, eligibility, and data abstraction and analysis.[17,18]

Identification is the stage of identifying research objectives and objects. This study aimed to discuss safety resilience measures in various industries through SLRs. The unit of analysis for this study was scientific journal articles with keywords "Safety Resilience" OR "Safety Resilience Assessment" OR "Resilience Assessment Grid" via Scopus, ScienceDirect, and SpringerLink. A total of 433 articles was found through search results, consisting of 87 Scopus articles, 167 ScienceDirect articles, and 179 SpringerLink articles. In the next stage, 433 articles were screened according to the inclusion and exclusion criteria determined for this study. The inclusion criteria were research articles and case studies in English from the integrated journals Q1-Q3 within a period of 2010-2022. While, the exclusion criteria were literature review, conference proceedings, and non-English books existing prior to 2010 with Q4 criteria.

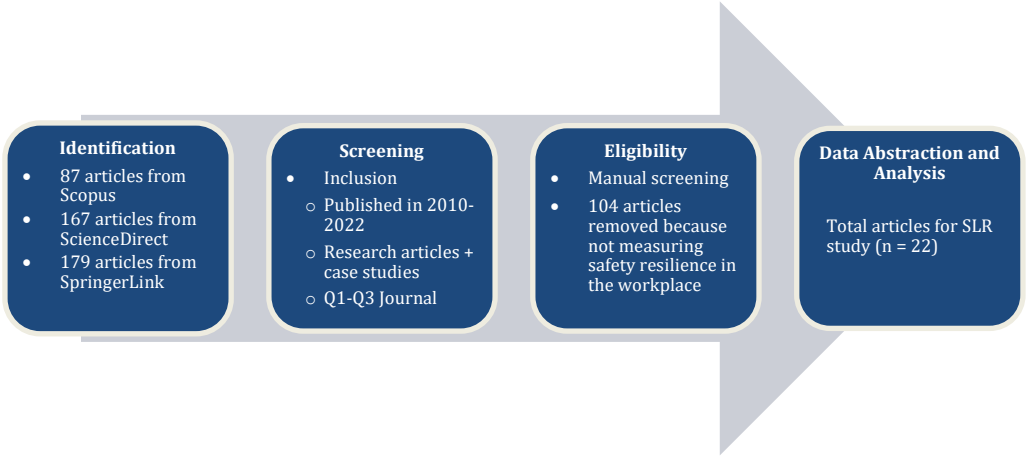

Figure 1. Article Selection Process Based on the PRISMA Method

The screening results revealed 126 articles met the inclusion criteria and they went to the following eligibility stage, manually filtering articles to obtain some which were feasible and truly suited to the research objectives. The screening was carried out using specified criterion: the article discussed the results of research on measuring resilience in the work environment. A total of 104 articles were excluded at this stage because they did not measure safety resilience in the workplace. The last stage was data abstraction and analysis. The remaining 22 articles were evaluated, reviewed, and analyzed by identifying similarities and differences in indicators, measurement methods, and results discussed in the articles.

Results

A total of 22 articles were reviewed (Table 2). Five articles came from the healthcare industry, three articles from the construction industry, three articles from the petrochemical industry, two articles from electricity industry, two articles from nuclear industry, one article from oil and gas industry, one article from aviation, one article from the process industry, one article from maritime sector, one article from road transportation sector, one article from chemical industry, and one article from solid waste company sector. Most articles came from scientific journals with impact quartiles of Q1 (68%) and Q2 (32%), more than half came from journals of Safety Science (41%), Safety (9%), Journal of Loss Prevention in the Process Industries (9%), Progress in Nuclear Energy (5%), Mathematical Problems in Engineering (5%), Journal of Building Engineering (5%), Applied Ergonomic (5%), Annals of Nuclear Energy (5%), PLoS One (4%), Safety and Health at Work (4%), Reliability Engineering and System Safety (4%), and Journal of Evaluation in Clinical Practice (4%).

Table 1. Characteristics of Articles by Year, Industry, Journal Name, and Journal Impact Quartile

Year	Industry	Title of Journal	Journal Impact Quartile	Number of Articles
2022	Health Care	Safety Science	Q1	1
2022	Health Care	PLoS One	Q1	1
2022	Electricity	Mathematical Problems in Engineering	Q2	1
2021	Construction	Safety Science	Q1	1
2021	Maritime	Safety	Q2	1
2021	Health Care	Safety Science	Q1	1
2021	Nuclear	Progress in Nuclear Energy	Q2	1
2021	Construction	Journal of Building Engineering	Q1	1
2020	Health Care	Safety Science	Q1	1
2020	Construction	Applied Ergonomics	Q1	1
2020	Road Transportation	Safety	Q2	1
2020	Chemical	Safety Science	Q1	1
2021	Aviation	Safety Science	Q1	1
2018	Health Care	Journal of Evaluation in Clinical Practice	Q2	1
2018	Solid Waste	Safety Science	Q1	1
2018	Nuclear	Annals of Nuclear Energy	Q1	1
2018	Petrochemical	Safety and Health at Work	Q1	1
2017	Oil and Gas	Journal of Loss Prevention in the Process Industries	Q2	1
2016	Petrochemical	Journal of Loss Prevention in the Process Industries	Q2	1
2016	Petrochemical	Safety Science	Q1	1
2013	Process Industry	Reliability Engineering and System Safety	Q1	1
2011	Electricity	Safety Science	Q1	1
			TOTAL	**22**

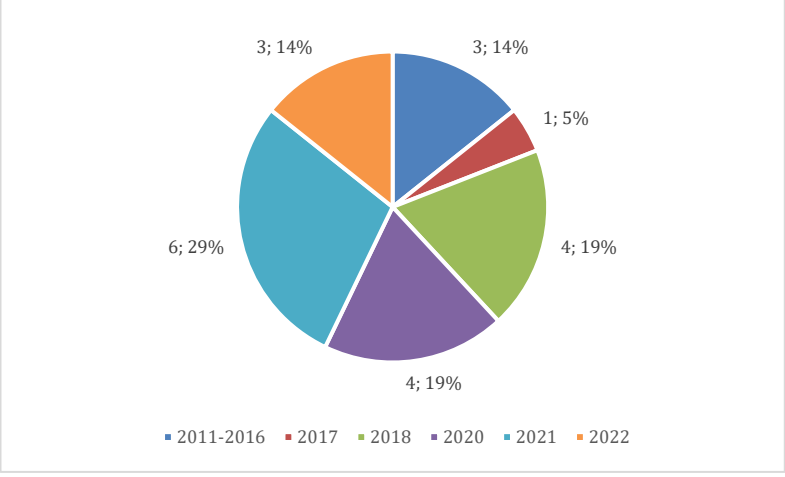

Figure 2. Article Distribution by Year

Figure 2 shows the year distribution of articles taken from 2011 to 2022. A total of 29% of articles come from 2021, 19% of articles come from 2018 and 2020, followed by 14% of articles from 2022 and under 2016. Only 5% of the articles come from 2017. Figure 3 shows a distribution of 12 industries based on the review results of the identified articles.

Healthcare is the largest industry at 23%, followed by construction industry at 14% and nuclear and electricity at 9%.

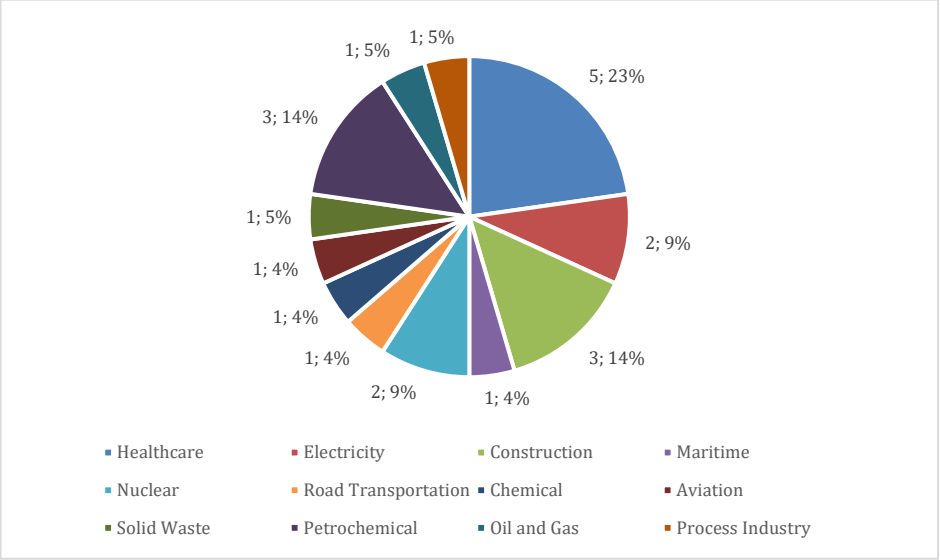

Figure 3. Article Distribution by Industry

Table 2. Detailed Review of Articles

No.	Article Title / Journal / DOI	Industry	Authors	Objective & Participant	Method Used to Measure Safety Resilience	Resilience Result
1.	The resilient potential behaviours in an Internal Medicine Department: Application of Resilience Assessment Grid[19] PLoS One, 2022: 17 (20) https://doi.org/10.1371/journal.pone.0276178	Health Care	Safi *et al.*	**Objective** Understanding and assessing the resilience performance of the Internal Medicine Department at Denmark's General Hospital using RAG **Participants** ● Doctors, middle managers, and nurses. (n = 44 in Survey 1 and n=36 in Survey 2) ● Purposive and snowball sampling	● Quantitative research ● Instrument: RAG Questionnaire ● Scoring: a 5-point Likert scale (1–5) (e.g., never, rarely, sometimes, often, or always ● The survey was conducted in two stages (January 2021 and February 2022) to see changes in resilience performance ● Descriptive analysis	● From January 2021 to February 2022, all resilience abilities (respond, monitor, learn, and anticipate) have decreased ● Respond decreased from 2.82 to 2.66 ● Monitor decreased from 3.09 to 2.96 ● Learn decreased from 2.94 to 2.75 ● Anticipate decreased from 2.83 to 2.69
2.	Measurement of resilience potentials in Emergency Departments: Applications of a tailored Resilience Assessment Grid[20] Saf Sci, 2020: 121 https://doi.org/10.1016/j.ssci.2019.09.012	Health Care	Chuang *et al.*	**Objective** Assessing the resilience performance of Emergency Department in public and private hospitals through 4 resilience abilities **Participants** 1 Emergency Department's director, administrative staff, doctor, and head nurse from 4 hospitals (n = 16)	● Qualitative research ● Interview using RAG guidelines and some Emergency Department-tailored questions. ● Answers are coded as 1 to 4 ● Descriptive analysis	● Public hospitals (Hospital C + D) have a higher group score of all resilience abilities than private hospitals (Hospital A + B). ● Respond: The highest (61.50% by Hospital C), the lowest (33.28% by Hospital A). ● Monitor: The highest (36.61% by Hospital C), the lowest (16.96% by Hospital B). ● Learn: The highest (86.46% by Hospital C), the lowest (64.24% by Hospital A). ● Anticipate: The highest (58.33% by Hospital C), the lowest (17.71% by Hospital A).
3.	Monitoring complexity and resilience in construction projects: The	Construction	Peñaloza *et al.*	**Objective** Identify opportunities to improve SPMS based on analysis of source complexity and	● Semi-quantitative research ● Measure resilience: Interview with RAG guideline	● Ability to respond: Project A (3.3), Project B (4.1), Project C (3.8). ● Ability to monitor: Project A (3.0), Project B (3.5), Project C (3.6).

No.	Article Title / Journal / DOI	Industry	Authors	Objective & Participant	Method Used to Measure Safety Resilience	Resilience Result
	contribution of safety performance measurement systems.[21] Appl Ergonom, 2022: 82 https://doi.org/10.1016/j.apergo.2019.102978			resilience in construction based on case studies in Brazil (Project A) and Chile (Project B & C). **Participants** Project manager, safety engineer, and safety technician (n = 4)	• Answers are coded as 0 (missing), 1 (deficient), 2 (unacceptable), 3 (acceptable), 4 (satisfactory), and 5 (excellent). • Documents analyzed: Standardized operating procedures, description of performance indicators, checklists, safety and production schedules, and safety reports. • Descriptive analysis	• Ability to learn: Project A (2.1), Project B (2.5), Project C (2.7). • Ability to anticipate: Project A (2.3), Project B (2.7), Project C (2.8). • Based on RAG and TOE implementation, there are 16 opportunities for improvements in the SPMS of the three companies.
4.	Measuring resilience potentials: A pilot program using the Resilience Assessment Grid[22] Saf, 2020: 6 (4) https://doi.org/10.3390/safety6040051	Road Transportation	Klockner *et al.*	**Objective** Measuring 4 potential resilience (respond, monitor, learn, and anticipate) in transport companies in Queensland **Participants** Middle management and supervisory positions at a single transport organization in Queensland (n = 15)	• Quantitative research • Instrument: RAG Questionnaire distributed by e-mail • Answers category: "Yes," "No," and "Unknown" • Not using scoring • The level of each potential resilience is analyzed based on the participant who answered "Yes" • Descriptive analysis	• Potential to learn: 83.3% • Potential to respond: 77% • Potential to anticipate: 52.9% • Potential to monitor: 41.3%
5.	A resilience engineering-based framework for assessing safety performance measurement systems: A study in the construction industry[23] Saf Sci, 2021: 142 https://doi.org/10.1016/j.ssci.2021.105364	Construction	Peñaloza *et al.*	**Objective** Assess 4 potential resilience and identify opportunities for improvement of SPMS **Participant** Project manager, site manager, safety coordinator, foreman, 6 front-line workers (n = 10)	• Semi-quantitative research • Instrument: RAG questionnaire • Scoring RAG: 6-point Likert scale 0 (missing), 1 (deficient), 2 (unacceptable), 3 (acceptable), 4 (satisfactory), 5 (excellent) • Documents analyzed: safety indicators, weekly safety reports, HSE non-conformity database, booklets, job safety analysis, standardized operating procedures, and the weekly work schedule. • Descriptive analysis	• Average score: Respond (2.9), Monitor (3.4), Learn (3.7), Anticipate (3.5). • There are 8 opportunities for improvements in the SPMS based on RAG, TOE, and RE implementation.
6.	A multicountry comparative survey about organizational resilience in anaesthesia[24] J Eval Clin Pract, 2018: 24 https://doi.org/10.1111/jep.13054	Health Care	Falegnami *et al.*	**Objective** Testing the AHP-RAG questionnaire to measure anesthesiologist resilience across countries. **Participants** Anesthesiologists from 16 nations (n = 172)	• Quantitative research • Instrument: RAG questionnaire with a 5-point scale, questionnaire distributed by e-mail • Scoring: using AHP framework (each question has a different value weight)	• The α level of Cronbach analysis is 0.910 → Has an adequate level of interitem reliability (>0.700). • FA and PCA confirmed the absence of underlying unexpected factors. • Implementing the AHP-RAG questionnaire is too complicated and time-consuming

No.	Article Title / Journal / DOI	Industry	Authors	Objective & Participant	Method Used to Measure Safety Resilience	Resilience Result
					• Construct validity using FA and PCA	
7.	Analysis of the Safety Resilience Implementation in the Maritime Industry at Public and Private Companies (A Case Study in Indonesia)[25] Saf, 2021: 7 (56) https://doi.org/10.3390/safety7030056	Maritime	Djunaidi *et al.*	**Objective** Analyzing the implementation of safety resilience in the Indonesian maritime sector **Participants** • Key informant: designated person ashore, Triangulation informant: quality health safety environment officer • Purposive sampling technique	• Semi-quantitative research • Collection of data from documents and interviews • Interview based on RAG + questions according to the research topic • Descriptive analysis	• The level of implementation of resilience in public companies is 75.1%, while in private companies, 70.2% • Resilience abilities in public and private companies: Respond (80%), Learn (74.62%), Monitor (70.77%), Anticipate (66.92%) • Based on the results of the resilience assessment, there are 4 recommendations proposed to the company
8.	How to identify key players that contribute to resilient performance: A social network analysis perspective[26] Saf Sci, 2022: 148 https://doi.org/10.1016/j.ssci.2021.105648	Health Care	Bertoni *et al.*	**Objective** Identify health workers who contribute the most (key players) to resilience performance using Social Network Analysis **Participants** Doctors, nurses, nurse technicians, allied health professionals (n = 133)	• Semi-quantitative research • Resilience is measured using RAG with 5 scales (1 = never, 2 = less than once a month, 3 = one to three times a month, 4 = one to three times a week, 5 = daily) • The 10 participants with the highest score (10 top players) will enter the follow-up interview stage • Data analysis: Network metric calculations and sociogram development using UCINET software • Descriptive analysis	• Doctors, nurses, and nurse technicians are the professions most frequently included in the top-10 players based on resilience scores • The highest score in resilience abilities: Monitor by a doctor (DR169, Score = 1204.7), Anticipate (N135, Score = 1217.5), Respond by a nurse (N135, Score = 1318.0), Learn by a nurse (N94, Score = 1371.9).
9.	Monitor, anticipate, respond, and learn: Developing and interpreting a multilayer social network of resilience abilities.[27] Saf Sci, 2021: 136 https://doi.org/10.1016/j.ssci.2020.105148	Health Care	Bertoni *et al.*	**Objective** Develop and interpret multilayer resilience networks **Participants** Doctors, nurses, nurse technicians, allied health professionals (n = 133)	• Semi-quantitative research • Resilience is measured using RAG with 5 scales (1 = never, 2 = less than once a month, 3 = one to three times a month, 4 = one to three times a week, 5 = daily). • Interviewed 2 doctors and 3 nurses that stood out based on actor-centered metrics at the layer level • Research phase: Data collection, multilayer modeling (WAI and WAD networks), and data analysis. • Multilayer network data analysis: (i) actor-centered	• Only actor N94 (a nurse) appears among the top-10, both in the multilayer and the single layer, for both WAI and WAD • All interlayer correlation values are in the interval [0.78; 0.79] → This shows that social interaction is strong in terms of contributing simultaneously to the four abilities. • All assortativity correlations are within the interval [0.98; 0.99] → This indicates there is a cluster formation of high-level and low-level actor groups that can hinder multiple perspectives when monitoring, anticipating, responding, and learning.

No.	Article Title / Journal / DOI	Industry	Authors	Objective & Participant	Method Used to Measure Safety Resilience	Resilience Result
					metrics (workers) (ii) layer-centered metrics (4 resilience abilities) ● Descriptive analysis	
10.	Identification of gaps in safety management systems from the resilience engineering perspective in upper and lower-tier enterprises[28] Saf Sci, 2020: 130 https://doi.org/10.1016/j.ssci.2020.104851	Chemical Industry	Pęciłło M.	**Objective** Assess which of the four resilience pillars predominate at the upper and lower-tier companies in Poland. **Participants** Workers in OSH departments and line managers responsible for safety performance from 14 upper companies and 16 lower companies	● Quantitative research ● Resilience is measured using RAG with 5 scales (5 = strongly agree, 4 = agree, 3 = neutral, = disagree, 1 = strongly disagree) ● Descriptive analysis	● The ability to respond has the highest score, and the ability to learn has the lowest score, especially regarding safety information. ● The use of leading indicators is more dominant than lagging indicators.
11.	Composite leading indicator to assess the resilience engineering in occupational health & safety in municipal solid waste management companies[29] Saf Sci, 2018: 108 https://doi.org/10.1016/j.ssci.2018.04.014	Solid Waste	Romero *et al.*	**Objective** Develop a quantitative evaluation method of CLI for Resilience in the Municipal Solid Waste Sector **Participants** Collection and delivery service workers from a solid urban waste company in the city of Málaga, Spain (n = 205)	● Quantitative research ● Resilience is measured using CLI (Shirali *et al.*, 2013), including top management commitment, just culture, culture of learning, awareness and opacity, preparedness, and flexibility ● The questionnaire has a 5-point Likert scale (1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high). ● Descriptive analysis	● Maintenance operator has the highest resilience score (3.59), driver has the lowest score (3.18) ● Driver has the lowest score in all indicators (top management commitment, just culture, culture of learning, awareness and opacity, preparedness, and flexibility).
12.	A new method for quantitative assessment of resilience engineering by PCA and NT approach: A case study in a process industry[30] Reliab Eng Syst Saf, 2013: 199 http://dx.doi.org/10.1016/j.ress.2013.05.003	Process Industry	Shirali *et al.*	**Objective** Conduct a quantitative assessment of Resilience Engineering using a questionnaire based on PCA **Participants** Managers, supervisors, and operators from 11 work units (n = 88)	● Quantitative Research ● Resilience is measured using CLI: Top management commitment, just culture, culture of learning, awareness and opacity, preparedness, and flexibility ● The questionnaire has a 5-point Likert scale from "strongly disagree" to "strongly agree" ● Descriptive analysis using PCA	● Storage tanks unit has a highest PCA final score (74.34). Technical inspection unit has a lowest PCA final score (-8.78). ● 4 indicators in the technical inspection unit have negative values, namely learning culture (−0.178), awareness and opacity (−0.226), preparedness (−0.332), and flexibility (−0.174). This shows that the four indicators are in a critical situation and require special attention.
13.	The phased application of STAMP, FRAM and RAG as a strategy to improve complex sociotechnical system safety.[31] Prog Nucl Energy 2021: 131 https://doi.org/10.1016/j.pnucene.202	Nuclear	Linhares *et al.*	**Objective** Analyzing the accident documents of the loss of the USS nuclear submarine using the STAMP, FRAM, and RAG methods	● Qualitative Research ● Instrument: RAG ● Accident documents were analyzed and coded on a 5-point Likert scale from "strongly disagree" to "strongly agree" ● Descriptive analysis	● STAMP, FRAM, and RAG have outputs with different levels of precision. ● STAMP and FRAM have more detailed outputs but require a lot of time and skill. RAG is a simpler and faster alternative. ● RAG focuses more on analyzing stakeholder involvement in the safety of the sociotechnical system.

No.	Article Title / Journal / DOI	Industry	Authors	Objective & Participant	Method Used to Measure Safety Resilience	Resilience Result
	0.103571					
14.	Development of a quantitative resilience model for nuclear power plants.[32] Annals Nucl Eergy 2018: 122 https://doi.org/10.1016/j.anucene.2018.08.042	Nuclear	Kim *et al.*	**Objective** Assess resilience quantitatively based on the resilience model for unforeseen situations developed by Électricité de France	● Mix-methods research ● 222 incident reports at the Fukushima nuclear power plant in 2003 – 2016 ● Indicators based on Hollnagel *et al.* (2013): Anticipation, Robustness, Adaptation, Collective Functioning, Learning Organization. ● Analysis of the relationship between resilience and resilience attributes	● There is a significant correlation between resilience and all attributes except learning organization ● Learning organization only has a significant correlation with anticipation. ● Collective functioning affects robustness and adaptation. Adaptation and robustness influence each other.
15.	Construction SMEs safety challenges in water sector in Oman.[33] Saf Sci, 2021: 136 https://doi.org/10.1016/j.ssci.2020.105156	Construction	Mawli *et al.*	**Objective** Explore the understanding of the safety of water sector construction staff in Oman **Participants** Ministries, clients, and contractors (n = 88)	● Quantitative research ● Resilience measured using PEROSH with a 5-point Likert scale ● Resilience indicator: preparedness from unexpected events and recover ability from unexpected events. ● Descriptive analysis	● The company is not prepared for unexpected events (2.5) ● The company do not easily recover from unexpected events (2.7)
16.	Assessing the relationship between organizational management factors and a resilient safety culture in a collegiate aviation program with Safety Management Systems (SMS).[34] Saf Sci, 2020: 131 https://doi.org/10.1016/j.ssci.2020.104909	Aviation	Adjekum *et al.*	**Objective** To validate a survey instrument that assesses the relationship between an RSC and 4 organizational management factors **Participants** • Aviation students, certified flight instructors, faculty, maintenance personnel, dispatch, administrative, and top management in collegiate aviation program in the US (n = 519) • Purposive sampling	● Quantitative research ● Questionnaire based on Reason's attributes of an organization with an RSC (40 items). ● Indicator: Principles, Policy, Procedures, and Practices. ● 5-point Likert scale from 1 "strongly disagree" to 5 "strongly agree" ● Multivariate analysis	● Principles, policy, procedures, and practices had a significant predictive relationship with RSC ● Policy has the highest predictive relationship, meanwhile, practices have the weakest predictive relationship with RSC. ● Procedures strongly mediated path between policies and practices. ● There was no significant causal relationship between principles and practices.
17.	Assessing Reliability and Validity of an Instrument for Measuring Resilience Safety Culture in Sociotechnical Systems.[35] Saf Health Work, 2018: 9 (3) https://doi.org/10.1016/j.shaw.2017.07.010	Petrochemical	Shirali *et al.*	**Objective** Evaluate the reliability and validity of an instrument in measuring the RSC in sociotechnical systems. **Participants** Staff members from 12 units of a petrochemical plant (n = 354).	● Quantitative Research ● Self-designed questionnaire from literature review (66 items) ● 13 Indicators: Just culture, Management of change, Learning culture, Risk assessment/management, Preparedness, Flexibility, Reporting case, Management commitment, Awareness, Safety management system,	● The results of the content validity index and content validity ratio were 0.97 and 0.83, respectively. ● The reliability of the RSC instrument, as measured by internal consistency, was found to be satisfactory (Cronbach α ¼ 0.94). ● This new instrument is valid for use in assessing RSC in sociotechnical systems, such as the petrochemical, chemical, and oil refinery industries.

No.	Article Title / Journal / DOI	Industry	Authors	Objective & Participant	Method Used to Measure Safety Resilience	Resilience Result
					Accident investigation, Involvement of staff, and Competency ● 5-point Likert scale from "strongly disagree" to "strongly agree" ● Validity and reliability analysis	
18.	Resilience Capacity Evaluation for the Safety Management System of Power Grid Enterprise Based on AHP-MEE Model.[36] Math Prob Eng, 2022 https://doi.org/10.1155/2022/8065814	Electricity	Zhang *et al.*	**Objective** Evaluate the safety management system's safety resilience capability from four basic elements: stability, redundancy, efficiency, and adaptability **Participants** Technicians, engineers, managers, administrative staff (n = 11)	● Quantitative Research ● The questionnaire was prepared based on the 4 elements of SMS theory: Stability, redundancy, efficiency, and adaptability ● Scoring using AHP concept ● Descriptive analysis	● Evaluation indicators for electric power companies are reclassified based on SMS "1438" ● The AHP-MEE combined model can be optimally implemented in the electric power industry ● Safety resilience of the sample is at level 2 (Stronger safety resilience)
19.	A consensus-based AHP for improved assessment of resilience engineering in maintenance organizations.[37] J Loss Prev Process Ind, 2017: 47 http://dx.doi.org/10.1016/j.jlp.2017.02.028	Oil and Gas	Azadeh *et al.*	**Objective** Develop valid methods to improve resilience engineering assessments. **Participant** Employees from 11 maintenance departments of Theran Gas Company (n = 99)	● Quantitative Research ● Resilience is measured using CLI: Top management commitment, just culture, culture of learning, awareness and opacity, preparedness, and flexibility. ● The questionnaire has a 6-point Likert scale (strongly disagree, disagree, slightly disagree, slightly agree, agree, strongly agree) ● Scoring using AHP ● Regression analysis.	● There is a significant relationship between RE and human-related PSFs ● Increasing RE intervention can lead to an increase in the condition of PSFs so that the number of human errors will decrease and company safety will increase.
20.	Quantitative assessment of resilience safety culture using principal components analysis and numerical taxonomy: A case study in a petrochemical plant.[38] J Loss Prev Process Ind, 2016: 40 http://dx.doi.org/10.1016/j.jlp.2016.01.007	Petrochemical	Shirali *et al.*	**Objective** Assessing the RSC of a petrochemical plant quantitatively using PCA and NT. **Participants** Employees from 12 units in a petrochemical plant (n = 312)	● Quantitative Research ● Self-constructed questionnaire (based on literature review and interview with safety experts) with the 5-point Likert scale ● 13 Indicators: Just culture, Management of change, Learning culture, Risk assessment/management, Preparedness, Flexibility, Reporting case, Management commitment, Awareness, Safety management system, Accident investigation,	● DMU6 is the best unit regarding resilience safety culture indicators with the final score of 25.960. ● DMU11 is the worst unit with the final score of 0.560 (needs a serious attention to promote safety resilience indicators).

No.	Article Title / Journal / DOI	Industry	Authors	Objective & Participant	Method Used to Measure Safety Resilience	Resilience Result
					Involvement of staff, and Competency. ● Descriptive analysis performed using PCA. Then, NT approach was used to verify and validate the results of the PCA.	
21.	Evaluation and improvement of a method for assessing HSMS from the resilience engineering perspective: A case study of an electricity distributor.[39] Saf Sci, 2011: 49 https://doi.org/10.1016/j.ssci.2010.09.017	Electricity	Saurin *et al.*	**Objective** Evaluate the HSMS assessment method using the philosophy of RE **Participants** Front-line electricians, directors, and deputy directors of the HS department (n = 120)	● Qualitative Research ● Data collection through document analysis, observation, and interview results. ● Resilience principle based on Costella *et al.* (2009): Top management commitment, learning, flexibility, and awareness. ● Evaluation based on MAHS: HSMS planning, Production processes, People management, General safety factors, Planning of performance monitoring, Feedback and learning, Results ● Descriptive analysis	● The results of the assessment identified 17 sources of resilience and 47 sources of brittleness. ● Strengths: MAHS provides information on informal processes that are not normally covered by HSMS audits. This is important in the perspective of RE, namely the ability to learn normal jobs compared to specified jobs. ● Weaknesses: This method takes a long time and requires a lot of auditors who understand RE theory.
22.	An intelligent framework for assessment and analysis of human resource from resilience engineering, motivational factors, HSE and ergonomics perspectives.[40] Saf Sci 2016: 89 http://dx.doi.org/10.1016/j.ssci.2016.06.001	Petrochemical	Azadeh *et al.*	**Objective** Assessing productivity and analysis of human resources in petrochemical plants by considering the concept of RE, motivation in the work environment, and HSE. **Participants** The staff of various departments of the plant (n = 165)	● Quantitative Research ● Resilience questionnaire based on Hollnagel (2006) and Azadeh *et al.* (2014) ● Resilience indicators: Top management commitment, Reporting culture, Learning, Preparedness, Flexibility, Awareness, Self-organization, Teamwork, Redundancy, and Fault-tolerance. ● 10-point Likert scale (1 = quite disagree, 10 = quite agree) ● Relationship analysis between RE indicators and performance (efficiency and effectiveness)	● Top management commitment has significant positive effects on efficiency. ● Top management commitment, flexibility, reporting culture, awareness, and teamwork have significant positive effects on effectiveness.

Notes: RAG = Resilience Assessment Grid, SPMS = Safety Performance Measurement Systems, TOE = Technical, Organizational, and Environmental Framework, HSE = health, safety, environment, RE = resilience engineering, AHP = analytic hierarchy process, FA = Factor Analysis, PCA = principal component analysis, WAI = work-as-imagine, WAD = work-as-done, OSH = occupational safety and health, CLI = composite leading indicator, STAMP = System-Theoretic Accident Model and Process, FRAM = Functional Resonance Analysis Method, PEROSH = Partnership for European Research in Occupational Safety and Health, RSC = Resilience Safety Culture, SMS = Safety Management Systems, NT = numerical taxonomy, HSMS = health and safety management systems, MAHS = Method for Assessing Health and Safety Management System.

Table 2 lists 13 quantitative research articles, three qualitative research articles, five semi-quantitative research articles, and one mixed-method research article. Data collection regarding resilience was carried out by filling out

questionnaires and interviews and analyzing safety-related documents. RAG questionnaires were mostly used (n = 11). This questionnaire was also heavily modified according to the sector or the researcher's needs.

The answer scale used between studies varied widely. Some used a 10-point Likert scale, a 6-point Likert scale, a 5-point Likert scale, and 3 categories of answers "Yes," "No," or "Unknown." Major articles calculated scores by calculating the average score of each question on the resilience questionnaire.

However, some articles performed calculations using the AHP concept, a tool arranging questions into hierarchies so that each question has a different value weight. A total of 13 articles only took a descriptive analysis to determine the level of resilience ability in the industry; four articles examined the relationship between overall safety resilience, resilience abilities/indicator, and other variables; two articles observed a more complicated and complex analysis by mapping the social interaction between workers; and trials of a resilience measurement instrument were carried out in three other articles.

Table 3. Detailed Article Comparison by Industry

No	Industry	Scoring Method	Highlight	Limitation
1	Health Care	Using RAG with a 5-point Likert scale	There are different number results in each dimension	• Limited number of samples • Data collection problems (such as availability for interview or field review) • There are some contextual factors, such as social interaction, that need to be explored
2	Construction	Using RAG and PEROSH	The learning dimension becomes the most concerned dimension in each article	• Limited number of samples • Data collection problems, such as availability for interview or field review
3	Maritime	Using interview-based RAG	Specifically, discussing the differences in the results of public and private sector resilience assessments	• No further information
4	Chemical	Using RAG with a 5-point Likert scale	Most activities related to monitoring, responding, and anticipating are aimed at maintaining an acceptable risk level rather than reaching the optimal situation; while, the learning potential focuses on those that contribute to the optimal situation	• Preliminary studies in Poland • Limited number of samples
5	Oil and Gas	AHP with a 6-point Likert scale	AHP can be considered as an appropriate method for resilience assessment in oil and gas	• No further information
6	Petrochemical	Different quantitative method	The interaction of each dimension inferred that the factors of top management commitment and preparedness factor need to be discussed in this industry	• Limited number of samples • Data collection problems (such as availability for interview or field review)
7	Process Industry	Tailormade Questionnaire (including just culture, flexibility, preparedness, awareness, and learning culture)	Four indicators out of six have a negative score (critical situation) in the technical inspection unit. Their score is learning culture (−0.178), awareness and opacity (−0.226), preparedness (−0.332), and flexibility (−0.174).	• Limited number of samples • Potential improvement for accurate variables for qualitative study.
8	Road Transportation	RAG	A high number of respondents answered Yes to the questions about responding with the question around alternative tasks.	• Limited number of samples
9	Electricity	Different method, mainly developing their specific model and scoring number	It is necessary to speed up the construction of emergency command centers and enhance the emergency response capabilities of enterprises to better respond to emergencies in these industries.	• Limited number of samples • Data collection is centralized only in the main office
10	Aviation	Resilient safety culture (Reason,	Procedure as mediator for all elements, policy becomes the highest	• It is recommended that the inferences drawn from this study be

		2011) with a 5-point Likert scale	number, practice the lowest.	limited to the study population and not generalized
11	Solid waste	Tailormade Questionnaire	Highlight indicators: Top management commitment, just culture, culture of learning, awareness and opacity, preparedness, flexibility	• No further information
12	Nuclear	Different method	It is possible to devise a safety management strategy that maximizes the benefits of using each of these approaches	• The studies are mainly preliminary

Notes: RAG = Resilience Assessment Grid, PEROSH = Partnership for European Research in Occupational Safety and Health, AHP = analytic hierarchy process.

Table 3 explains the 12 industries. There were similar limitations, such as limited number of samples and data collection problems in each industry. Contextual factors, such as influential social interactions in the analysis, were found in the healthcare industry. Each industry has various methods for resilience analysis. It is not uncommon for industries to choose to develop their analysis methods to suit the conditions of their respective industries.

Discussion

The SLR results showed that a mixed approach of Safety I, Safety II, and Resilience Engineering dealt with capacities for managing both the expected and unexpected events, creating a more adaptive approach to safety. This study showed that most articles used the RAG instrument (n = 11) to measure safety resilience in the workplace. Of the 11 articles, most presented a company's safety resilience profile (n = 7). The safety resilience profile found has varied results in each industry. The ability to learn and respond is the resilience ability that got the highest scores in several articles. Nonetheless, the abilities to learn and respond also got the lowest scores in two articles.[21,28]

The ability to monitor got the highest score in one article and the lowest score in two articles.[22,24,26] The ability to anticipate neither got the highest nor lowest scores in one article.[19] Most articles included were based on Resilience Engineering theory by Hollnagel *et al.*, encompassing the dimensions of Respond, Monitor, Learn, and Anticipate. The other articles highlighted alternative theoretical frameworks. This emphasizes that resilience engineering could also be explored and understood through multiple theoretical lenses beyond the approach by Hollnagel *et al.*

Most articles only used descriptive analysis to display the resilience profile and did not further explore the findings or identify suggestions for improvements a company could make. However, three articles not only presented a resilience profile but also identified opportunities for improvement in safety management.[30,34,40] Among the articles included in this study, three articles used qualitative methods to capture the subject's resilience engineering profile, showing that resilience engineering could be captured through quantitative methods and qualitative approaches.[30,39,40]

Apart from the RAG, other instruments for resilience measures were the Composite Leading Indicator (n=3), PEROSH (n=1), Safety Management System attributes (n=1), theory by Hollnagel *et al.* (2013) (n=1), Resilient Safety Culture attributes by Reason (n=1), theory by Costella *et al.* (2009) (n=1), and self-construct questionnaires from resilience's works of literature (n=3). The research results were varied for different indicators of resilience. Most analysis results were only a description of the safety resilience profile.

However, four articles further analyzed the relationship between safety resilience and other variables, such as work performance and organizational safety, as well as the relationship between each resilience indicator.[29,34,35,37] Besides, the results might also be varied due to limitations associated with minimum sample sizes in the included articles, data collection methods centralized in specific settings such as work environment, and the absence of comparable data as they represent the first study once conducted in respective areas. In short, studies on resilience have a variety of research approaches and dynamic methods for identifying the resilience profile of an industrial sector or company.

Conclusion

Although most of articles apply the resilience ability concept by Hollangel *et al.,* other articles from various industries highlight alternative theoretical frameworks for resilience engineering methods to explore and comprehend. A significant relationship is found between each resilience indicator according to several studies. Besides, an increase in safety resilience positively improves work performance and organizational safety. Further studies that display the safety

resilience profile and explore the findings in more depth need to be conducted, so that improvement opportunities could be identified for improving organizational performance.

Abbreviations

SLR: systematic literature review; PRISMA: Preferred Reporting Items for Systematic Review and Meta-Analyses; RAG: Resilience Assessment Grid; SPMS: Safety Performance Measurement Systems; TOE: Technical, Organizational, and Environmental Framework; HSE: health, safety, environment; RE: resilience engineering; AHP: analytic hierarchy process; FA: Factor Analysis; PCA: principal component analysis; WAI: work-as-imagine; WAD: work-as-done; OSH: occupational safety and health; CLI: composite leading indicator; STAMP: System-Theoretic Accident Model and Process; FRAM: Functional Resonance Analysis Method; PEROSH: Partnership for European Research in Occupational Safety and Health; RSC: Resilience Safety Culture; SMS: Safety Management Systems; NT: numerical taxonomy; HSMS: health and safety management systems.

Ethics Approval and Consent to Participate

This study is a systematic literature review that does not use specific informed consent for a specific population.

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 first author can provide all data and materials from this study.

Authors' Contribution

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

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Menstrual Personal Hygiene Behavior Among Adolescents with Physical and Intellectual Disabilities

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Abstract

Reproductive health for adolescents with disabilities is often disregarded, and education on personal hygiene is insufficient because some people perceive menstruation as a sensitive topic and have a false belief that adolescents with disabilities have no sexual desire. This study aimed to determine the overview of personal hygiene behavior among adolescents with physical and intellectual disabilities when facing menstruation. The method used was qualitative, with case studies, in-depth interviews, and observations for data collection. The informants comprised four adolescents aged 19-21 years, two mothers, and two therapists for special needs children. This study was conducted at two growth and development clinics in South Jakarta, Indonesia, from July to September 2021. This study found a lack of apprehension about menstrual personal hygiene among mothers and adolescents with disabilities, a lack of understanding about menstrual personal hygiene in general among adolescents with disabilities, and inappropriate menstrual personal hygiene behavior among adolescents with disabilities. To conclude, this study underlines the importance of improving the ability of adolescents with disabilities in terms of menstrual hygiene behavior.

Keywords: adolescent, disabilities, menstruation, personal hygiene

Introduction

The United Nations Children's Fund (UNICEF) estimates the number of children with disabilities globally at nearly 240 million children.[1] According to the 2018 Indonesian Basic Health Research, 3.3% of children aged 5-17 years in Indonesia have disabilities.[2] Adolescence is a significant stage in reproductive health with changes during puberty, a transition period from childhood to adulthood marked by hormonal changes such as menstruation.[3] Based on the 2013 Indonesian Basic Health Research data, 43.3 million young girls aged 10-14 years in Indonesia perform bad practices of hygiene, such as less awareness in taking care of the reproductive organs' hygiene during period.[4] Consequently, the incidence of infectious diseases related to the reproductive tract in Indonesia at the age of 10-18 years is by 25-42%, and 27-33% at the age of 18-22 years.[5] Nevertheless, problems associated with menstrual personal hygiene occur in adolescents without and with disabilities.[6]

Reproductive health for adolescents with disabilities is often disregarded. Most barriers to reproductive health care and education stem from the mistaken belief that adolescents with disabilities do not have sexual desire.[7] Furthermore, common problems related to puberty, such as mood swings and menstrual pain, are often experienced by adolescents with limited oral communication.[8] Female adolescents with disabilities may have a different experience of menstruation compared to those without disabilities. As reported, during menstrual cycle, female adolescents with disabilities more frequently have dysmenorrhea (menstrual pain), menorrhagia (severe menstrual bleeding), menstrual hygiene problems, and changes in mood and behavior, which is similar to premenstrual syndrome.[9]

Menstruation remains a taboo thing to talk about in Indonesia. According to UNICEF, one in four children in Indonesia has never received information on menstruation before having their first menstruation. Thus, the first menstrual cycle (menarche) could be a frightening experience.[10] Inadequate training and counseling about personal

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hygiene during menstruation and lack of information on menstrual personal hygiene for parents or caregivers provided to adolescents with intellectual and physical disabilities, result in a lack of knowledge and difficulties for the adolescents in performing personal hygiene behaviors during menstruation.[11] Adolescents with disabilities then should know how to maintain their reproductive health. An action to take is by practicing personal hygiene behavior.[12] According to UNICEF, personal hygiene behavior refers to women who practice clean menstrual management, that is, changing sanitary napkins as often as possible to absorb or contain blood during menstruation, using soap and water to wash the body as needed, having access to dispose of used sanitary napkins in the right and safe place, and can access the toilet to clean themselves comfortably while maintaining privacy. Adolescents should understand the knowledge of menstrual cycle and how to manage their menstruation without discomfort or fear.[11]

Studies and guidance on menstrual hygiene behavior in adolescents with disabilities are still limited; accordingly, the handling by the adolescents and parents or caregivers is less than optimal. This study aimed to determine an overview of menstrual personal hygiene behavior in adolescents with physical and intellectual disabilities, which further could be used as materials for planning and developing strategies in creating appropriate guidelines and interventions regarding menstrual hygiene behavior for adolescents with disabilities.

Method

This qualitative study used a case study design to describe the personal circumstances or conditions of menstrual hygiene in adolescents with physical and intellectual disabilities. The major informants selected using purposive sampling were adolescents with physical and intellectual disabilities aged 15 to 24 years who had started menstruating and were willing to take part in in-depth interviews. While, criteria for supporting informants were parents and therapists who gave their consent to participate in an in-depth interview. This study took place at two growth and development clinics in South Jakarta, Indonesia, from July to September 2021.

The number of female adolescents with physical and intellectual disabilities at Clinic 1 was 16. However, only four of them had menstruation, and two were willing to participate in the study. While, at Clinic 2, of 31 female adolescents with physical and intellectual disabilities, 11 were having menstruation and only two were interviewed. The total of informants in this study was eight. The major informants consisted of four female adolescents aged 19-21 years with cerebral palsy (CP) and physical and intellectual disabilities who were having menstruation. Supporting informants included parents of two adolescents with disabilities and two of their therapists.

The severity levels of two female adolescents with CP and intellectual disabilities of the four female adolescents observed in this study were moderate and severe, respectively. For the adolescent with CP aged 19 years at moderate level, an in-depth interview could still be carried out as she was a student at SLB-D, a special senior high school for people with disabilities in Indonesia, and she was still able to communicate clearly. For the adolescent aged 21 years at severe level, an in-depth interview was taken with her mother because she was not able to speak, did not understand simple instructions, and had communication disorders. Adolescents with CP having good cognition were a 21 year-old student of Law, and a 20 year-old SLB-D student.

Table 1. Characteristics of Major Informants

Informant	Age	Education	Occupation	Diagnosis
In-1	21	Higher education (Bachelor's degree in Law)	Student	CP
In-2	21	-	-	CP + ID grade Profound (represented by the mother)
In-3	19	Senior high school	Student	CP+ID grade Moderate (IQ score: 49)
In-4	20	Senior high school	Student	CP

Notes: CP = Cerebral Palsy, ID = intellectual disability

In addition, this study involved supporting informants consisting of mothers and therapists of two adolescents with disabilities. Therapist informants interviewed were therapists working directly with adolescents with disabilities

and were willing to participate in the interview. Parents were included in supporting informants because they knew problems experienced by adolescents with disabilities and could provide answers from different points of view. While, the therapist informants were included to get their point of view on menstrual personal hygiene behavior performed by adolescents and parents who help with their children's menstrual hygiene.

Table 2. Characteristics of Supporting Informants

Informant	Description	Age	Education	Occupation
Ik-1	Adolescent's Mother	56	Bachelor of Chemistry	Private Employee
Ik-2	Adolescent's Therapist	27	Diploma IV of Physiotherapy	Physiotherapist
Ik-3	Adolescent's Mother	50	Vocational High School	Housewife
Ik-4	Adolescent's Therapist	28	Master of Reproductive Science	Physiotherapist

The research instruments used were observation guidelines and in-depth interview guidelines developed by the authors. Observation guidelines examined medical records of adolescents with disabilities to learn their diagnoses and motoric development abilities achieved. Interview guidelines consisted of general topics on personal identity and some other topics to be studied, such as knowledge of menstruation and menstrual personal hygiene, the source of information obtained by the adolescents, and personal hygiene behavior of the adolescents with disabilities. Tools used were notebooks, recording devices, and laptops for video conferencing.

The interview guidelines were tested on one adolescent with disability of the same criteria: 15- to 24-year-old adolescents, already having their menstrual cycle, and willing to conduct in-depth interviews), one adolescent with disability' parents, and one therapist for a child with special needs after filling in informed consent via Zoom platform on July 9, 2021. The time trial results required 30-45 minutes for each informant. After the trial, several questions were revised so that statements were easy to understand, questions were sorted well and added to improve the clarity.

Ethical consent was obtained from the Commission of Research Ethics and Community Engagement of the Faculty of Public Health, Universitas Indonesia on June 25, 2021. The permission for data sampling was applied by sending e-mail to the growth and development clinic managers. Approval for the research and data sampling was received on July 6, 2021. Direct observations took place in September 2021 at the two growth and development clinics in South Jakarta, Indonesia, to examine the medical records of adolescents with physical and intellectual disabilities to obtain an overview of the level of disability.

In-depth interviews were performed after the informants completed informed consent form sent via WhatsApp. Parents and adolescents were allowed to complete the consent form online. Two adolescents with disabilities completed the informed consent themselves, while the other two needed assistance from their parents due to their intellectual disabilities. The interview was taken online from July 11 to September 20, 2021, via Zoom platform (video conferencing) for ±45 minutes for each informant. Informants' consent to be recorded during the interview had been performed by assuring a confidentiality of any information provided. Online interviews were employed because the government issued an Enforcement of Community Activity Restrictions policy to prevent an increase in COVID-19 cases; consequently, the growth and development clinics were closed from July to August.

In-depth interviews were carried out without a research assistant. The interview was then documented by Zoom Meeting recording to prevent any data loss, and the data validity could be accounted for. After the interview recording was completed, the recording was played and then transcribed verbatim. The transcribed data were coded by selecting relevant data to the topic of discussion and then summarized in a matrix form. This study used Content Analysis as an analysis method.

Confirmation and clarification of data obtained from informants after in-depth interviews were carried out to maintain the validity of the data. The triangulation method was then carried out by examining the medical records of the adolescents with disabilities. The source triangulation was also done by comparing and contrasting data from supporting informants, parents, and therapists of adolescents with disabilities.

Results

The study results were obtained through the observation of four adolescents with disabilities as the informants. In-depth interviews were performed with three adolescents with disabilities and one representative of the mother of

adolescents with disabilities. These findings were aligned with several broad categories, including menstrual personal hygiene behavior, knowledge of menstrual personal hygiene, and source of information on personal menstrual hygiene.

Menstrual Personal Hygiene Behavior

Based on the interview results, all adolescents changed their sanitary napkins if full of menstrual bleeding. The napkin-changing frequency was only twice a day on average because the sanitary napkins used were diapers with a greater blood capacity than sanitary napkins in general. They did not use the smaller size of napkin because it made them feel uncomfortable while sitting in a wheelchair, and they also had difficulty in positioning the napkins into the right position. However, some of them said that it was still challenging to find the right napkin because using diapers made them feel uncomfortable due to perspiration arising in the vaginal area.

The adolescents with disabilities used napkins made from towel pants as well, but it made them feel uncomfortable because it was difficult to wash and therefore unhygienic. Additionally, towel pants were reusable; then, they should be washed and sun-dried. In the end, the adolescents returned to using the 42-cm diapers during menstruation but still felt very uncomfortable because there was still a possibility of blood spilling out.

All of those adolescents complained of itching, blisters and redness in the groin area for their sensitive skin and overused diapers. To overcome this, they put olive and baby oil so their skin did not blister. According to the points of view of the adolescents' therapists, they rarely replaced diapers during both menstruation and urination; as a result, they were most likely prone to infection in the vaginal area. In addition, they also had problems like hypo-sensory. Most of them did not aware that they already had a vaginal infection.

The adolescents with disabilities needed their mothers' help in behaving hygienically because of their stiff hands. They also still used soap to clean the area of intimate organs. Most informants could not provide detailed directions for cleaning the intimate organs, but only explained that they cleaned the intimate organs using water. The adolescents needed some assistance while using sanitary napkins because it was difficult to do so in the bathroom. Unfortunately, the mothers who usually helped also needed assistance because of the unstable sitting conditions and their children having to be carried to the bathroom. The mothers were not able to easily help them since they had a record of lumbago and their children weighed more than 40 kg. This made them not to practice menstrual hygiene in their children. The adolescents with disabilities also found it challenging to practice menstrual hygiene behavior and to position their sanitary napkins comfortably due to their disability conditions, such as stiffness in hands, feet, and neck. They also could not feel anything if the napkin position was in a misplaced condition, so menstrual blood sometimes spilled out of the underwear.

In the disposal of used sanitary napkins, all adolescents still used containers wrapped in plastic. Some adolescents did not wash the napkins in advance, but immediately did wrap them in plastic and threw them in the trash for that the napkin content would fall apart when washed. Adolescents with disabilities should be educated about menstruation such as how to dispose of used napkins properly.

Table 3. Themes and Sub-themes Related to the Informant's Statement of Menstrual Personal Hygiene Behavior

Theme	Sub-theme	Informant Statement
Menstrual Personal Hygiene Behavior	Type of napkin and frequency of changing napkin	"*I once used towel pants, but it was uncomfortable and I can't wash them clean. Now, I'm wearing the longest 42-cm napkin. I only change the napkin when it's full."* (In-1) *"Her skin is more sensitive. You know, there are creases in diapers, right? If I don't put baby oil on her, her skin will blister." (In-2)* *"Hmm still wearing diapers during periods. Changing napkins is recommended twice a day."* (In-4) *"Napkins should be changed frequently at least every four hours. They do not so, only once a day. So, there is also risk of infection. Additionally, they also have problems such as hypo sensory, they are not aware that there is a problem of infection in the vagina."* (Ik-4) *"Diapers have to be changed frequently, I'm worried that disease will arise because it harbors bacteria due to blood and urine mixing and sticking to vital parts."* (Ik-2)
	How to clean the genitalia from menstrual blood	*"I usually only clean the front. But after defecating, I clean backwards. I just tried to stretch my hand to reach the back. Right now, I feel so itchy. I think I'm allergic to soap."* (In-1) *"The intimate organs are cleaned with soap, so it is clean. I dry her with a towel after wash, because her skin is sensitive."* (In-2) *"You know, it is quite hard to lift her, she has a large body. So, I only clean her genital only when showering."* (Ik-3)

	Obstacles in performing personal hygiene during menstruation	*"If the napkin is misplaced, I just let it be, I don't notice it either."* (In-1) *"It's hard to take her to the bathroom. Child Z is over 40kg, and I don't have the strength to carry her."* (In-2) *"The challenge is I can't do it by myself, everything must be helped by mom. [Mom] must help put on pants and clean too. My arms, legs, and neck are stiff, you know."* (In-4)
	Disposing of used pads and wearing pads	*"I throw the napkin immediately without washing. I'm afraid it will be messy, and it's gross."* (In-1) *"I washed the diapers, then I put them in plastic. Then I throw it in the trash. So, there is no longer blood in it."* (In-2)

Knowledge of Menstrual Personal Hygiene

Based on the interview results, all informants described menstruation as the process of discharging dirty blood that monthly occurs in women, but not all the adolescents and parents can say the average length of a normal menstrual cycle. They changed the napkins only when the napkins were fully contained by menstrual blood. The proper procedure for cleaning intimate organs would be using water and soap. Only a few mothers can explain in which direction the correct way to clean intimate organs is from front to back so that feces in the anus are not carried to the front.

All the adolescents told how they felt during their menarche. They were shocked, uncomfortable because of the pain, and confused because they had never been explained about menstruation before. All the adolescents experienced complaints of irritation and blisters in the groin area, itching around the intimate organs, redness of the skin caused by using diapers too long, and allergies to the soap they used. Most adolescents had an irregular menstrual cycle (longer than 40 days) and experienced excessive pain during menstruation. Mothers gave painkillers and sour turmeric herbal medicine to make menstrual blood flow more smoothly. Even some of the adolescents stayed still and did not move much, sometimes showing symptoms of menstrual cramps.

According to therapists' point of view, the adolescents and their parents still needed the knowledge related to reproductive health, such as menstrual hygiene, because many parents had the wrong view and assumed that their children would not reproduce like typical adolescents, so they often dismissed the menstrual hygiene. Moreover, many parents assumed that their children would not get married in the future. Knowledge of menstruation is fundamental for both the adolescents and their parents to prevent adverse effects such as vaginal infections. Therefore, education in the form of seminar or counseling on how to have a proper menstrual hygiene is needed further.

Table 4. Themes and Sub-themes Related to Informant's Statement on Knowledge of Personal Menstrual Hygiene Behavior

Theme	Sub-theme	Informant's Statement
Knowledge	Understanding of menstruation	*"Menstruation produces dirty blood. I don't know how many days the normal menstrual cycle are."* (In-1) *"Menstruation... a monthly production of dirty blood. Menstrual cycle? Errr."* (In-4)
	Understanding of menstruation personal hygiene	*"The full napkin should be immediately changed and intimate organs are cleaned by spraying water. I don't know the direction."* (In-1) *"Wearing diapers is recommended twice a day, changed during the menstruation."* (In-3) "*Parents assume children with disabilities will not reproduce in the future, so they ignore menstrual hygiene."* (Ik-4)
	The experience of menarche and menstrual symptoms in adolescents with disabilities	*"Her menstruation got early. She had it before nine years old. I was shocked, I thought she was wounded or something. The cycle is irregular, she hasn't got it for three months. When she has her period, she likes to stay quiet, doesn't move much, sometimes she has seizures. "* (In-2) "*Sometimes I have pain in my stomach and waist. When I'm on my period, I'm upset, crying and grimacing because it hurts."* (In-3) *"I had complaints of itches or blisters on the intimate organs like a red rash, but she told me it is because we change the napkin's brand."* (In-4)

Personal Menstrual Hygiene Information Source

All the adolescents and their mothers have smartphones, social media platforms such as Facebook and Instagram accounts, and access to the internet very well. However, the mothers had never sought out information on menstrual hygiene either from social media or by participating in reproductive health seminars or trainings. The reasons were that such information could be obtained from her own experience when cleaning her period, the symptoms her daughter experienced during menstruation were not too severe to handle alone, and her adolescent daughter had a normal metabolism like children in common.

The adolescents furthermore rarely got information related to menstruation prior to their first menstruation and had not received menstrual hygiene information from parents, therapists, and teachers at school. The therapists stated

that neither the adolescents nor their mothers were seeking information on menstrual hygiene because the topic was still considered taboo and ignored related problems. The therapists suggested that they should also be educated by reproductive health professionals. Therefore, they could also comprehend the menstrual hygiene and provide true information to the adolescents and parents.

Table 5. Themes and Sub-themes Related to Informant's Statement on the Sources of Information on Menstrual Personal Hygiene

Theme	Sub-theme	Informant's Statement
Source of Information	Information obtained by the mothers of adolescents about menstrual personal hygiene	*"I have never attended training on proper menstrual hygiene in children with disabilities. I think In-1 has a normal metabolism like typical children"* (Ik-1) *"I never sought information on it. If there's a problem with my child, I will learn from my experience."* (In-2) "*Err not yet, I think her symptoms are not too severe, so I don't find out more."* (IK-3)
	Information obtained by the adolescents about menstrual personal hygiene	*"No, not at school. [I] know menstrual information only from Google."* (In-3) *"I never got that information from anyone."* (In-4) *"They rarely seek information on menstruation, maybe because it is still taboo and still ignored."* (Ik-4) *"We therapists also need to be literate about menstrual hygiene."* (Ik-2)

Discussion

Female adolescents with disabilities have a limited ability to practice the menstrual hygiene, resulting in a high risk of vaginal infection.[12] According to a cross-sectional study in India, 93 adolescents with CP stated that they used napkins (69.4%), while the rest used old rags, assisted by their mothers or caregivers to change the sanitary napkins (38.8%). Also, adolescents with CP showed signs of vaginal infection (58.3%), and some showed signs of premenstrual syndrome (25%). The pain in adolescents with disabilities is caused due to their stiff muscle conditions, muscle cramps, and joint limitations.[13]

The results of study by Zacharin ndicated that fifty four of the 79 (68.4%) menstruating adolescents described their menstrual cycles as regular, with cycles ranging from 21 to 35 days. Twelve girls (15%) had cycle lengths of less than 21 days, and 13 (16.5%) of greater than 35 days.. Various medical co-morbidities and the use of medications that are common for people with CP might cause menstrual cycle irregularities. Irregular menstrual cycle could also be resulted by the limited mobility or wheelchair dependence and deficient vitamin D due to limited exposure to the sunlight. [14]

Adolescents with disabilities seriously require information on dealing with menstruation because many of them do not understand what they should do while they are on period, such as improper use of napkins, rarely changing napkins, unstable emotional changes, menstrual pain, and improper personal hygiene.[15] With the proper approach to menstrual management in female adolescents with disabilities, it is expected that they would be able to manage their menstruation independently.[16]

The cloth napkin is often not recommended due to its repeated use. In addition, it is unhygienic washing process which might result in rashes and infections. Cloth-type napkins are also risky for abnormal vaginal discharge and skin irritation. Disposable sanitary napkins are preferred because they are more hygienic, convenient, and easy to use. However, the disposal process of disposable napkins can produce much waste; hence, a proper waste management is needed to avoid some environmental issues.[17]

Sanitary napkins should be changed every 4-5 hours even if only a little blood comes out and can be changed more often if more blood comes out.[18] Adolescents often wait until the napkin is fully contained with blood to change them.[18] Continuous and prolonged diaper use may cause skin irritation and reproductive tract infection.[19] The blood released during menstruation contains bacteria that multiply within 30 minutes, so that within 1-2 hours there are too many bacteria. It is necessary to wash hands before and after changing the napkins.[20]

Adolescents with physical and intellectual disabilities need assistance for menstrual hygiene, such as cleaning the genitals from menstrual blood.[14] The proper way to clean a woman's genitals is to use clean water in the direction from the front (vagina) to the back (anus) so that bacteria from the anus do not enter the vagina.[21] There is no need to frequently use particular cleansing soaps since the vagina already has a natural mechanism to maintain its acidity to prevent bacteria from entering the vagina.[22] Frequent use of soap will kill the good bacteria in the vagina.[22]

The disposable napkins should be wrapped first for disposal to prevent disease transmission. If there is much menstrual blood in the sanitary napkin, it should be washed first with running water, then wrapped and thrown into a

special trash can for disposal. Wrapping the napkins should use paper instead of plastic since plastic is nondegradable so that it can pollute the environment.[10]

Female adolescents with disabilities are poorly informed and unprepared for menarche due to the inadequate knowledge of menstruation and menstrual hygiene behavior.[6] A study in Yogyakarta, Indonesia, indicated that about 61.5% of adolescents are categorized as lacking knowledge. A phenomenon that often occurs in the community is the feeling of taboo towards menstruation so that adolescents' acceptance of some physical and psychological changes related to menstruation is poorly understood. Knowledge of menstruation can influence the attitude and behavior of the following periods. Behavior towards menstruation is a response in adolescents with disabilities to symptoms that occur during menstruation, such as discomfort due to menstrual pain and emotional imbalance.[15]

During the first period, adolescents mostly catch discomfort feelings, such as fear and shock to see blood release or stick to their underwear.[23] They thought that there is a disease or injury. The feeling arises in adolescents who, when they get their first period, have not yet received information on menstruation.[23] Preparation for menstruation, such as knowledge and management during periods, is minimal for adolescents with disabilities.[15]

Moreover, a misconception that people with disabilities do not have the same reproductive system as people without disabilities makes them less likely to receive information on menstrual hygiene management.[24] Yet, such information is usually kept secret from people with intellectual disabilities because it is thought that they will not understand it. If this is the case, communications while providing information should be more simplified and adapted to their level of understanding to manage their periods.[25]

Based on the problems described, educational media are needed to elevate the knowledge of adolescents with disabilities and their parents.[26] Providing educational media on menstrual health management in posters, videos, leaflets, and modules can increase the adolescents' knowledge and attitude to be more positive towards menstrual symptoms.[27] The media provision in the form of a booklet affects an improvement in the knowledge of menstruation in adolescents with disabilities. The booklet has several advantages, including that it contains images and attractive colors and is easy to understand; therefore, children with disabilities are interested to read it. Growth and development clinics should provide information in the forms of posters, videos, and booklets about menstrual hygiene procedures to maintain the reproductive health of adolescents with disabilities.[28]

Conclusion

This study underlined the significance of increasing adolescents with disabilities' independence in menstrual hygiene behavior. Evidence shows adolescents with disabilities and their caregivers receiving less information, thus they have not been practicing proper menstrual personal hygiene behavior, and they still need some assistance from mothers or caregivers. Providing information at growth and development clinics through posters, videos, and booklets on menstrual hygiene procedures provides knowledge to adolescents with disabilities to maintain their reproductive health. Interventions from therapists by creating more programs to train adolescents' independence in practicing menstrual hygiene are needed to minimize adolescents' dependence on their parents or caregivers.

Abbreviations

UNICEF: United Nations Children's Fund; CP: Cerebral Palsy.

Ethics Approval and Consent to Participate

The authors guaranteed confidentiality on any information provided by informants. All informants were explained about the research and requested willingness to fill out an informed consent form according to the Declaration of Helsinki, which states that the informant's participation can provide voluntary and non-coercive informed consent. Participants were allowed to continue or stop their participation in the study. Ethical approval was obtained from the Commission of Research Ethics and Community Engagement of the Faculty of Public Health, Universitas Indonesia No. Ket-353/UN2.F10D11/PPM.00.02/2021).

Competing Interest

The authors declared that they have no competing interests in this study.

Availability of Data and Materials

Data and materials are available upon request.

Authors' Contribution

NKE conceived the idea and planned the research, carried out the research, discussed the results, writing a draft of the manuscript. AK, EW, and KNS directed and supervised this study, overviewed, and gave final approval to the manuscript.

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Exploring the Multifaceted Nature of Occupational Stress Among Nurses: A Systematic Review

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Abstract

This systematic review examined occupational stress among nurses, its multifaceted nature, and its significant impact on healthcare delivery and nurse well-being globally. This study identified various stressors, including intrinsic job factors, organizational structure, role expectations, interpersonal relationships, and career development. Using the Cooper and Marshall stress model, a thorough literature search was conducted across databases like ISI Web of Knowledge, PubMed, Scopus, Ovid Medline, and Google Scholar, focusing on publications from 2010 to 2023. This rigorous approach included diverse research methodologies, emphasizing studies measuring outcomes related to occupational stress and mental health among nurses. A total of 10 studies met the inclusion criteria, highlighting stressors such as workload, job demand, job insecurity, and less reward, categorized into five primary sources. The review revealed that occupational stress in nursing is a global issue, leading to adverse outcomes like burnout, decreased job satisfaction, and increased turnover. The discussion emphasized the need for a holistic approach to stress management, advocating for supportive work environments, adequate staffing, and professional development opportunities. In conclusion, strategic interventions are crucial for improving mental health, job satisfaction, and healthcare quality, necessitating collaborative efforts from healthcare leaders, policymakers, and practitioners.

Keywords: healthcare system, nurse well-being, occupational stress

Introduction

Occupational stress, which significantly affects nurses globally, presents substantial health and financial challenges, with its prevalence varying widely from 9.2% to 75%, as evidenced by studies showing a 68% prevalence in the UK and Nigeria and 75% in Ghana.[1] This issue has a substantial financial impact, costing an estimated $5.4 billion annually in lost productivity.[1] Nursing is notably stressful, impacting nurses' physical, emotional, and psychological health. Nurses play a crucial role in healthcare, delivering comprehensive care across diverse demographics and health conditions, with responsibilities that span from direct patient care to mentorship and counseling within the healthcare community.[2]

The Oxford Dictionary defines nurses as trained individuals responsible for caring for the sick and disabled, mainly in hospitals. Nurses face multiple stressors in their role, including physical labor, human suffering, shift work, staffing issues, and interpersonal relationships, all of which contribute to job stress, while they remain integral to healthcare teams, collaborating with doctors, social workers, and technicians.[3] Their role involves planning and delivering medical and nursing care to patients in various settings, including hospitals and homes, and providing support to doctors in managing patients' physical and mental health challenges.[4]

Occupational stress can arise from a mismatch between workplace demands and physiological needs. While some stress can motivate and improve performance, excessive stress can have detrimental effects on both mind and body. Stressors, or environmental triggers of stress, vary in their impact depending on individual reactions, with work-related stress negatively affecting both individuals and organizations. At the individual level, it leads to job dissatisfaction, lower motivation, insomnia, psychological distress, depression, anxiety, aggressiveness, loss of self-confidence, concentration

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difficulties, cardiovascular diseases, high cholesterol, and high blood glucose levels.[4] At the organizational level, it results in increased costs, failure to meet goals, heightened healthcare expenses, reduced job satisfaction, and, importantly, increased absenteeism and turnover among staff, which in turn diminishes the quality of healthcare and client satisfaction. Workplace stress is a common phenomenon influenced by an individual's perception of the disparity between job demands and coping abilities. This stress may disrupt work-life balance and is considered a universal aspect of daily life. This aligns with the transactional theory, suggesting that any work-related situation could be perceived as a stressor based on individual evaluations and perspectives.[5]

Several studies have examined the impact of stress on nursing professionals. Tesfaye pinpointed role conflicts and minimal support from patients and their families as key sources of job stress for nurses.[6] Furthermore, workplace violence, inadequate salaries, and limited involvement in decision-making processes were identified as common stress factors in the profession.[7] High stress levels in nurses may adversely affect the quality of care they provide, as symptoms like fatigue, reduced focus, and emotional burnout can diminish their ability to deliver safe and effective treatment, increasing the risk of medical errors and negative patient outcomes.

Additionally, many hospitals face financial constraints and staffing shortages. This situation is corroborated by a study from China, finding that most nurses reported high stress due to insufficient staff, excessive workload, and subpar working conditions.[8] A study in Africa investigated the stress and coping mechanisms among nurses.[9] The findings indicated that the primary sources of stress were insufficient motivation, inadequate staffing, managing numerous patients single-handedly, absence of breaks during shifts, and caring for challenging patients.[9] Besides, another study in Ethiopia revealed that 41% of hospital nurses were dissatisfied with their jobs, and 22% intended to leave their roles within a year, attributing their decision to workplace stress.[10]

Several work-related stressors are associated with increased risks of adverse stress outcomes. The original model by Cooper and Marshall (1976) outlined five primary sources of workplace stress.[11] According to the Cooper and Marshall model, stressors can be divided into several key categories. Job-related stressors include factors such as time management, workload, working environment and resources, job demands, insufficient job control, and role conflicts. In the area of organizational structure and climate, stressors encompass job insecurity, organizational systems, and lack of recognition or rewards. Role-related stressors in the organization involve issues such as nurse compensation, work schedules, interactions with patients and caregivers, verbal abuse, and coworker relationships. Stressors related to workplace relationships include employment status, turnover rates, health status, sleep disturbances, work-family conflicts, and fear of COVID-19. Lastly, career development stressors pertain to nurses' educational backgrounds, work experience, job positions, and professional commitment.

Despite extensive research into the stressors affecting nurses, a notable gap exists in understanding the interplay between these stressors and the broader healthcare system. Specifically, existing literature often fails to fully explore how systemic issues in healthcare policy and administration exacerbate individual stress factors. This gap is particularly significant considering ongoing global health crises, which have intensified the challenges faced by nurses. Moreover, there is a lack of comprehensive, cross-cultural studies considering diverse healthcare systems and the unique stressors encountered in different regions. This systematic review sought to fill these gaps by providing a global perspective and considering the impact of systemic issues on nursing stress.

Method

To conduct this review, relevant articles published in 2010-2023 were comprehensively searched. The search encompassed five primary databases: ISI Web of Knowledge, PubMed, Scopus, Ovid Medline, and Google Scholar. To refine the search for relevant literature, this study employed a Boolean operator to combine a set of carefully selected keywords. Articles mentioning either "occupational stress," "job stress," "work stress," or "burnout" in conjunction with terms like "nurse," "nursing," or "healthcare workers" were searched. The inclusion criteria were designed to focus specifically on cross-sectional studies. The study specifically targeted articles involving registered nurses and nursing staff working in various healthcare settings, such as hospitals, clinics, and nursing homes. The studies had to measure outcomes related to occupational stress, burnout, job satisfaction, emotional exhaustion, or any related mental health outcomes among nurses.

Conversely, the exclusion criteria aimed to narrow down the scope by eliminating non-empirical studies such as opinion pieces, editorials, commentaries, and reviews lacking original data. The initial screening of article titles was based on these eligibility criteria. The process began with the identification of 1,062 records through database screening.

After duplicates were removed, 502 records remained. All abstracts from these records were screened, which led to the exclusion of 469 articles. The remaining 33 full-text articles were assessed for eligibility, resulting in the exclusion of 23 articles, primarily because they did not meet predefined inclusion criteria or present empirical data. Ultimately, 10 studies met all the necessary conditions and were included in the review (Figure 1).

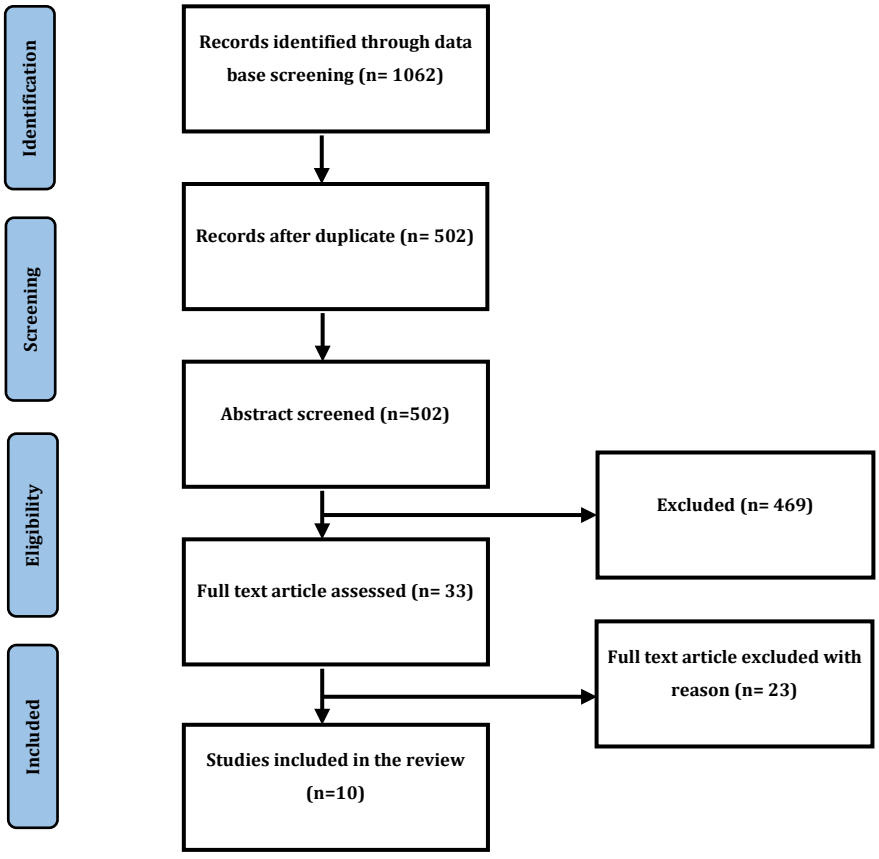

Figure 1. Process of the Article Selection

Results

The characteristics of the 10 studies that met the inclusion criteria after a rigorous selection process are depicted in Table 1. These studies, spanning from 2010 to 2023, investigated various stressors impacting nurses across a diverse range of geographical locations, including China, South Korea, Japan, Canada, Ethiopia, and Iran. This global perspective highlighted the universal nature of occupational stress within nursing, underscoring both commonalities and regional specificities in stress factors. Each study focused on different populations of nurses, ranging from frontline nurses dealing with COVID-19 in China to operating room nurses in South Korea, emphasizing the wide scope of the nursing roles examined. The sample sizes vary significantly, from 193 to 831 participants, reflecting a broad spectrum of research scales and potentially affecting the generalizability of findings across different healthcare settings.

The tools used to measure stress and its predictors were notably diverse, including the Nurse Job Stressors Scale, Perceived Social Support Scale, Kessler Psychological Distress Scale, Fatigue Severity Scale, Quality of Nursing Work Life, and the Maslach Burnout Inventory, among others. This variety in measurement instruments points to the multifaceted nature of occupational stress and its different dimensions, from workload and job demand to interpersonal relations and organizational structure. The stressors identified as predictors of occupational stress or burnout varied similarly. They included time allocation, workload, job demand, organizational system, job insecurity, lack of reward, sleep disturbance, verbal abuse, work-family conflict, and fear of COVID-19. These stressors were categorized according to the Cooper and Marshall model, offering a structured framework for understanding the sources of stress among nurses. The outcomes of the studies were primarily focused on stress, fatigue, quality of life, and burnout, indicating the significant impact of identified stressors on nurses' mental health and job satisfaction. Several studies also noted the relationship between stress and turnover, suggesting that occupational stress not only affects individual health outcomes but also has broader implications for healthcare systems through its impact on staff retention and the quality of patient care.

Table 1. Characteristics of Included Studies

Author	Sample Size	Population	Country	Tool	Stressors as Predictor	Stress Category (Cooper and Marshall)	Outcome
Hu S *et al.*[12]	723	Frontline nurses exposed to COVID-19	China	• Nurse Job Stressors Scale • Perceived Social Support Scale, • Kessler Psychological Distress Scale	• Time allocation • Workload • Job demand • Organizational system	• Intrinsic to the job • Organizational structure/climate'	Stress
Lee H *et al.*[13]	234	Nurses from multiple hospitals	South Korea	• Fatigue Severity Scale • Short Depression Scale, • Korean Occupational Stress Scale, • Insomnia Severity Index, • Epworth Sleepiness Scale	• Job demand, • Insufficient job control • Role conflict, • Job insecurity, • organizational system, • Lack of reward, • Sleep disturbance.	• Intrinsic to the job • Organizational structure/climate • Relationship with word	Fatigue and stress
Hwang E[14]	207	Female nurses working in tertiary general hospitals	Japan	• Quality of Nursing Work Life	• Nursing work, • Role conflict, • Educational status • Verbal abuse • Work family conflict. • Work schedule. • Patients and caregivers	• Intrinsic to the job • Role in the organization • Structure and climate of organization. • Relationship at work • Career development	Quality of life
Maddigan J *et al.*[15]	661	Registered Nurses in an Eastern Canadian Province	Canada	• Professional Quality of Life Scale	• Work schedule. • Turnover • Employment status	• Relationship with Work • Role in the organization	Stress and burnout
Tadesse B *et al.*[16]	393	Nurses working in West Shoa Zone public hospitals	Ethiopia	• Perceived Stress Scale	• Educational status • Working experience • Work position. • Professional commitment • Organizational system, • Job satisfaction	• Career development • Organizational structure/climate	Stress
Park SK *et al.*[17]	200	Clinical nurses at three general hospitals	South Korea	• Perceived Stress Scale • Insomnia Severity Index • Eating Behaviour Questionnaire • WHOQoL-BREF questionnaire	• Health status • Sleep disturbance. • Workload • Job demand • Fear of COVID-19	• Relationship with Work • Intrinsic to job	Quality of life
Belji Kangarlou M *et al.* [18]	831	Hospital nurses General Hospital	Iran	• Maslach Burnout Inventory • NASA Task Load Index Perceived threat of COVID-19 scale	• Workload, • Fear of COVID-19 • Workload • Job demand	• Relationships at Work • Stressors Intrinsic to job	Burnout
Gu M *et al.*[19]	193	Operating room nurses	South Korea	• Verbal Abuse Experience Scale, • Job Stress Scale	• Verbal abuse, • Nurse compensation	• Relationships at Work • Role in the Organization	Turnover and stress
Mousavi SM *et al.*[20]	300	Nurses in Khuzestan Province,	Iran	• Mental Workload scale • Job Stress scale	• Workload • Work-family conflict. • Fear of COVID-19 • Workload • Coworker	• Relationships at Work • Role in the Organization	Turnover and burnout
Zhou L *et al.*[21]	654	Nurses in hospitals in Jiangsu Province,	China	• Perceived Stress Scale • Turnover Intention Scale	• Patients and caregivers • Workload • Coworkers • working experience • Educational status	• Career development • Intrinsic to job • Role in the organization	Stress

Discussion

Based on the systematic review utilizing the Cooper and Marshall stress model, this discussion delved into the complexities of occupational stress within nursing. It scrutinized elements like intrinsic job components, the framework

of the organization, roles nurses occupy, their relationships at work, and paths for career growth, pinpointing pivotal stress inducers such as excessive workload, high job demands, conflicts in roles, and insecurity in employment, all of which profoundly affect the well-being of nurses.

Stressors Intrinsic to the Job

Stressors intrinsic to the job refer to those aspects of a job that inherently have the potential to induce stress. These are typically the fundamental elements or conditions of the work environment and role itself. Six studies[12-14,17-18,21] in this review highlight the impact of specific job stressors on nurses, contributing to a few factors, including workload, working environment and resources, job demand, insufficient job control, and role conflict. Work overload, a primary stressor, emerges when employees face work demands exceeding their capacity and available resources, leading to difficulties in completing tasks within set timeframes.[22] While job demands themselves are not inherently negative, they can become stressors when fulfilling them requires substantial effort and results in adverse reactions like depression, anxiety, or burnout. Role conflict, defined as the simultaneous occurrence of two or more conflicting pressures in a worker's role, is another significant occupational stressor. This stressor arises from incongruities or incompatibilities in role expectations.[23]

Additionally, job control, previously known as decision latitude, is an influential factor in nursing turnover rates. A lack of perceived control often leads to job stress and is a critical yet frequently overlooked factor contributing to the voluntary departure of highly employable nurses from the profession.[24] Additionally, time allocation plays a critical role, as it allows nurses to prioritize care and perform crucial interventions first. Frontline healthcare professionals have endured intense physical and psychological pressure. Under such conditions, nurses operate in high-stress settings for prolonged durations, often resulting in burnout.[25]

Organizational Structure/Climate

Organizational climate, perceived by employees as a series of characteristics within their work environment, significantly influences their behaviors. Three studies[12,13,16] underscored the impact of organizational climate on nurses, focusing on aspects like job insecurity, the organizational system, and the lack of reward. The global health sector heavily relies on nurses, and enhancing their quality of life is beneficial for society at large.[26] Job insecurity in nursing is linked to migration for better pay and quality of life, and it correlates with declining health, increasing burnout, stress, and vulnerability, and lower job satisfaction.[27]

Regarding organizational systems, frequent changes lead to change saturation, overwhelming the organization's capacity to adapt. Around 54% of change initiatives fail due to the high frequency and volume of changes, necessitating staff to prioritize which changes to adopt.[28] This often results in stress, cynicism towards the organization, and a decrease in commitment, job satisfaction, trust, and motivation.[29] Recognizing and rewarding staff effectively, including nurses, is crucial. Such recognition, whether symbolic, emotional, or financial, should acknowledge both exceptional and regular performances and be rooted in professional relationships characterized by respect, support, and feedback.

Role in the Organization

The role of nurses within an organization encompasses various competing values, including efficiency, quality, and staff well-being, with the organization itself seen as a system of roles, each with its expected behaviors. Five studies[14,15,19-21] focused on the role of nurses in the organization, examining factors like compensation, work schedule, patient and caregiver interactions, and issues of abuse and coworker relationships. Compensation, particularly basic pay, is crucial as it directly impacts job performance, with satisfaction in pay correlating with higher performance levels. Efficient management of schedules, essential for ensuring nurses' competencies, number, flexibility, equality, and skill mix, is a process that ranges from planning to controlling work shifts, intending to ensure patient safety and effective nursing service.[30]

Nurses frequently interact with families and are pivotal in facilitating end-of-life discussions, often leading to stress and emotional burdens. They are also more exposed to verbal and physical abuse due to their frontline role in hospitals, acting as intermediaries between patients, desk staff, technicians, and doctors.[31] Coworker incivility, characterized by disregard for others' feelings and impertinent remarks, further contributes to burnout and psychological problems. This aspect is often analyzed through the lens of Conservation of Resources (COR) theory, which helps understand the emotional exhaustion resulting from such workplace dynamics.[32]

Relationship with Work

Work relationships significantly influence the workplace, affecting employees' feelings, energy, and performance. As Bella highlights, mood levels are crucial in determining work performance.[33] Six studies[13,15,17,18-20] emphasize the impact of work relationships on factors like turnover, health status, sleep disturbance, work-family conflict, and fear of COVID-19. Nurse turnover is a pressing global issue in health care, with rates ranging from 13% to 37%, affecting patient care, especially when experienced staff leave and less-experienced nurses dominate units, impacting care continuity and quality. Turnover often increases with dissatisfaction with benefits, professional opportunities, and work conditions.[34]

Nurses' health status is also a concern, with many experiencing poor health due to shift work, affecting mental, physical, and social adaptability. Poor sleep quality and sleeplessness, prevalent among shift workers, are linked to health issues like metabolic syndrome and endocrine and immune system disturbances, leading to various psychophysiological problems, with one study reporting that 29.7% of rotating day shift health staff frequently experienced sleep disruption.[35] Work-family conflict arises when individuals struggle to balance responsibilities at work and home, leading to stress due to arguments, insufficient home time, and increased work responsibilities. Nurses face a high personal fear of COVID-19, more so than other healthcare workers and the general population. A study noted that fear of infection or uncertainty is a significant challenge, especially among nurses on the front lines.[36]

Career Development

In the realm of nursing, career development is a crucial aspect of progression through an individual's professional life, and it involves selecting roles that align with one's professional aspirations. This development is a lifelong journey of actions and decisions, gaining significance in contemporary times due to the heightened focus on work-life quality and the necessity of educational advancement. Factors such as nurses' educational status, working experience, position, and professional commitment are crucial to this development, which is included in three studies.[14,16,21] Nursing education, demanding and rigorous, imposes substantial challenges, paralleling the academic and clinical rigor faced by undergraduate nurses.

Exacerbating this stress is the working experience, where insufficient staffing, as highlighted by Hegney, leads to nurses' frustration over unmet patient needs and their professional dissatisfaction.[37] Cheng also identified a link between clinical competence and the inclination of nurses to leave the profession, a concern, especially for newly recruited nurses transitioning from student to staff roles.[38] Mlambo suggests that this challenge in adapting and improving professional skills could drive nurses away from the profession.[39] Professional commitment is the alignment of an individual's beliefs with their professional goals, influenced by factors like working conditions, work-family conflict, and sociodemographic characteristics. The pandemic has notably altered these aspects, reduced healthcare professionals' well-being and diminishing professional commitment when organizational obstruction increases, subsequently elevating stress levels.

Conclusion

This systematic review has critically examined the prevalence of occupational stress among nurses, revealing a wide range of stressors and their significant impact on nurses' well-being and healthcare delivery. Occupational stress in nursing is influenced by various factors, including job demands, organizational structure, role expectations, interpersonal relationships, and career development challenges. These stressors lead to negative outcomes like burnout, decreased job satisfaction, emotional exhaustion, and increased turnover, highlighting the need for targeted interventions. This study advocates for a holistic approach to stress management, emphasizing supportive work environments, better communication, adequate staffing, and opportunities for professional growth. Addressing these issues is crucial for improving nurses' mental health and job satisfaction, as well as ensuring high-quality patient care and healthcare system efficiency.

Abbreviations

Not applicable.

Ethics Approval and Consent to Participate

This systematic review did not involve primary research with human or animal subjects, hence obviating the need for an ethics approval or consent process. The investigation was conducted solely based on previously published data, adhering to all relevant ethical standards for secondary data analysis.

Competing Interest

The authors declare no competing interests in this study's preparation, analysis, or presentation. This statement affirms that no personal or financial relationships or affiliations could have inappropriately influenced the work presented in this review.

Availability of Data and Materials

The data supporting the conclusions of this systematic review are derived entirely from publicly accessible sources. These sources include established academic databases such as ISI Web of Knowledge, PubMed, Scopus, Ovid Medline, and Google Scholar. A supplementary file, offering additional insights and specifics about the utilized datasets, is available for public scrutiny, ensuring transparency and replicability of the research findings.

Authors' Contribution

BMS wrote original draft manuscript and did technical writing, proofreading, validating, reviewing, and editing; SK and SUM worked on formal and statistical analysis and data curation. All authors contributed to the study design and interpretation of the analysis and approved the final draft of the manuscript.

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Prevention of HIV Transmission Among Men Who Have Sex with Men and Compliance with Sexual Protective Equipment

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Abstract

Sexual orientations, such as gay, lesbian, and bisexual, are prevalent among individuals at high risk of experiencing mental health problems, including drug use, depression, emotional distress, and suicide. Therefore, this study aimed to assess the compliance of men who have sex with men with protective equipment and determine the dominant influential factors. This cross-sectional study included 187 men who had sexual intercourse with men who were recruited from two foundations based in Palembang City, Indonesia, focusing on people living with HIV/AIDS. Data were analyzed using Chi-square and binomial logistic regression. In this context, 50.8% of men who have sexual intercourse with men did not comply with the use of sexual protective equipment, exceeding those in compliance. The multivariate logistic regression showed that knowledge was the dominant factor (PR = 15.733; 95% CI = 4.063-60.920), and most low-knowledge individuals were 15.733 times more at risk of non-compliance. Intensive education is needed regarding the potential risk of transmission, considering the ease of access to condoms.

Keywords: condom, knowledge, men who have sex with men, people living with HIV/AIDS

Introduction

Men who have sex with men (MSM) are key parts of populations in which the risk of human immunodeficiency virus (HIV) continues to increase.[1] In addition, the current trend is shifting towards a younger age group, enabling the persistence of the risk group for longer periods with various types of behavior.[2,3] This trend shows the pressing issue of sexually transmitted infections (STIs), which affect reproductive health with a broad impact on public health, costs, and long-term care for the community.[4] Therefore, the disease continues to increase among MSM with a high rate of reinfection with syphilis.[5]

Men who have sex with men (MSM) are at high risk of contracting HIV and STIs transmitted through unsafe sexual intercourse.[6] MSM accounts for 93% of infections, particularly in the young age group.[7] Young adults (15-24 years) with this sexual orientation experience various STIs, such as chlamydia, gonorrhea, and syphilis,[4] necessitating effective health education.[8] Unsafe sexual behavior by MSM is also influenced by opioid abuse, which has an impact on uncontrolled sexual activities, such as sexual intercourse without a condom, having sex with multiple sexual partners, group sex, sexual exchange, and inconsistent use of condoms.[9] HIV-infected people are spread across the world. The highest HIV prevalence among MSM on the African continent is in the Central Africa at 19%, followed by the HIV prevalence in Latin America at 11%, and the Central Europe and North America at 8%.[10] More than half of HIV cases in Indonesia occur in the MSM at 64.5%; while acquired immunodeficiency syndrome (AIDS) cases are by 68.6%.[11] South Sumatra Province was ranked 17th in 2019 based on the number of people living with HIV/AIDS (PLWHA) in Indonesia.[11]

The estimated population of MSM in Palembang, the capital city of South Sumatra Province, is 6,802.[12] HIV screening is carried out on commercial sex workers, which in 2021 resulted in 281 people being screened, and an increase of 480 people in 2022. The aggregate for PLWHA found in Prabumulih City, Indonesia, was 187 people in December 2022, of

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which 122 have HIV and 65 are with AIDS.[13] This data shows the urgency of addressing sexual risk behavior among HIV-positive MSM, particularly in the context of unprotected anal intercourse, which necessitates the need for protective equipment to prevent the STI transmission. Other risky behaviors spreading this disease include drug use and social stigma against sexual orientation.[14] Furthermore, HIV is a prevalent STI among MSM, and the high increase requires the need for prevention. Therefore, it is important to identify determinants of compliance using sexual protective equipment in this group. This article is worthy of publication due to its contribution to finding solutions to the problems.

Method

This study used a quantitative method with a cross-sectional design to analyze determinants of compliance with sexual protective equipment used in preventing HIV risk in Palembang City, Indonesia. The population of this study was MSM, specifically members of two foundations based in Palembang City, Indonesia, focusing on PLWHA. The minimum sample calculation in this study used the hypothesis test formula for the difference between two proportions using a cross-sectional study with a sample size of 187 people.[15] The sample used a non-random technique, which was purposive sampling. The independent variables included sexual orientation, access to condoms, MSM comfort, fear of infection, social support, and knowledge; while, the dependent variable was compliance using sexual protective equipment.

Sexual orientation refers to information on a person's attraction and desire for one or more genders having the potential to engage in HIV-risk behavior. The data were obtained through interviews using questions from a structured questionnaire, which was compiled and developed and then tested for validity and reliability. Interviews were conducted after respondents obtained approval through signed informed consent. The concept was categorized as "homosexual and bisexual" for further analysis. Access to condoms refers to how the respondent obtained condoms. Data on respondents' access to condoms were obtained through interviews using a structured questionnaire. The 10 questions with a total score of 10 were a modification of Winahyu (2016).[16] In addition, the categorization was based on a natural cut-off point formula from the total. For example, a score of ≥5 represents "easy access" and "difficult access" if the score was <5 for further analysis.

Meanwhile, fear of being infected refers to respondents' concerns about the vulnerability to STIs, using the median value of not normally distributed data. This variable was categorized into "afraid of being infected" for a score ≥ median and "not afraid" for < median in further analysis. Furthermore, social support is the assistance received from the environment, such as family, professional friends, and health workers, concerning the prevention and transmission of HIV or STIs. The determination used a median value based on normally distributed data, classifying respondents as "receive social support" for a score of ≥ median and "do not receive social support" if the score was < median for further analysis. Knowledge refers to respondents understanding of condoms and STIs, HIV, and AIDS, including the meaning, symptoms, transmission, function, and prevention. Categorization was determined for a total of 13 scores by applying a cut-off, where "high" was based on score ≥6.5 and "low" for <6.5 for further analysis.

Compliance with the use of sexual protective equipment refers to sexual relations in the last month, such as using condoms based on personal awareness or taking medication when engaging with a partner. The categorization was based on the median value due to data that were not normally distributed, classifying compliance as "comply" when the score was ≥ median or "not comply" if < median for subsequent analysis. The instrument was modified, and the validity and reliability were assessed before data collection. The data were statistically analyzed in three stages: editing, coding, and entering. The refined data were further analyzed using univariate, bivariate, and multivariate methods.

Furthermore, the first analysis was conducted to describe the characteristics and distribution of each variable: age, education level, occupation, sexual orientation, fear of infection, social support, knowledge, and compliance with the use of sexual protective equipment. In this context, bivariate statistical analysis used the Chi-square test to explore the relationship between independent variables and compliance with the use of sexual protective equipment. To determine dominant factors, a multivariate analysis was conducted using a multiple logistic regression test. The significance level of 5% was considered in the multivariate analysis, and when the p-value was <0.05, the independent variables could significantly predict compliance with the use of sexual protective equipment.

Results

This study was conducted among the MSM with an average age of 28.75 years, ranging from aged 17 to 59 years. Most respondents were self-employed (42.2%) and had completed their education at high school (52%). The results showed that 50.8% did not comply with the use of sexual protective equipment, but most MSM reported easy access to condoms (69%), and 84.4% expressed comfort in not using condoms (Table 1).

The reliability test results of knowledge, access to condoms, social support, and compliance with the use of sexual protective equipment had Cronbach's Alpha values of 0.893, 0.847, 0.827, 0.803, and 0.942, respectively. Knowledge (p-value <0.001), access to condoms (p-value <0.001), and fear of being infected (p-value <0.001) reported a significant relationship with compliance with the use of sexual protective equipment in MSM. Meanwhile, age (p-value = 0.838), education level (p-value = 0.631), sexual orientation (p-value = 0.126), and sexual support (p-value = 0.069) showed no significant relationship, as shown in Table 2.

Table 3 shows a multivariate analysis with a predictive model, showing knowledge (p-value <0.001: OR 15.753 (95% CI: 4.063 – 60.920)) as access to condoms (p-value <0.001: OR 6.188 (95% CI: 2.717 – 14.090)), and fear of being infected (p-value = 0.001: OR 3.668 (95% CI: 1.739 – 7.737)). The results showed that knowledge was the dominant variable in predicting compliance when having sexual intercourse with the partners. The MSM with poor knowledge were 15.733 and would most likely not use protective equipment.

Table 1. Demographic Characteristics Among Men Who Have Sex with Men

Variable	Frequency	Percentage (%)
Age (years)		
17-30	100	53.5
31-59	87	46.5
Age (years): Mean-Median (Minimum-Maximum)	**28.75 -27 (17-59)**	
Education		
Uneducated	2	1.1
Primary education	12	6.4
Secondary education	62	33.1
Higher education	111	59.4
Occupation		
Civil servant	1	0.5
Laborer	41	21.9
Self-employed	79	42.2
Art worker	6	3.2
Makeup Artist	11	5.9
Workers in bar/café/restaurant/hotel	21	11.3
Unemployed	23	12.3
Other	5	2.7
Sexual orientation		
Homosexual	41	21.9
Bisexual	146	78.1
Access to condoms		
Easy	129	69
Difficult	58	31
Fear of being infected		
Yes	100	53.5
No	87	46.5
Social support		
Yes	99	52.9
No	88	47.1
Knowledge		
High	139	74.3
Low	48	25.7
Compliance with the use of sexual protective equipment		
Yes	92	50.8
No	95	49.2

Table 2. Predictors of Compliance with the Use of Sexual Protective Equipment

Variable	Compliance with the Use of Sexual Protective Equipment				p-value	PR (95% CI)
	Not comply		Comply			
	n	%	n	%		
Age (years)						
17-30	48	48	52	52	0.838	0.949 (0.709-1.270)
31-59	44	50.6	43	49.4		
Education level						
High	58	52.7	52	47.3	0.631	0.910 (0.680-1.218)
Low	37	48.1	40	51.9		
Sexual orientation						
Homosexual	25	61	16	39	0.126	1.329 (0.983-1.797)
Bisexual	67	45.9	79	54.1		
Knowledge						
Low	36	92.3	3	7.7	<0.001	2.440 (1.947-3.057)
High	56	37.8	92	62.2		
Access to condoms						
Difficult	44	75.9	14	24.1	<0.001	2.039 (1.561-2.663)
Easy	48	37.2	81	62.8		
Fear of being infected						
No	55	63.2	32	36.8	0.001	1.709 (1.263-2.311)
Yes	37	37	63	63		
Social support						
No	50	56.8	38	43.2	0.069	1.339 (0.999-1.795)
Yes	42	42.4	57	57.6		

Notes: PR = prevalence ratio, CI = confidence interval

Table 3. Multivariable Logistic Regression Modeling to Assess Compliance with the Use of Sexual Protective Equipment

Risk Factors	Category	β	p-value	Adjusted PR (95% CI)
Knowledge	low	2.756	<0.001	15.733 (4.063-60.920)
	high	Reff		
Access to condoms	difficult access	1.823	<0.001	6.188 (2.717-14.090)
	easy access	Reff		
Fear of being infected	no fear	1.300	0.001	3.668 (1.739-7.737)
	fear	Reff		

Notes: PR = prevalence ratio, CI = confidence interval

Discussion

The results showed that 50.8% of MSM did not use condoms due to convenience, and this group had a high risk of transmitting STIs. In this context, preventive measures such as using protective equipment must be ensured to protect people from being infected.[17] Consistent use of condoms could enhance compliance with the use of sexual protective equipment, which was significantly related to knowledge. A study in the US also stated that the variable is related to condom skills during sexual relations.[18] Additionally, intention, confidence, and knowledge of using condoms increase with age, and according to this study, the average age was 28 years.[18] Strategies to increase condom use could be done with education-based interventions to elevate the knowledge of the target group, such as through radio campaigns and social media. Knowledge interventions could improve self-efficacy about the ability to use condoms, foster positive attitudes to condom use, and be able to overcome barriers to condom use.[19]

This study showed that more individuals aged under 30 years complied with using sexual protective equipment, unlike the ones above 30 years. The decline in condom use in both developing and developed countries occurred among the younger generation aged 15–24 years. The decline in condom use among younger generation is related to limited exposure to intense condom promotion, use of psychoactive substances, low perception of sexual satisfaction, low perception of risk of STIs, having a regular sexual partner, low perception of self-efficacy towards condoms and negotiation skills especially among women.[20,21] Therefore, comprehensive behavioral interventions are crucial to eliminate HIV by 2050.[22]

The fear of contracting HIV infection could significantly influence the MSM's compliance with the use of sexual protective equipment. This study's results showed that most MSM with fear of contracting HIV had a higher compliance than those with no fear. Risk perception has the potential to shape health behavior, necessitating the need for public health interventions.[23,24] The findings was in line with Chautrakarn *et al.* stating that more people are afraid of being infected with HIV in the adult population by 54.4%.[25] The perceptions of health challenges increase compliance in

preventing risks such as implementing safe sexual behavior, other factors include knowledge, low risk perception, and young age.[26]

MSM are a significant population group at risk of contracting STIs, which is supported by poor behaviors, such as the use of narcotics and unsafe protective equipment with partners of the same sex. Furthermore, the practice of using drugs before or during sex, known as "chemsex" or "party and play," is common among bisexuals and other MSM.[27–29] A study in the Netherlands showed that 64% of MSM had receptive anal sex without condoms, and 40% had one chemsex practice session lasting at least 12 hours.[30] In this context, the risk of HIV transmission includes a high number of sexual partners and unprotected sex with partners whose status is unknown or HIV-negative and have a detectable viral load.[28,31] MSM are one of key populations who are vulnerable to contracting HIV; therefore, it is necessary to increase awareness of this group regarding sexual protective equipment, such as condoms, knowledge of HIV, and the dangers of being infected.

Conclusion

One of the effective interventions in preventing HIV transmission through sexual intercourse is to use condoms. The contraceptive method is still highly recommended to prevent new STIs in key population groups. Access to condoms is widely available in the community and is not difficult to obtain. The MSM group's awareness of using sexual protective equipment is still low, and individuals frequently show a sense of complacency in abstaining from the use of such precautions. Therefore, intense education is given the large potential risk of infection and easy access to condoms.

Abbreviations

MSM: Men having sexual intercourse with men; HIV: human immunodeficiency virus; STIs: sexually transmitted infections; AIDS: acquired immunodeficiency syndrome; PLWHA: people living with HIV/AIDS; PR: prevalence ratio; CI: confidence interval.

Ethics Approval and Consent to Participate

This study was approved by the ethical review committee of the Faculty of Public Health Sriwijaya University with reference number 280/UN9.FKM/TU.KKE/2023.

Competing Interest

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

Availability of Data and Materials

All data and related materials from this study are available and can be provided by the first author.

Authors' Contribution

RJS designed the study, developed a data instrument for data collection analysis, and drafted the manuscript. RVS contributed to proofreading and drafting the manuscript. MNP contributed to the interpretation of results, as well as the reviewing and editing of the manuscript. Furthermore, DA contributed to proofreading and editing the manuscript, while NO assisted in data collection and analysis. Y contributed to reviewing and editing the manuscript. All co-authors reviewed and approved the final manuscript before submission.

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Analysis of Factors Affecting Hospital Risk Management in Indonesia: The SEM-PLS Approach

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Abstract

Healthcare workers, especially those in hospitals, face a variety of complex hazards and exposures. One of the essential aspects of reducing risks and dangers is effective risk management. This study used a cross-sectional approach to survey the implementation of occupational health and safety management systems in Indonesian hospitals and to identify factors predisposing hospital risk management in Indonesia. A purposive sampling method was employed to select 90 hospitals distributed across 10 provinces in Indonesia. Data were analyzed using descriptive analysis, correlation, and SEM-PLS. A total of 44 hospitals (48.9%) had complete status plenary, and the majority were type C hospitals (43.3%). The results of SEM-PLS analysis showed that the hazard and risk identification analysis and Standard Operating Procedures (SOPs) factor-variables significantly predisposed the high quality of hospital risk management in Indonesia, with path values of 0.282 and 0.469, respectively. Enhancing hospital risk management in Indonesia could be achieved by increasing the use of appropriate SOPs and conducting a thorough analysis of hazards and risk identification.

Keywords: healthcare, hospital risk management, SEM-PLS

Introduction

Healthcare services workers, especially at hospitals, face high demands in their daily working conditions. In addition to high workloads, staff shortages, and shift work, the workers have to deal with suffering patients and face death, along with pressure from family, stressful work hours, a perceived lack of appreciation and sometimes conflicts with other professions.[1,2] Workers in this sector experience physical and psychological burdens continuously, which could have an impact on their safety and health.[3] According to Wagner,[4] in the field of healthcare services, especially at hospitals, more studies have focused on the safety culture. However, in reality, many of these studies on occupational safety pay more attention to patient safety than occupational safety or even more comprehensive safety (patients, workers, and the environment). In several studies, occupational safety culture is considered ancillary to patient safety culture and does not represent the primary aspect of safety.[5–7]

The role of risk management is to enable organizational leadership to identify, analyze, and evaluate risks for modification using risk mitigation measures to a level that meets the organization's risk criteria. Organizations of all types and sizes face internal and external factors and predispose that create uncertainty about whether and when they will achieve institutional goals.[8] Previously, the assessment of the reliability of the Hospital Occupational Health and Safety Management System (Hospital OHS-MS) has been focused more on patient safety and service quality rather than risk management.[9,10]

This study explored the influence of hospital risk management variables on risk control success. While occupational health and safety (OHS) in healthcare facilities has traditionally prioritized patient safety and service quality, worker safety has often been disregarded. A study in England highlights several obstacles to implementing risk management in hospitals, such as ineffective communication, a lack of transparency and consistency, and inadequate risk assessment guidance. These challenges undermine risk management's ability to promote safety for everyone involved.[11] This study

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aimed to investigate impacts of standard compliance factors, competence, hazard and risk identification analysis, and risk management on risk management in hospitals in Indonesia.

Method

This study used a cross-sectional design with a survey method to implement the Hospital OHS-MS. A total of 90 selected hospitals participated in this study. The sample consisted of 90 hospitals across 10 provinces, including West Sumatra, South Sumatra, Lampung, Banten, West Java, Jakarta, Special Region of Yogyakarta, Central Java, East Java, and East Kalimantan. The hospital sample selection technique used a purposive sampling approach. Regional samples (10 provinces) were selected in response to a request by the Director General of Occupational Health and Sports, Indonesian Ministry of Health.

Subsequently, in collaboration with an Islamic non-governmental organization (NGO), hospitals from those 10 provinces were carefully identified to serve as representative samples. The selection criteria primarily focused on the feasibility of the Islamic NGO's regional implementation team regarding human resources. The specified criteria included hospitals of type A, B, C, and D, with status accreditation plenary, main, intermediate, and base, encompassing both government and private institutions, that are cost-effective and open to cooperation with the human resources of the Islamic NGO regional implementation team. Data collection was conducted through the distribution of pre and post-questionnaires and walkthrough inspections, followed by focus group discussions (FGD). The study took place on July-October 2022.

The research instruments and questionnaires refer to the Regulation of the Minister of Health of the Republic of Indonesia No. 66 of 2016 concerning the Hospital OHS-MS.[12] The latent variables studied in this study included compliance with exogenous variables (standards (St), competence (Ko), hazard and risk identification analysis (Hr), Standard Operational Procedure/SOP (So), and endogenous variables (hospital risk management (Mr)). Each latent variable contains indicators measured based on the Regulation of the Minister of Health of the Republic of Indonesia No. 66 of 2016. Details of each indicator for each variable are presented in Table 1.

This study examined the direct predispose and correlation of several factors on risk management with several hypotheses, as follows: (H1) There is a direct predispose of standard compliance factors on risk management; (H2) There is a direct predispose of competence factors on risk management; (H3) There is a direct predispose of hazard and risk identification on risk management; (H4) There is a direct predispose of risk management factors on risk management; (H5) There is a correlation between each pair of standards compliance factors, competence, hazard and risk identification analysis, and SOPs (Figure 1a).

Data was collected at 90 hospitals in Indonesia, including both public and private hospitals, with type A, B, C, and D hospital standards and plenary, primary, intermediate, and basic accreditation categories. The participants in this study were hospital staff specifically tasked with implementing and overseeing the OHS-MS at the hospital, encompassing the individual who holds the position of authority or leadership within the OHS-MS unit or committee. Data collection was acquired by administering pre- and post-questionnaires, then continued with an inspection walkthrough. The FGD was attended by the top management and shareholders of the hospital.

Hospital risk management is defined as the application of hospital risk management, including identifying, analyzing, and eliminating hazards and/or mitigating to an acceptable or tolerable level of hazards and subsequent risks that could threaten the organization's continuity.[13] Commitment is defined as efforts made by the hospital management regarding safety procedures, policies, and practices,[14] of which are applied to all levels of the hospital.[15] Understanding related to hazards and risks is defined as the hospital's understanding of hazards and risks as evidenced by process management knowledge actions as well as analysis actions identifying hazards and risks.[13] Risk management is defined as a risk management system implemented based on a flow of activities, including identification of potential hazards, risk analysis, monitoring and evaluation, and risk management with trials or follow-up, including risk registers.[16]

This study used descriptive analysis, correlation, and the Structural Equation Model Partial Least Square (SEM-PLS). A descriptive analysis was conducted to determine general profiles of 90 hospitals included in this study. A correlation between exogenous latent variables was carried out to examine the direction of relationship and closeness between exogenous latent variables that predispose risk management in hospitals. Next, SEM-PLS analysis was used to determine how each standard latent variable, competence, hazard, risk identification analysis, and SOP directly affected hospital risk management. The analysis used Smart-PLS 4 statistical software (licensed).

Table 1. Exogenous and Endogenous Latent Variables and Indicators

Latent Variables	Indicator Code	Indicator
Compliance with Standards	St1	1. Does the hospital have guidelines/SOPs that regulate Hazardous and Toxic Materials and their waste under World Health Organization (WHO) and statutory regulations?
	St2	2. Are there guidelines and SOPs for safe Hazardous and Toxic Materials management?
	St3	3. Has supervision been carried out on inventory, storage, handling, and use of Hazardous and Toxic Materials?
	St4	4. Has training and Hazardous and Toxic Materials spill simulation been carried out?
	St5	5. Is there a special Hazardous and Toxic Materials storage cupboard available?
	St6	6. Is there a body watering place available if exposed to Hazardous and Toxic Materials management (body wash)?
	St7	7. Is there an eye-washer available?
	St8	8. Is Personal Protective Equipment (PPE) available, and is the use of PPE correct and by potential dangers?
	St9	9. Has sharp waste been handled (sharp containers, SOPs, special officers, etc.)
	St10	10. Has contaminated equipment been handled (sterilization, autoclave, radiology, etc.)
	St11	11. Has medical waste been handled (SOPs, trained officers, temporary waste storage area, etc.)
	St12	12. Is there proof of permits related to Water Treatment Plant, Hazardous and Toxic Materials storage (which is still valid) Incinerator/third party MOU related to Hazardous and Toxic Materials management if carried out by another party, along with transporter permits?
	St13	13. Has the Hazardous and Toxic Materials symbol been installed in places where Hazardous and Toxic Materials is found?
	St14	14. Is there proof of procurement/purchase of Hazardous and Toxic Materials accompanied by Material Safety Data Sheet (MSDS) from the supplier?
	St15	15. Does the hospital have a complete and up-to-date Hazardous and Toxic Materials and waste list under WHO and statutory regulations?
	St16	16. Has the hospital mapped risk areas for Hazardous and Toxic Materials?
Competence	Ko1	1. Is the determination of the coordinating officer (person in charge) of the Hospital OHS-MS organization based on certain qualifications?
	Ko2	2. Are members appointed to the Hospital OHS-MS organization based on certain qualifications?
	Ko3	3. Are members appointed to the Hospital OHS-MS organization based on certain qualifications?
Hazard and Risk Identification Analysis	Hr1	1. Has the hospital prepared a strategic disaster management plan (Hospital Disaster Plan)?
	Hr2	2. Has the hospital identified major internal and external disasters (Condition Risk Analysis) that may occur in the community?
	Hr3	3. Has the hospital carried out a self-assessment of readiness to face emergencies using the HSI (Hospital Safety Index) from WHO?
	Hr4	4. Does the hospital have an emergency room and a decontamination room that complies with statutory regulations?
	Hr5	5. Has the hospital carried out a hazard vulnerability analysis (HVA) in the hospital?
	Hr6	6. Has the Hospital made efforts to control emergency conditions in the form of forming an emergency and disaster response team?
SOPs	So1	1. Does the hospital have documented rules/regulations/SOPs related to the management of support systems (infrastructure)?
	So2	2. Are there SOPs for contractors, suppliers, patient visitors, patient introducers, guests, and other parties?
	So3	3. Are there any guidelines and SOPs related to fire safety?
	So4	4. Does the hospital have guidelines/SOPs that regulate Hazardous and Toxic Materials and waste under WHO and statutory regulations?
	So5	5. Has sharp waste been handled (sharp containers, SOPs, special officers, etc.)
	So6	6. Has medical waste been handled (SOPs, trained officers, garbage disposal, etc.)
	So7	7. Are there guidelines and SOPs for safe Hazardous and Toxic Materials management?
	So8	8. Does the hospital have regulations/rules/SOPs regarding Hospital OHS-MS recording and reporting?
	So9	9. Does the hospital have guidelines/SOPs regarding emergency response?
	So10	10. Is there a Spill Management program (SOPs, spill kit, trained officers)?
	So11	11. Have you ensured that there is a SOP?
Risk management	Mr1	1. Is there a program regarding the management of work safety in hospitals?
	Mr2	2. Is there a program for managing security in hospitals?
	Mr3	3. Is there a work unit that is responsible for work safety?
	Mr4	4. Is there a work unit responsible for security?
	Mr5	5. Are there any guidelines/SOPs regarding providing identity to waiters, visitors, staff, and all third parties who work in the Hospital?
	Mr6	6. Has the hospital carried out regular inspections/checks of facilities, made improvement plans, and carried out repairs?
	Mr7	7. Has the hospital mapped risk areas for possible accidents and security disturbances?
	Mr8	8. Has the hospital installed CCTV monitors in safety and security risk areas?
	Mr9	9. Is there a Lock Out Tag Out (LOTO) Procedure?
	Mr10	10. Is there SOPs sign and label for work safety and security?

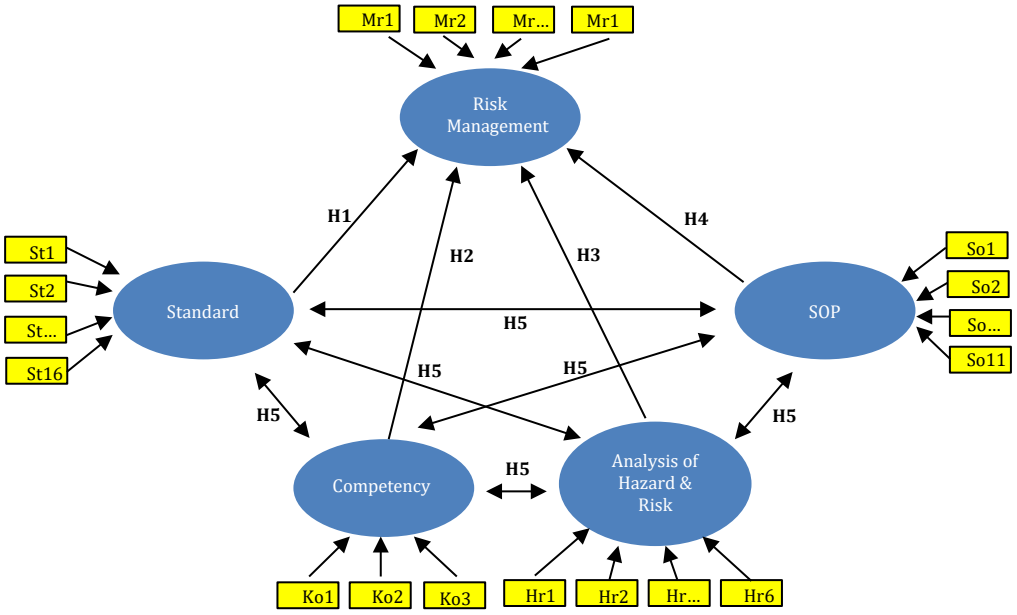

Figure 1a. Conceptual Framework

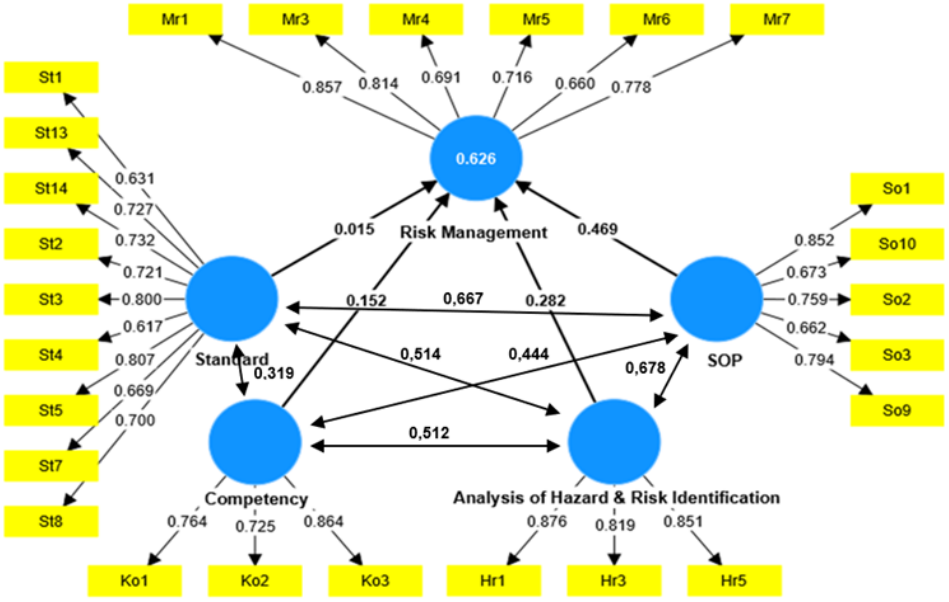

Figure 1b. Final Model of Factors that Affecting Hospital Risk Management in Indonesia

Many researchers are interested in the SEM-PLS method as it lets them estimate complicated models with many indicators and structural paths without assuming that the data is distributed in a certain way.[17,18] It could also be used with smaller sample sizes with higher coefficient values. The minimum path expected to be significant is between 0.21 and 0.3 at a significance level of 5%, which is 69 samples.[19]

Evaluation of reflective measurement model is the first step in using the SEM-PLS for analysis, then evaluation of the structural model. In assessing the reflective measurement model, the first step is to evaluate the reliability of the indicators for each latent variable in which the loading factor value is above 0.708. The indicator values could be considered between 0.4 and 0.708 as long as they meet the internal criteria of reliability, consistency, or convergent validity. Then, Cronbach's alpha value between 0.6 and 0.95 was used to check the reliability consistency. Finally, use an Average Variance Extracted (AVE) value >0.5 to check the model's validity. The final stage evaluates discriminant validity using the Heterotrait-Monotrait Ratio (HTMT Ratio) correlation value criterion; the recommended value is 0.9 or 0.85. Several things need to be looked at to examine how good the SEM model is when assessing the structural model. These

are collinearity (VIF <3), adjusted R2 and R2 values (0.75, 0.50, and 0.25 are considered substantial, moderate, and weak, respectively), and Q2.[19]

Results

Most hospitals interviewed in this study were type C, with a total of 39, or 43.3%, and almost half of the total hospitals had complete accreditation status (48.9%). There were still quite a lot of hospitals with basic accreditation status (23.3%). From Table 2, information is also obtained that the number of human resources at the hospital is 476, with a very high range of 2.777.

The results in Table 3 show that the overall criteria for the goodness of the model in both reflective measurement model and structural model have been met, in which for reliability, the value of the loading factor for each indicator is in the range of 0.617 to 0.876. The Cronbach's alpha value of each latent variable ranges from 0.701 to 0.880. This model could also be valid in which the overall AVE value is >0.5, and the Heterotrait-Monotrait correlation value in Table 4 shows <0.9.

Table 5 shows a significant and positive predispose of hazard and risk identification analysis and SOPs on risk management in hospitals, with path values of 0.282 and 0.469, respectively. A correlation test was carried out between factor-variables, and all factor-variables have a positive correlation. The better the compliance with standards at the hospital, the better the competence (r = 0.319), hazard and risk identification analysis (r = 0.514), and SOPs (r = 0.667). Likewise, the better the competence, the better the analysis of hazards and risk identification (r = 0.512) and SOPs (r = 0.444). Lastly, the better the analysis of hazards and risk identification, the better the SOPs (r = 0.678).

Discussion

Based on the results of the hypothesis test (Table 5), there is no significant predispose between meeting standards and risk management, with a path coefficient value of 0.015. There were many reasons why fulfilling a standard did not have a direct predisposition to a hospital's risk management. In Figure 1b, nine selected indicators significantly measure the standard compliance variable, in which the three most dominant indicators are the availability of special Hazardous and Toxic Materials storage cabinets (loading factor = 0.807), monitoring of inventory, storage, handling, and use activities, Hazardous and Toxic Materials (loading factor = 0.8), and there is evidence of Hazardous and Toxic Materials procurement along with an MSDS from the supplier (loading factor = 0.732). If compliance with a standard has not been implemented optimally, such as compliance with basic provisions, codes, regulations, or applicable laws, weak supervision also predisposes the implementation of standards, affecting the process safety.[6,22] Hence, implementing standards is not optimal and does not affect risk management.

Competence had a positive relationship with risk management, although it was insignificant, with a path value of 0.152. This positive relationship means that the better the competence is, the tendency for aspects of hospital risk management would also be better. Process safety competence is an element of knowledge, behavioral skills, and attitudes needed to carry out work related to process safety. This component is very important in the successful implementation

Table 2. Distribution of Hospital Characteristics

Characteristic	Category	Number (n)	Percentage (%)
Hospital type*	A	9	10
	B	13	14.4
	B Special	2	2.2
	B Education	4	4.4
	C	39	43.3
	C Special	5	5.6
	D	18	20
	Total	90	100
Hospital status**	Plenary	44	48.9
	Main	17	18.9
	Intermediate	8	8.9
	Base	21	23.3
	Total	90	100
Number of hospital human resources	median [min; max]	476	[77; 2854]

Notes:

**Based on the Indonesian Ministry of Health Regulation No. 03 of 2020* [20]

***Based on the Indonesian Ministry of Health Regulation No. 12 of 2020* [21]

Table 3. Reflective Measurement and Structural Model

Latent Variable	Indicator	Reliability		Validity	VIF		R2	R2-adj	Q2
		Outer loading	Cronbach's alpha	AVE	Outer	Inner			
Standard	St1	0.631	0.880	0.510	1.441	1,914	0.626	0.608	0.617
	St13	0.727			1.728				
	St14	0.732			2.098				
	St2	0.721			2.205				
	St3	0.800			2.243				
	St4	0.617			1.63				
	St5	0.807			2.593				
	St7	0.669			1.696				
	St8	0.700			1.931				
Competence	Ko1	0.764	0.701	0.619	1.279	1,388			
	Ko2	0.725			1.422				
	Ko3	0.864			1.454				
Analysis of hazard & risk identification	Hr1	0.876	0.808	0.720	1.827	2,079			
	Hr3	0.819			1.766				
	Hr5	0.851			1.686				
Standard Operating Procedure	So1	0.852	0.807	0.565	2.151	2,656			
	So10	0.673			1.515				
	So2	0.759			1.48				
	So3	0.662			1.445				
	So9	0.794			1.727				
Risk management	Mr1	0.857	0.848	0.571	2.95	-			
	Mr3	0.814			2.401				
	Mr4	0.691			1.629				
	Mr5	0.716			1.633				
	Mr6	0.660			1.585				
	Mr7	0.778			1.821				

Table 4. Discriminant Validity

	Hr	Co	Mr	So
Analysis of Hazard and Risk Identification				
Competence	0.641			
Risk management	0.805	0.624		
Standard Operating Procedure	0.817	0.553	0.863	
Standard	0.571	0.397	0.602	0.824

Table 5. Hypothesis Test Results of Factors that Affecting Hospital Management in Indonesia and Correlation Between Factor-Variables

Hypothesis Test Results of Factors that Affecting Hospital Management in Indonesia					
Path		**Coeff**	**St. Dev**	**T-stat**	**P-value**
From	**To**				
Standard	Risk Management	0.015	0.097	0.158	0.875
Competency		0.152	0.089	1,711	0.087
Analysis of Hazard and Risk Identification		0.282	0.101	2,793	0.005*
Standard Operating Procedure		0.469	0.123	3,822	0,000*

Correlation between Factor-Variables			
Variable	**St**	**Ko**	**HR**
Standard	-		
Competency	0.319		
Analysis of Hazard and Risk Identification	0.514	0.512	
Standard Operating Procedure	0.667	0.444	0.678

of a process safety management program in the process industry at a hospital.[22] Based on significant indicators measuring the competency variable in this model, it could be said that within a 90% confidence interval, the better the determination of the coordinating officer or person in charge of the OHS-MS organization in the hospital who met the specific competence qualifications and education required, the clearer the functions and duties of the committee or installation. The hospital's OHS-MS was known, and the more precisely the person in charge of the hospital's OHS-MS organization was determined based on certain classifications or qualifications, the better the risk management would be.

Competence, collaboration, and independence are three pillars supporting effective risk management.[23] The sustainability of an organization is enhanced by including risk identification and assessment during strategy planning and

by implementing risk mitigation measures using good governance and compliance during strategy implementation. The suitability of qualifications of members appointed in the Hospital OHS-MS organization was the most dominant indicator describing the competence variable, in which the factor loading was the highest (0.864). The second highest indicator was the function and duties of the Hospital OHS-MS committee or installation (loading factor = 0.764), followed by the indicator of the suitability of qualifications of coordinating officers in the Hospital OHS-MS organization (loading factor = 0.725).

Competence can be defined as a person's ability to do certain work, and process safety competence is a competence related to inside prevention and mitigation.[23] It can be said that the ability to perform work related to process safety is determined by a person's knowledge and skills, which could be obtained through training. However, building process safety competence is more than that, as it requires establishing behaviors, attitudes, and mindsets necessary to perform process safety-related work efficiently, maintaining a chronic anxiety mentality allowing these individuals to continuously identify and solve process safety problems, and understanding the ever-changing boundaries of process safety knowledge to recognize the need for continuous improvement. Thus, process safety competency should be defined as a combination of knowledge, skills, behavior, and attitudes required to perform work related to process safety.[24] The findings of this study were consistent with a study by Majid *et al.*[25] on the impact of personnel competence on safety performance in the aviation sector, finding that airport personnel competence had a significant direct predispose on aviation safety performance of 81.8% and a significant direct predispose on safety risk management of 98.1%.

The third factor, hazard and risk identification analysis, had a positive and significant relationship to management in a hospital (path coefficient = 0.282). The better the identification of hazards and risk evaluation in a facility or hospital in all its activities, the better the implementation of risk management in the hospital. The three indicators that were the most dominant and included in the model, respectively, were that the hospital had prepared a strategic disaster management plan (hospital disaster plan), the hospital had taken an HVA, and the hospital had carried out a self-assessment analysis. Assessment of readiness to face emergencies used a Hospital Safety Index (HSI) from WHO, in which the path coefficient values were 0.876, 0.651, and 0.876, respectively. Risk assessment provides support for decision making in selecting between alternatives, accepting activities and products, and implementing risk reduction measures.[16]

The results of the HSI confirmed that hospitals needed to continue operating during a disaster, meaning it was very important to carry out regular HSI-level assessments. This study showed that the HSI scores of hospitals in Jakarta (0.766), West Java (0.673), and Special Region of Yogyakarta (0.709) provinces were in category A (scores between 0.66 and 1.00). It means that hospitals could provide services during and after a disaster. However, hospitals in the Special Region of Yogyakarta Province must improve their office and warehouse equipment and supplies, currently in category C.

On the other hand, hospitals in North Sumatra were in category B (score between 0.36 and 0.65) with a score of 0.507. Major and immediate improvements must be made to several things in terms of emergency and disaster management, which were still in category C, especially in terms of coordinating emergency and disaster management activities, hospital emergencies and disaster response and recovery planning, and communication and information management. Hospitals in category A would continue to function in emergencies and disasters. However, it is recommended that measures continue to increase emergency and disaster management capacity and that medium- and long-term measures should be taken to increase safety levels in the event of emergencies and disasters. Hospitals in Category B still have risks when facing disasters. It is recommended that all elements (structural, non-structural, and emergency disaster management) in hospitals be improved.[26] The average HSI level of the hospitals studied was B, indicating that their functional ability during and after emergencies and disasters is potentially at risk, so intervention measures are needed in the short term.[27]

Risk management is an important part of safety analysis, and hazard identification is the first step in a risk management process.[28] Hazard identification is a systematic project involving a lot of work. For effective identification purposes, hazard identification requires a participation of all workers across the institution, not departments or individuals. Hazard identification, assessment, and risk management are essential for safe and efficient industrial systems.[29] Hazard control and prevention efforts are significantly related to safety compliance, safety participation, safety motivation, and safety knowledge.[30]

According to a study in Iran,[31] several variables predispose the implementation of clinical risk management in hospitals, which are workers' understanding of risk management, policies and procedures related to risk management, training on risk management, and the position of the risk management program at the hospital. Risk identification and analysis are integral parts of risk management process.[32] This also means that if the hazard and risk analysis process is

implemented well, it will be directly proportional to the hospital's risk management quality.

The SOPs are written instructions, either in electronic or printed form, including steps related to tasks assigned and explain steps which must be carried out. In this study, the SOPs variable had a direct predisposition to risk management in hospitals, with a path value of 0.469. This coefficient value showed that SOPs were the most dominant variable in their predisposition to hospital management. A positive value means that the better the SOPs, the better the risk management aspect of the hospital will be. Good procedures also describe the process, hazards, equipment, protective equipment, and controls in sufficient detail so that operators understand the hazards, verify that the controls have been implemented, and confirm that the response process is in the intended manner.

In every work activity, SOPs must be available and easily accessed; existing SOPs must be documented, accurate, and regularly updated; and SOPs must be well maintained and enforced. In this study, the most important and dominant indicator for the SOPs variable for risk management was the presence of rules and regulations for managing supporting facilities and infrastructure systems. This indicator had the highest loading factor at 0.852. Furthermore, the second highest dominant indicator was that hospitals have SOPs related to emergency response (loading factor = 0.794), followed by the third indicator, the existence of SOPs for external parties such as contractors, suppliers, patients, visitors, patient deliverers, guests, and other external parties, with a loading factor of 0.759.

The combination of pair relationships between factor-variables (exogenous latent) had a positive relationship. This indicated that the better a factor-variable affects the goodness of other factor-variables, SOPs were a variable factor that had an important effect on good compliance with standards and high-risk and hazard identification analysis. Both show the highest correlation values in the model, respectively, 0.678 and 0.667. Due to limitations of this study, a more detailed discussion exhaustively analyzes a complex relationship between endogenous and exogenous variables, such as how standards and risk management interact through competence and SOPs. However, this topic deserves a comprehensive discussion in the future to shed more light on the subject.

Conclusion

This study finds SOPs to be the main element that positively influences risk management in Indonesian hospitals. Effectively-executed SOPs are strongly associated with high standards of hazard and risk identification studies conducted at hospitals. Increasing the quantity of hospital samples in Indonesia is recommended for future studies to make them more representative. Apart from interventions with factors that dominate risk management, integrating the Hospital OHS-MS with patient safety can be an alternative to boost the program.

Abbreviations

OHS-MS: Occupational Health and Safety Management System; OHS: Occupational Health and Safety; FGD: focus group discussion; SOPs: Standard Operating Procedures; SEM-PLS: Structural Equation Model Partial Least Square; WHO: World Health Organization; PPE: personal protective equipment; MSDS: Material Safety Data Sheet; HVA: hazard vulnerability analysis; HSI: Hospital Safety Index

Ethics Approval and Consent to Participate

This study has received ethical approval from the Research Ethics Commission, Faculty of Public Health, Muhammadiyah University, Jakarta, with Ethical Review Number 10.015.C/KEPK-FKMUMJ/I/2024.

Competing Interest

The authors stated that no ethical issues arose after the publication of the manuscript.

Availability of Data and Materials

This study used secondary data that can be accessed with permission from PP Aisyiyah Muhammadiyah.

Authors' Contribution

DD conceptualized and designed the study, collected data, and analyzed and interpreted the results. FM guided data analysis, review, and manuscript approval. BW provided the latest research literature, prepared and reviewed draft manuscripts. BB analyzed, interpreted the result, and reviewed it.

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Performance of Stunting Reduction Acceleration Team: An Explorative-Qualitative Study in Indonesia-Timor Leste Border Area

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Abstract

Stunting is a complex issue influenced by multiple factors, including specific factors within and outside the health sector. Achieving a significant reduction in stunting needs the involvement of relevant local government offices in the Stunting Reduction Acceleration Team (SRAT). This study aimed to investigate SRAT performance in a specific context of accelerating stunting reduction in Malaka District. This qualitative study, with a phenomenological approach, was conducted in Malaka District, Indonesia, and Timor Leste Border Area from July to September 2023. This study revealed four major themes of SRAT performance to accelerate stunting reduction in Malaka District: activities to accelerate stunting reduction, challenges faced in implementing the programs, supporting factors for program implementation, and alternative activities initiated by the local government. This study showed that the many local government agencies responsible for specific and sensitive interventions have effectively fulfilled their mandatories and roles in accelerating the elimination of stunting in Malaka District. However, inadequate internal coordination within SRAT has led to a dearth of harmonization in its execution.

Keywords: border area, stunting, Stunting Reduction Acceleration Team

Introduction

Stunting prevalence among toddlers is a significant public health concern in Indonesia.[1] Based on the 2022 Indonesian Nutritional Status Survey (INSS), the prevalence of stunting in Indonesia was 21.6%.[2] According to multiple national health research datasets, East Nusa Tenggara (ENT) Province has consistently ranked the highest frequency of stunting in Indonesia since 2013.[2–5] Specifically, the province's prevalence of stunting is 36.3%, encompassing all the provincial districts and cities, including Malaka District.[2] Stunting data by Malaka District Government reveals a decline in prevalence from 2019 to 2022: 32.2%, 26.2%, 21.5%, and 15.8%, respectively.[2,5] However, it is imperative to persist with diverse initiatives to reach a target of a 14% reduction in emissions by 2024.[1] Stunting evidently has detrimental effects on a child developmental trajectory, manifesting in a range of adverse consequences, including impairments in cognitive growth, diminished learning capacities,[6] and the potential for enduring metabolic problems such as diabetes, hypertension, and obesity.[7] Numerous interventions, encompassing health and cross-sectoral interventions, have been implemented, yet stunting is a significant concern at both national and regional levels.

The Central Government commits to reducing the prevalence of stunting by implementing Presidential Regulation No. 72 of 2021, which focuses on accelerating the decrease of stunting. This regulation serves as the overarching legal framework for all the national strategies aimed at accelerating stunting rate reduction and achieving the 14% target of reduction by 2024.[1] The Presidential Regulation also functions as a reorganizational measure to accelerate the national stunting reduction by implementing a family-based intervention approach involving the local government's role in safeguarding families at risk of stunting. The Malaka District Government established a Stunting Reduction Acceleration Team (SRAT) within Malaka Regent Decree No. 110/HK/2022 to supervise the implementation of the presidential decree.[8] The Malaka District SRAT employs several officers at the local government to address stunting through specific and sensitive intervention services. The formed SRAT coordinates, synchronizes, and facilitates assistance to reduce stunting at the district, subdistrict, and village/urban village levels.

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Stunting is a complex issue for multiple factors, including specific factors in and out of health sector. To achieve a significant reduction in stunting, relevant local government offices are required to involve in the SRAT to effectively perform their duties in implementing various technical programs aimed at accelerating stunting reduction in Malaka District. The local government responds to the national strategy to accelerate stunting reduction by establishing a district-level SRAT and implementing several derivative regulations. However, evaluation of the implementation of those regulations should be taken within a structured research framework according to situations described in this study.

Previous studies found that SRAT is evidently efficacious in mitigating the stunting prevalence at subdistrict level. This positive outcome is attributed to collaborative efforts of multiple stakeholders, including nutrition officers at primary health care, village midwives, integrated health care (IHC) cadres, and supplementary feeding (SF) cadres.[9–11] Another study also examined the efficacy of local government initiatives, such as the SRAT implementation and other intervention programs to accelerate stunting rate reduction.[12] However, studies of duties and performance of regional technical organizations responsible for overcoming stunting, which includes specific and sensitive services, have not been researched at the district level, especially in Malaka District.

This study provides sequential and comprehensive data and information. It builds upon the findings of a previous general situation analysis on the acceleration of stunting reduction in Malaka District. The results of this analysis were derived from a higher education assistance program implemented in Malaka District, as mandated by the Deputy for Population Control at the National Population and Family Planning Agency No. 5/KEP.DALDUK/D2/2022.[13] This program established an Implementation Team for Higher Education Assistance, specifically aimed at accelerating stunting reduction in districts and cities within ENT Province in 2022.

The significance of this study is that findings on SRAT performance can serve as a valuable contribution to the Malaka District Government. This, in turn, can facilitate the implementation of corrective measures. This initiative is to optimize effectiveness of SRAT in implementing several programs aimed at accelerating the stunting reduction. SRAT performance assessment then should regularly be done to determine effectiveness of efforts to implement policies for acceleration in stunting reduction and achievement in predetermined national reduction targets. Therefore, this study aimed to investigate the SRAT performance in the context of accelerating stunting reduction in Malaka District.

Method

This qualitative study, using a phenomenological approach, was conducted to comprehend the district-level SRAT performance in facilitating the decrease of stunting in Malaka District, as well as many influential elements of this process. The phenomenological approach was applied by exploring experience of each participant in implementing stunting reduction program. This study took place in Malaka District, the border region of Indonesia and Timor Leste, during July to September 2023.

The study procedure commenced by initiating an application for ethical review to guarantee adherence to ethical principles governing health research. Subsequently, preliminary investigation into the constitution of SRAT following the most recent legislation enacted in 2023 had been carried out. Furthermore, an interview guide was created in the form of a formulation of the problem to be investigated and data collected from the purposively-selected informants. The study participants voluntarily participated after filling out an informed consent consisting of information sheet and consent form. A total of nine informants came from Health, Women's Empowerment and Child Protection, Population Control and Family Planning, Agriculture, Food Security and Fisheries, Public Works and Public Housing, Village Community Empowerment, Information and Communication, and Regional Planning, Research and Development Offices with duties of specific and sensitive intervention service programs related to stunting reduction in Malaka District.

The reliability and credibility of qualitative data were assessed by member checking and theoretical triangulation techniques. Member checking was done during the interview process and at the end of the session by asking informants for feedback about the response which had been conveyed. Theoretical triangulation was applied by using various theories to explain and reveal the unique discovery of this study.

The data-gathering methods employed in this study encompassed formal interviews and examination of secondary data sources. The study took structured interviews, by applying an interview guide, to gather data on the implementation of programs and activities and to identify elements facilitating or hindering the implementation. Additionally, the study carried out a secondary data analysis consisting of exact underpinning data related to each implemented program and

activity, from each office to be examined. Subsequently, the data obtained from the structured interviews underwent processing and analysis through qualitative data analysis techniques to categorize themes based on relevant keywords.

Results

Table 1. Thematic Analysis Result

Topics	Subtopic	Description
Specific Intervention	Activity	a. Anemia screening and giving blood supplement tablets to adolescent girls b. Health education and provision of iron supplementation for prospective brides and grooms who take pre-wedding courses c. Supplementation feeding for malnourished toddlers d. Nutritional actions at school (counseling about the contents of my plate/*isi piringku* activity, exercise, and breakfast together) e. SF for pregnant women with CES f. Requiring pregnant women to have an ultrasound twice during pregnancy g. Postpartum visits (home visits)
	Supporting factor	a. Direct FWE involvement in IHC activities b. The ENT Governor's policy is to add Moringa powder for SF in toddlers
	Obstacle factor	a. Malnourished toddler refuses to be referred to Therapeutic Feeding Center b. Unavailability of diet formula for malnourished toddlers for outpatient services c. Lack of public awareness d. Lack of MCH books e. Lack of ultrasound equipment in community health centers f. Lack of obstetricians for emergency maternal referral services
	Alternative program	2H2 (2 days after delivery) Center
Sensitive Intervention	Activity	**a. Village Community Empowerment Office** Coordination and monitoring of the use of 30% of village funds for handling stunting **b. Communication and Information Office** Publication of activities related to stunting **c. Social Office** 1) Providing information to beneficiary families through FHP assistants 2) Monitoring FHP companion activities 3) Outreach of the use of social assistance **d. Food Security and Fisheries Office** 1) Providing food assistance in the form of rice (10 kg), frozen chicken, 1 kg eggs (10 pieces), and fish for stunted children in 127 villages 2) Formation of a Sustainable Food Patterns group 3) Providing fish seeds to communities in coastal areas e. **Agriculture Office** 1) Provision of 14.175 tons of rice seeds to be planted on 567 hectares of land spread across 7 villages (funding source: general allocation funds) 2) Provision of 7.85 tons of rice seeds to be planted on 227 hectares of land in 7 villages in Malaka District (funding source: state budget) 3) Assistance to farmer groups by placing 1 P2L (a community program) person in each village **f. Public Works and Public Housing Office** 1) Provision of hygienic water in 4 villages with a total of 820 house connections in 2022; providing clean water in 6 villages with a total of 850 house connections by 2023 2) Sanitation assistance would be provided through the provision of toilets in 1 village with a total of 95 units in 2022; in 2023, it was provided to 9 villages with a total of 684 units. **g. Population Control and Family Planning Office** 1) Organizing stunting convergence actions 1, 2, 3 for cross sectors 2) Heath education regarding stunting 3) Providing a stunting kit containing educational games 4) Contraceptive preparation **h. Regional Planning, Research and Development Office** 1) Carrying out the SRAT coordination function 2) Organizing 8 stunting convergence actions
	Supporting Factors	**a. Village Community Empowerment Office** 1) Helped by the existence of NGOs and their programs 2) Budget support in monitoring safety, hygiene, and happiness/*3K* program **b. Social Office** 1) Helped by having a FHP companion **c. Food Security and Fisheries Office** 1) Assistance from the Regional House of Representatives aspiration funds 2) Provision of fish seeds from the Regent 3) Helped by the existence of agricultural instructors in each village **d. Agriculture Office** 1) Assistance to field agricultural instructors in each village

Topics	Subtopic	Description
		2) Strengthening the Moringa commodity by the Provincial Government as an addition to complete SF for stunted children
		e. Public Works and Public Housing Office
		1) There is assistance in every activity
		2) Intervention from the province in terms of providing hygienic water
		f. Population Control and Family Planning Office
		1) FA Team in each village
		2) Cadres and FA Team mobilize the community and help cross-sector coordination
		g. Regional Planning, Research and Development Office
		1) NGOs involvement
		2) District regulation to allocate 30% of village funds to accelerate stunting reduction
	Obstacle Factors	**a. Village Community and Empowerment Office**
		1) Activities have not run smoothly because of sectoral ego
		2) Political dynamics cause changes in health cadres
		3) There is no detailed report on the use of 30% of village funds for stunting
		4) It is not yet certain whether the SF is on target or not
		5) Empowerment of village communities is still lacking
		6) There are children who are not weighed because of family matters in another city
		b. Communication and Information Office
		1) Lack of programmers
		2) Facilities are inadequate
		3) Budget limitation
		c. Social Office
		1) Budget limitation
		2) Lack of FHP assistance staff in the large assistance area
		3) Barriers to updating data due to unavailability of budget and human resources
		d. Food Security and Fisheries Office
		1) Budget limitation
		2) Transportation costs related to procuring seeds from outside Malaka District
		e. Agriculture Office
		1) Budget limitation
		2) Obstacles in planning and difficulties in intervention in stunting locus villages due to delays in the first action of stunting convergence actions
		f. Public Works and Public Housing Office
		The remote location and steep terrain slow down the mobilization of goods
		g. Population Control and Family Planning Office
		Budget limitations hamper the implementation of convergence actions to accelerate stunting reduction
		h. Regional Planning, Research and Development Office
		1) The SRAT internal meeting has not yet been held
		2) There is no technical guidance regarding the foster parent program
		3) There is no good coordination between teams in SRAT
	Alternative programs	a. the domains of gardening, animal confinement, and aquatic facilities/*3K* Program
		b. Foster parent/*orang tua asuh* program
		c. Use of Moringa powder in all SF for stunted children

Notes: SF = supplementary feeding, CES = chronic energy shortage, FWE = Family Welfare Empowerment, IHC = integrated health care, ENT = East Nusa Tenggara, MCH = maternal and child health, FHP = Family Hope Program, SRAT = Stunting Reduction Acceleration Team, NGO = non-governmental organization, FA = family assistance.

This study's findings indicated that actions to accelerate stunting reduction encompassed two categories: targeted intervention services and sensitive intervention services. Intervention service activities refer to specific actions directly contributing to stunting management. The emphasis of accelerating the reduction is placed on prioritizing interventions during the first 1,000 days of life. Nevertheless, in Malaka District, targeted intervention services have been implemented to cater to the needs of adolescent girls and school children.

The Health Office provided some targeted intervention services for various demographic groups. These services encompass a range of activities to address the health needs of young women, pregnant women, postpartum mothers, infants, toddlers, and school children. The implemented interventions encompass anemia screening and administration of iron supplementation tablets to female adolescents; dissemination of health education and provision of premarital counseling services, including the provision of tetanus toxoid vaccination for individuals participating in wedding preparation courses; provision of therapeutic feeding for undernourished toddlers; implementation of nutritional interventions within educational settings, including counseling on dietary composition, physical exercise, and breakfast consumption; implementation of therapeutic feeding for pregnant women with acute malnutrition; mandatory biweekly ultrasound examinations for pregnant women; and conducting postpartum home visits.

Discussion

Specific Intervention Services

Iron supplementation tablet interventions and screening for anemia among female adolescents were implemented as a preventive measure against stunting in offspring during their childhood. The significance of such endeavor in Malaka District, which is close to the border, lies in the fact that a substantial number of young ladies opt to enter into matrimony after completing secondary education. Iron supplementation tablet administration has been empirically demonstrated to effectively mitigate the occurrence of anemia among female adolescents.[14] The implementation of anemia screening and provision of iron supplementation tablets to young women was a proactive measure to equip them for a safe pregnancy in subsequent years. Previous studies have established a correlation between anemia in female adolescents and the occurrence of anemia during pregnancy, resulting in adverse outcomes for both the mother and the newborn, including stunted growth.[15,16]

Furthermore, guidelines for preventing stunting were provided to individuals about to get married. This intervention was administered when individuals planning to get married participated in a sequence of pre-marriage courses a church served. The initiatives encompassed health education and the provision of iron supplementation tablets. The provision of health education during pre-wedding period was expected to elevate knowledge and awareness of the soon-to-be bride and groom on necessary preparations for a healthy pregnancy phase, as well as the effective measures to avoid stunting among under-five children.[17]

In addition, achieving a healthy pregnancy could be facilitated by effective collaboration between partners to ensure sufficient nutrition during pregnancy and jointly make informed decisions on their health circumstances. Conversely, a deficiency in comprehension will lead to a deficiency in attentiveness toward the partner's gestation state, thus yielding adverse consequences for both the maternal figure and the offspring. To safeguard well-being of the soon-to-be bride and groom, they were provided with health education and iron supplementation tablets. These measures aimed to address nutritional requirements of their bodies and prepare prospective mothers for pregnancy to prevent anemia during gestation. The efficacy of iron supplementation tablets in mitigating the prevalence of stunting among the under-five had been substantiated.[18,19]

Previous studies have stated that implementing interventions during the preconception phase might effectively mitigate the incidence of stunting.[20,21] Nevertheless, available premarital intervention in Malaka District was restricted to individuals engaged in premarital courses, specifically targeting the soon-to-be brides and grooms. To mitigate adverse consequences, the FA team has implemented a data collection procedure at village level to vet those soon-to-be brides and grooms. This intervention aimed to provide them with the necessary knowledge and skills to navigate a successful pregnancy. To note, some individuals had previously had children before enrolling in premarital classes at the church.

The subsequent intervention entailed the provision of supplementary nutrition for 90 days to pregnant women diagnosed with chronic energy shortage. Technical guidelines guided the SF administration and consider the individual's dietary requirements. The SF was prepared by healthcare personnel in accordance with technical guidelines. The SF implementation was anticipated to enhance the nutritional well-being of expectant mothers, thus facilitating optimal fetal growth within the womb. Consequently, mothers were more likely to deliver infants with favorable nutritional status, including adherence to established standards for body length.

Unfavorable pregnancy conditions could significantly contribute to problems for both the fetus and the mother, ultimately impacting the long-term health status of infant.[22] During the program implementation, several challenges were encountered. A notable obstacle was the present SF recipients who did not avail themselves of the opportunity to receive additional food. Consequently, the cooking team visited each recipient's residence to provide the SF. However, it was worth noting that the food delivery was not facilitated by the village office or supported by funding from the health center.

Pregnant women were typically advised to receive a minimum of six prenatal check-ups, encompassing various assessments and examinations, including at least two instances of ultrasound imaging throughout the course of their pregnancy. This condition aligned with protocols established by Indonesian Ministry of Health of the guidelines for prenatal healthcare.[23] The primary objective of pregnancy ultrasonography, following established guidelines, is to take a comprehensive assessment for potential complications during pregnancy, such as intrauterine growth restriction. The timely identification of the issue enables implementation of suitable preventive measures, thus facilitating the delivery of a newborn with a typical body length. The most influential factor in determining growth status throughout the initial two years of life is the body length at birth.[24]

The provision of pregnancy services in Malaka District continues to face obstacles for the absent maternal and child handbooks at 20 Primary Health Cares. This issue arose from deficiencies in procurement systems at Indonesian Ministry of Health. Moreover, in 2022, three ultrasound devices would be accessible exclusively within three designated healthcare facilities. Consequently, this limited availability was anticipated to impede the ultrasound service provision, typically recommended to be administered twice throughout course of a pregnancy. A subsequent challenge pertains to insufficient obstetricians, necessitating a redirection of emergency maternal referral services to hospitals situated beyond the confines of Malaka District.

Health services were delivered through home visits throughout postpartum period. Malaka District, located in the Indonesia-Timor Leste border, is characterized by a strong preservation of cultural customs, particularly those related to the postpartum period. According to findings, postpartum mothers were typically advised to refrain from leaving their residence for 40 days following childbirth. The circumstances above significantly influenced inadequate provision of postpartum services that ought to be received. Nevertheless, healthcare professionals did home visits to assess health conditions of both mothers and newborns.

A strategy to accelerate the decline of stunting in newborns and toddlers is SF provision. The Malaka District's primary objective is to prioritize interventions to mitigate stunting and reduce the stunting prevalence. This entails shifting a focus of Public Nutrition Program from exclusively targeting stunted infants to encompassing malnourished toddlers, regardless of their stunting status. This intervention is to mitigate the incidence of chronic malnutrition, which could ultimately lead to stunted growth. The local food-based SF is implemented in accordance with the technical criteria for the provision of local SF, specifically focusing on the utilization of the ENT moringa powder by 2023.[25]

Moringa powder, derived from the plant species Moringa oleifera, and its many preparations have been found to possess potential therapeutic properties for addressing stunting.[26,27] A prior longitudinal investigation demonstrated a positive correlation between SF and children's body length and height enhancement.[28,29] Within its execution, there existed groups of undernourished young children whose families decline to be directed to the Therapeutic Feeding Center for financial constraints related to lodging and sustenance for accompanying family members. Consequently, these children receive treatment for malnutrition via outpatient care. However, an additional challenge arises in the form of limited access to necessary resources. The development of a diet for outpatient treatment involves the responsibility of family to provide the necessary ingredients, which are then further developed by a nutritionist.

Interventions pertaining to the stunting issue are also implemented during the school-age period. Prior study findings indicate a significant impact of nutritious dietary intake in mitigating stunting among school children.[30,31] Furthermore, engaging in group exercise activities and promoting communal meals in educational institutions could assist parents in safeguarding their children's nutritional well-being during periods of limited supervision. Ensuring sufficient nutritional intake during the school day has a potential to lift up children's physical activity levels and cognitive performance.[18]

Sensitive Intervention Services

Sensitive intervention services encompass a range of activities with an indirect association with stunting phenomenon. Non-health interventions, such as providing nutritious food, social assistance, hygienic water and environmental sanitation, regulation of pregnancy spacing and the number of children, and coordination within the team to accelerate stunting reduction, are typically sensitive interventions.

The Central Government has restricted the utilization of local finances for initiatives for the acceleration program. The responsibility for coordinating and monitoring the allocation of 30% of village revenues towards addressing stunting lies with Malaka District Government, overseen by the Village Community and Empowerment Office. According to Village Minister Regulation Number 7 of 2021, a stipulation mandates allocating 30% of village funds towards various initiatives. These initiatives included the construction or renovation of village maternity huts, IHC, contractual agreements with village health workers such as midwives and other healthcare professionals, SF provision, the establishment of sanitary facilities and access to hygienic water, training, and guidance for community health cadres, provision of incentives for these cadres, and the development of roads leading to healthcare facilities. According to this regulation, villages in Malaka District were assigned several responsibilities, including establishing a decree for a monitoring team responsible for weighing operations, organizing cross-sector meetings to prepare for the weighing operation, relocating targets during the weighing process, overseeing weighing activities at the IHC in collaboration with cadres, conducting visits to

individuals who fail to attend the weighing sessions, promoting awareness of the *3K* program (pertaining to gardening, animal husbandry, and fish farming), and formulating village regulations restricting families with infants or pregnant women from undertaking prolonged travel outside the designated area.

The local government demonstrates a commendable response to regulations imposed by the Central Government. This has been achieved by establishing derivative regulations specifically governing the utilization of village finances. Nevertheless, the precise allocation and utilization of 30% of village funding for addressing the issue of stunting in rural areas remains uncertain, mostly due to inadequate communications and coordination mechanisms. The existing sectoral ego has hindered an optimal implementation of intervention efforts in rural areas. One persistent challenge which continues to face is absent adequate monitoring and evaluation mechanisms, resulting in the suboptimal implementation of novel initiatives like the utilization of 'Foster Parents' program for stunted children. Besides, many political factors in Malaka District has led to alterations in the composition of qualified health personnel.

To date, the local governing body has taken measures to address the issue of malnourished children by offering supplementary food assistance. This study's findings indicated variations in the duration of SF provision observed in two villages of Malaka District. Nevertheless, the present non-governmental organizations (NGOs) implementing programs at village level also plays a role in facilitating interventions indirectly contributing to the stunting mitigation in rural areas. The Food Security and Fisheries Office may facilitate stunting management through indirect measures such as providing food aid. Such activity involves providing some food assistance in the forms of essential commodities, including rice, frozen poultry, eggs, and fish. The challenges were mostly associated with financial constraints, resulting in providing food aid on a single occasion.

Apart from providing food assistance, a Sustainable Food Patterns initiative exist to specifically support families at risk of stunting. These activities are designed to cater to households including infants, toddlers, pregnant mothers, and stunted children. The family members susceptible to experiencing stunting are thereafter assembled into a collective unit and provided with instruction by agricultural educators. The arising limitations are associated with financial limitations of the project since it is sponsored by the ENT Provincial Government.

Consequently, the progress of the project cannot be predetermined, as it is contingent upon the availability of funds and potential transfers from the ENT Provincial Government. Nevertheless, there exist other corroborating elements that contribute to the indirect management of stunting. Several supportive factors can be identified, such as the provision of fish seed aid through the aspiration funds of the RRC and the provision of seeds by the Head of Malaka District. In addition, the community benefits from the presence of field agricultural instructors stationed in each village, who play a crucial role in disseminating knowledge of effective planting methodologies.

To overcome the situation, targeted interventions in the form of food assistance were implemented in collaboration with the Agriculture Office. A total of 14.175 tons of rice seeds was allocated for cultivation on 567 hectares of land across seven villages in Malaka District. These seeds were sourced from general allocation funds. Additionally, 7.85 tons of rice seeds was provided for cultivation on 227 hectares of land in the same seven villages, sourced from the state budget. In addition, farmer groups are supported by field agricultural instructors strategically deployed in each village, ensuring that each community had one instructor assigned.

Nevertheless, certain challenges hinder a complete implementation of this initiative in villages affected by stunting. The occurrence can be attributed to Malaka District's delayed implementation of the first stunting convergence action measures in 2023, posing challenges in delivering interventions in communities with a high prevalence of stunting. The delay above resulted in the Agriculture Office proceeding with activity planning without consulting the stunting locus communities. This should have been included in the first stunting convergence action, that is a situation analysis. Numerous actions have been taken to surmount the diverse challenges, encompassing the reinforcement of support at the village level by deploying field agriculture instructors in each village. This initiative aims to achieve a planting realization rate of 100%. Apart from that, the direction of the Governor of NTT Province regarding increasing Moringa commodities as a complementary effort to Integrated SF also aims to increase nutritional intake for malnourished children.

Stunting is a physiological state characterized by impaired growth resulting from prolonged malnutrition, primarily caused by insufficient nutrient consumption or recurrent illnesses. To mitigate the incidence of diseases among children, it is imperative to implement intervention measures encompassing provision of hygienic water and sanitation facilities. The Public Works and Public Housing Office enforces initiatives to address stunting by facilitating the provision of hygienic water in four villages, encompassing 820 house connections, in 2022. Additionally, hygienic water installation would be provided in six villages, totaling 850 house connections, in 2023.

Furthermore, efforts to improve sanitation would made through the provision of 95 units of toilet in one village in 2022. Subsequently, in 2023, sanitation assistance was extended to nine villages, comprising a total of 684 units. Access to hygienic water is essential for producing nutritious food in domestic settings. The provision of uncontaminated water facilitates the ability of individuals to make nutritious meals for their households, particularly for infants and young children. Additionally, it enables hand hygiene practice before and after meals, reducing the risk of contracting infectious ailments such as diarrhea among toddlers. Even though the provision of hygienic water has not yet been extended to all villages affected by stunting, the ENT Provincial government has implemented further interventions to further enhance the coverage of house connections in villages of Malaka District.

As per the directives of the Indonesian President, the responsibility of accelerating the stunting reduction has been assigned to the National Population and Family Planning Office. At the regional level, specifically in Malaka District, the Women's Empowerment and Child Protection Office assumes the role of implementing secretary for the SRAT established in accordance with the Decree of the Head of Malaka District Number 110/HK/2022 pertaining to SRAT in Malaka District. The Women's Empowerment and Child Protection Office is responsible for overseeing and coordinating various programs to accelerate the stunting reduction in Malaka District as part of its secretarial duties.

The Family Planning Office conducts internal activities, such as health education (HE) aimed at addressing stunting in rural communities. These interventions are implemented through IHC programs, directly engaging with the target population. The HE provision is facilitated by family planning counselors. The challenges under the initiatives due to financial constraints have resulted in the inability of HE to extend its outreach to the people residing in 127 villages of Malaka District. Nevertheless, it is anticipated that the present family assistance team at the local level would facilitate a dissemination of information to the respective communities under their jurisdiction. In addition to the HE, the Women's Empowerment and Child Protection Office is currently preparing for weighing operations and the distribution of stunting kits including educational games. However, as per the technical instructions, this distribution is currently restricted to Family Planning Communities.

The prevention of stunting is also achieved by implementing measures to control inter-pregnancy intervals and size of families. Concerning this matter, the Women's Empowerment and Child Protection Office makes arrangements for the provision of contraceptives to individuals classified as reproductive-age couples. The stunting management is indirectly influenced by pregnancy spacing and total of children. During the gestational period, women undergo hemodilution, a process leading to physiological anemia. The restoration of this condition is recommended during postpartum period; however, if subsequent pregnancies occur in close succession, there is an increased chance for the mother to have recurrent anemia. This syndrome leads to inadequate fetal nutrition, resulting in impaired intrauterine growth and the possibility of postnatal stunting in the child.

Furthermore, the Women's Empowerment and Child Protection Office also facilitates cross-sectoral operations through convergence actions to accelerate stunting reduction. As of August 2023, the third stunting convergence action has been successfully taken. Such initiative was delayed for financial constraints. Less reach of the series of interventions in villages of Malaka District hinders their effectiveness in addressing stunting in targeted areas.

The responsibility of coordinating cross-sector efforts falls within the purview of the Regional Planning, Research and Development Office, serving as a coordinator for the working group's initiatives for the stunting reduction acceleration in Malaka District.[8] The findings revealed their efforts to do the reduction in Malaka District. However, there had been poor cooperation in the team, as evidenced by the absent internal meetings of SRAT. This syndrome results in suboptimal coordination among the local government agencies, leading to a lack of consolidation in their actions.

The Malaka District Government has implemented many local initiatives, such as the 2H2 center program to accelerate stunting reduction. This intervention is to monitor pregnant individuals within a two-day period before and after giving birth. The ultimate objective of the 2H2 Center Program is to mitigate the incidence of maternal mortality in Malaka District. The subsequent pioneering endeavor is the *3K* program, encompassing domains of gardening, animal confinement, and aquatic facilities. The primary objective of this initiative is to improve the capacity of vulnerable families susceptible to stunting, enabling them to meet their nutritional requirements through the utilization of self-accessible gardens and ponds.

The program implementation involves diverse officers responsible for different aspects. These include the agricultural, food security and fisheries, Village Community Empowerment, and FWE services, as well as the active participation of NGOs. Also, a program has been established to support caregivers of stunted children. This initiative has

been mutually agreed upon and is outlined in the roadmap and regional action plan aimed at reducing the prevalence of stunting, maternal mortality rate, and infant mortality rate in Malaka District from 2022 to 2026.[32] The lack of specific indicators and intervention strategies for children with stunted growth has resulted in suboptimal implementation of the program.

Conclusion

Many local government agencies responsible for particular and sensitive interventions have effectively performed their duties in accelerating the stunting reduction in Malaka District. However, the low performance of internal coordination within SRAT has resulted in a lack of harmonization in its implementation. An active participation of the Head of Malaka District is crucial in taking the performance control to improve alignment between SRAT. This study is limited to structured interviews and secondary data analysis. It is strongly recommended that mixed methods and field studies be conducted at the subdistrict to village levels and their alignment with existing NGOs.

Abbreviations

INSS: Indonesian Nutritional Status Survey; ENT: Nusa Tenggara Timur; SRAT: Stunting Accelerating Reduction Team; IHC: Integrated Healthcare Center; SF: supplementary feeding; FA: Family Assistance; NGO: non-governmental organizations; FWE: Family Welfare Empowerment; HE: health education.

Ethics Approval and Consent to Participate

This study has successfully undergone the health research ethics assessment conducted by the health research ethics commission from STRADA Institute of Health Sciences, No. 000302/EC/KEPK/I/07/2023.

Competing Interest

The authors declare that there is no significant competing interest in this study.

Availability of Data and Materials

The data presented in this study is available in this article.

Authors' Contribution

MPMN is responsible for preliminary study, data collection, data analysis, and manuscript submission, while VN is responsible for data collection and manuscript preparation.

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