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Spatial Analysis for Enhancing the Use of Health Data Availability from Different Sources to Help the Decision-Making Process

Tris Eryando*

Department of Biostatistics and Population Studies, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia

Abstract

Spatial analysis in public health has become a common method used by researchers to understand the distribution of public health aspects related to the surrounding environment. It can also be used to analyze individual information in the form of a dot and the location or line of aggregated information in a specific area of study. Another benefit is the possibility of using different data sources to be analyzed in one statistical model analysis, as long as the identification area is sufficiently clear as a key variable. Spatial analysis can show an object's distribution on a locational map and explain the distribution type, whether random, cluster, or uniform. The statistical analysis model can also develop different risk factors for each region of the research area. A specific model sometimes explains how to treat health issues differently in a specific location and can be used as an alternative approach to dealing with an intervention plan for public health issues based on specific local phenomena.

Keywords: secondary data, spatial analysis

Spatial Analysis

Spatial analysis has been developed as a quantitative statistical geography method since 1950. Based on the statistical model for spatial data, it was then put in the mathematical model.[1] Spatial analysis procedures are quantitative techniques that apply to geographic or location analysis.[1] Spatial analysis is based on the idea that everything relates to each other: everything is related to everything else, but near things are more connected than distant things. This is the first law of geography introduced by Waldo R. Tobler in 1969.[2] Spatial analysis can be established if autocorrelation exists. Public health phenomena related to the evidence's location can be used in spatial statistics that explain the phenomenon based on a geographic aspect or location.

Spatial analysis is a common term for exhibiting a technique using locational information to understand the process of producing an observation attribute. Data gathered to investigate health aspects usually focus only on observational attributes, such as disease distribution.[3,4] However, when the coordinates of the cases are collected, the pattern can be traced back to see the additional risk factors in the spatial phenomenon.[3]

Any data or information gathered, including the geographic location, is known as spatial data and can be analyzed using spatial analysis. The data forms range from discrete to continuous. There are three types of spatial data: point, line, and area data. Point data are analyzed to generate the type of distribution of objects in a specific area, and the distribution is classified as random, scatter, or homogenous. Line data are calculated to differentiate the area's density or the length of the line features, such as roads and rivers. For instance, the road length in an area is computed to predict the level of population mobility. Spatial area data, mainly in the aggregate dataset, are related to the geographic location. These data can be treated as point data if they involve a certain number of areas in the analysis.

Spatial analysis can generate information on spatial dependency, heterogeneity, and autocorrelation to develop a statistical prediction model that considers risk factors and the distance among the areas of study. The distribution and the amount of information in each area are calculated with a spatial statistic to show not only the pattern but also the relation to the size of the area compared to a neighboring area. The distribution and dis-

Correspondence: Tris Eryando, Department of Biostatistics and Population Studies, Building A 2nd Floor, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia, E-mail: tris@ui.ac.id or tris.eryando@gmail.com, Phone: +62 811 181 447*

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tance from the neighborhoods offer the relative connectivity among areas following the object or variable calculated. For instance, the distribution of stunted under-five cases can be evaluated. The map can examine the country's highest proportion of stunting compared with neighboring areas. The results set the priority intervention areas based on the detected hotspots and risk factors.[5] It is essential to highlight studies that examine how geographic (spatial) heterogeneity is modeled and how such perspective enriches scientific inquiry into public health issues.[6]

Spatial data analysis can be easily performed, as most secondary data are collected with geographic location information. Data from population censuses, personal health records, health facilities, and schools include locations. Today, information on geographic locations can be easily collected using the Global Positioning System (GPS) installed on a smartphone. Another opportunity to use spatial analysis is to disclose the possibility of an unidentified pattern. A scatterplot map with a straightforward mathematical operation can show the data in a geographic pattern. It shows the distribution of the natural phenomenon, which likely has environmental implications in the study area.

Utilization of Spatial Analysis in Public Health

Public health is the science that studies all health issues in community. One of the essentials in improving public health development is analyzing the distribution of health indicators. The analysis includes the distribution of inputs, such as health facilities and resources, and the intervention of public health products or results. The information can be used to monitor and evaluate public health problems to help improve the performance of health development based on regional units. Information often discussed in the health sector is the distribution of health resources, as well as the incidence of illness, both communicable and non-communicable diseases, and environmental risks that contribute to public health problems. It is common knowledge that the more densely populated an area is, the more likely infectious diseases will occur in that area. Environmental factors, occupations, and the distribution of healthcare can be analyzed spatially.

Public health study questions that can be answered using spatial analysis are listed as follows:

a. What is the description or distribution of the health variable?
b. Does this condition affect neighboring locations if a location impacts a variable?
c. How do we identify the location that is the center in giving the impact of a variable?
d. Does the location element affect the variable or object of study in influencing the dependent variable?
e. How can a particular location be predicted based on the value of its neighboring location variable?

This analysis can provide insight into spatial patterns, identify disease clusters, and explain or predict the risk factor of the object of study.[1,3]

Locational health-related factors and health care are critical to consider because the location is directly related to health problems and the occurrence of the interaction between the agent, the host, and the environment. Spatial analysis can help predict how health events occur in a particular area concerning health-related aspects and health care. Spatial analysis, which considers the location or space, determines the risk factors for the occurrence of health problems and how the relationship is related to the area's characteristics. Knowing the spatial analysis results' pattern makes it easier to set the priority for interventions for health issues. In terms of infectious diseases, it is easier to control the process of disease transmission to other areas. Spatial analysis can help make decisions about mitigation or prevention actions in public health development. The uneven distribution of the population and healthcare providers leads to geographic disparity in accessibility and varying workloads for staff at hospitals and health centers. The former leads to inequality in the utilization of healthcare resources by people and, subsequently, their health outcomes; the latter affects the stress level of healthcare professionals and the quality of care that they deliver.[6]

Applications of spatial analysis in the field of public health include the following:

1. Health data visualization. Mapping makes it possible to know what is happening in each place. This information is used to understand and describe specific properties in global and local spatial distributions.
2. Environmental correlation studies can explain the relationship between health indicators and environmental exposure.
3. This study focuses on revealing or highlighting a phenomenon that shows the assumed risk around a location. The population near the source is considered exposed and compared to the unexposed population.
4. Spatial analysis can be used to detect places which are considered to have specific public health problems. This study allows us to see the prevalence or incidence of a health-related incidence in a place, concentration, cluster, central place, or pattern of certain phenomena. It shows the possibility of a causal relationship between the characteristics of the area and the observed health-related incidence.

Utilization of Secondary Data

Health care and related institutions have widely collected and published information on health and the environment. Utilizing these available data makes it possible

to conduct additional analyses using spatial analysis. To explain the phenomenon of public health and the environment surrounding it, secondary data are often considered inadequate for further analysis in some developing countries, including Indonesia. As national and international institutions collect the data, issues of validity and reliability become out of the question. The data are reasonably valid and reliable, therefore they can be used optimally for additional analysis to support decision-making at the local and national levels. Big data will be more accessible because specific data on key variables do not need to be merged before performing the analysis. Hence, scattered secondary data from many sources can easily be analyzed, without mentioning the type of data collection method, as the data represent the area of interest.

However, a weakness of secondary data is that large and massive data do not have the same measurement variable that can be used as a key variable for merging the variables with other data sources for additional statistical analysis. Spatial analysis allows the combination of various existing data sources, as long as the information on the geographic location of the data is well recorded. The location of these data is a key indicator for analyzing information from different data sources. Of course, the attention must be paid to the representativeness of the data for each area location. The data allow multivariable analysis to be carried out to determine the factors which play a role in developing regional-based health problem prediction models.

Threat to Validity

Threats to validity are not related to the secondary data to be used. The data available from national and international institutions are these institutions' legal and official products. Thus, the data that an institution has collected are explicitly designed for the framework it has set and do not always fit other parties' analysis plans. The issue of validity concerns how other parties will use the available data.

It should be noted that when researchers use secondary data for further analysis, they must pay attention to the measurement variables, so that they can be synchronized with the variables built within the framework of the research concept in further analysis. Several important issues are the non-identical measurement variables in the available data. Using a substantial amount of literature, the researcher must ascertain the possibility of making existing measurement variables proximate to the variables in the conceptual framework for further analysis of secondary data.

Advantages of Spatial Analysis Modeling

In addition to using information from various data sources, spatial analysis can build statistical models that show the phenomenon of health indicators. Spatial analysis can provide an overview, such as the distribution of health care, using maps as an information tool, and the distribution of health problems in each area of study. Therefore, researchers can easily understand whether there is a relation between the distribution of health problems and the distribution of healthcare. Evaluations can be used to strengthen the equity of the distribution of healthcare among the population in each region.

In addition, spatial statistics can help develop a statistical model that differentiates models for each area of study, such as using a geographically-weighted regression model. The results can inform researchers which independent variable is built or can explain the incidence of public health problems in an area that differs from the independent variables in other regions. Hence, the typical approach, such as the intervention scenario, is not necessarily the same, although the areas are similar. This technique can help decision makers evaluate the approach that has been performed. Later, they may change the scenario according to the local specific variable that forms the local spatial statistical model.

Conclusion

Encouraging public health researchers to use spatial analysis and GPS for distribution mapping or spatial statistics is essential. Big data from many different types of data collection and models are no longer an issue. As long as they represent the area of study, they can be used and analyzed together in a spatial model. The main statistical model represents different results for each analysis area, and the model can be used for a specific approach to an intervention for a particular area.

Abbreviations

GPS: Global Positioning System.

Ethics Approval and Consent to Participate

Not applicable.

Competing Interest

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

Availability of Data and Materials

Not applicable.

Authors' Contribution

TE contributed substantially to the conception, writing, and revising of the manuscript.

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References

1. Bhunia GS, Shit PK. Geospatial analysis of public health. New York: Springer; 2018.
2. GISGeography. What is Tobler's first law of geography? GIS Geography; 2022.
3. Pfeiffer DU, Robinson TP, Stevenson M, Stevens KB, Rogers DJ, Clements ACA. Spatial analysis in epidemiology. Oxford: Oxford University Press; 2008.
4. Fotheringham AS, Rogerson PA, editors. The SAGE handbook of Spatial Analysis. Los Angeles, London, New Delhi, Singapore: Sage Publication Ltd; 2008.
5. Eryando T, Sipahutar T, Budhiharsana MP, Siregar KN, Nur Aidi M, Minarto M, et al. Spatial analysis of stunting determinants in 514 Indonesian districts/cities: implications for intervention and setting of priority. Geospat Health. 2022; 17 (1).
6. Wang F. Why public health needs GIS: a methodological overview. Ann GIS. 2020; 26 (1): 1–12.

Ariawan, *et al. Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*. 2022; 17 (3): 169-174
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SARS-CoV-2 Antibody Seroprevalence in Jakarta, Indonesia

Iwan Ariawan[1,2], Hafizah Jusril[1,2*], Muhammad N Farid[1], Pandu Riono[1], Wiji Wahyuningsih[1,2], Widyastuti[3], Dwi Oktavia T L Handayani[3], Endang Sri Wahyuningsih[3], Rebekka Daulay[3], Retno Henderiawati[3], Safarina G Malik[4], Rintis Noviyanti[4], Leily Trianty[4], Nadia Fadila[4], Khin Saw Aye Myint[4], Frilasita A Yudhaputri[4], Neeraja Venkateswaran[5], Kodumudi Venkateswaran[5], Venkatachalam Udhayakumar[6], William A Hawley[6], Juliette Morgan[7], Paul M Pronyk[8]

[1]Department of Biostatistics and Population Studies, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia, [2]Reconstra Utama Integra, Jakarta, Indonesia, [3]Special Capital Region of Jakarta Provincial Health Office, Jakarta, Indonesia, [4]Eijkman Institute for Molecular Biology-National Research and Innovation Agency, Rumah Sakit Umum Pusat Nasional dr. Cipto Mangunkusumo, Jakarta, Indonesia, [5]Tetracore, Inc. Rockville, MD, USA, [6]Centers for Disease Control and Prevention, Center for Global Health, Division of Global Health Protection, Atlanta, GA, USA, [7]Centers for Disease Control and Prevention, South America Regional Office, Brasilia, Brazil, [8]The SingHealth Duke-NUS Global Health Institute, Singapore

Abstract

The SARS-CoV-2 transmission dynamics in low- and middle-income countries remain poorly understood. This study aimed to estimate the SARS-CoV-2 antibodies seroprevalence in Jakarta, Indonesia, and to increase knowledge of SARS-CoV-2 transmission in urban settings. A population-based serosurvey among individuals aged one year or older was conducted in Jakarta. Employing a multistage sampling design, samples were stratified by district, slum and non-slum residency, sex, and age group. Blood samples were tested for IgG against three different SARS-CoV-2 antigens. Seroprevalence was estimated after applying sample weights and adjusting for cluster characteristics. In March 2021, this study collected 4,919 respondents. The weighted estimate of seroprevalence was 44.5% (95% CI = 42.5-46.5). Seroprevalence was highest among adults aged 30-49 years, with higher seroprevalence in women and the overweight/obese group. Respondents residing in slum areas were 1.3-fold more likely to be seropositive than non-slum residents. It was estimated that 4,717,000 of Jakarta's 10.6 million residents had prior SARS-CoV-2 infection. This suggests that approximately 10 infections were undiagnosed/underreported for every reported case. About one year after the first COVID-19 case was confirmed, close to half of Jakarta's residents have been infected by SARS-CoV-2.

Keywords: antibodies, COVID-19, immunity, SARS-CoV-2, seroprevalence

Introduction

Urban areas are home to just over half the world's population yet are estimated to account for 90% of SARS-CoV-2 infections.[1,2] Serosurvey data suggest striking urban-rural gradients across diverse geographic and economic contexts including New York, the United States (20% urban vs 3.4% rural),[3] Spain (14% vs 1.7%),[4] Kenya (9.3% vs 1.7%),[5] and India (33% vs 1%).[6] Specifically, cities in low- and middle-income countries (LMICs) are where the pandemic's effects are likely to be most severe.[2] Greater population size, density, and connectedness alongside poor hygiene and infrastructure increase the frequency of infectious contacts and high-risk exposures.[2,7] Recent urban expansion and growing inequalities amplify these vulnerabilities, with the billion people globally residing in slums at the greatest risk.[7-9] High poverty levels hinder the introduction of public health measures such as mobility restrictions,[10,11] which must be carefully weighed against their adverse social and economic consequences.[12,13] Finally, inequities in access to basic health and laboratory services constrain the effectiveness of established control measures, including timely case detection and contact tracing.

In the Southeast Asia, 84% of the population resides in LMIC contexts, with nearly half in urban centers.[14] Prior to Delta variant-associated severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission in mid-2021, the region was lauded for its apparent success in controlling the coronavirus disease 2019 (COVID-19).[15] However, data to support these assertions have been limited. With levels of diagnostic testing among the region's LMICs 10- to 15- fold lower than in high-income countries, confirmed cases are likely to be under-reported.[16] Furthermore, the use of serosurveys to detect prior SARS-CoV-2 infection has been of poor quality.[17-19]

Indonesia is the largest LMIC in Southeast Asia and is home to the world's fourth-largest population.[20] Nearly 10% of inhabitants reside in and around the

Correspondence: Hafizah Jusril, Department of Biostatistics and Population Studies, Building A 2nd Floor, Faculty of Public Health, Universitas Indonesia, Kampus Baru UI Depok 16424, Indonesia, E-mail: hafizahjusril@gmail.com, Phone: +62 811 1809 292*

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Special Capital Region of Jakarta. SARS-CoV-2 infections were first detected in early March 2020, with cases confirmed across all 34 provinces within just four weeks. Despite having the highest number of reported COVID-19 cases and deaths in Southeast Asia, SARS-CoV-2 transmission remains poorly understood in Indonesia.[16] Similar to other LMICs in the region, national per capita testing rates have been low at just 1/25 levels of the United States or Singapore, and 1/4 levels in India which has a comparable per capita health expenditure.[16] While testing levels in the Special Capital Region of Jakarta are 10-fold higher than the national average,[21] concerns remain regarding the extent of underdetection.

To better understand the dynamics of SARS-CoV-2 transmission in an urban LMIC context in the Southeast Asia, a serological assessment was conducted in the Special Capital Region of Jakarta, Indonesia. The objectives were to estimate the seroprevalence of SARS-CoV-2 antibodies in the population by age group, sex, area of residence (slum/non-slum), and COVID-19 characteristics to compare seroprevalence to reported caseloads and to assess whether levels of prior SARS-CoV-2 infection approaches herd immunity thresholds.

Method

This population-based cross-sectional survey was conducted in March 2021 in the Special Capital Region of Jakarta, Indonesia, one year after the first COVID-19 cases were confirmed. Respondents included residents aged one year and older across six municipalities of the province. All samples were collected in advance of initiating COVID-19 vaccination programs for general population.

A multistage sampling design was employed. At the first stage, one hundred urban villages were selected by probability proportional to size (PPS) sampling, with urban village populations as size. The urban villages were selected independently in every subdistrict and stratified by slum and non-slum areas. Sample sizes of urban villages in each slum/non-slum stratum were allocated proportionally to the total number of urban villages in each stratum. Urban villages containing slums were based on Statistics Indonesia/*Badan Pusat Statistik* (BPS) data. At the second stage, within each selected urban village, one neighborhood was selected by PPS sampling. Finally, individuals within each neighborhood were stratified by sex and age group. The number of individuals in each stratum was derived from lists provided by the Civil Registry Office and cross-checked by local health care provider staff. Sample sizes were estimated assuming a 5% SARS-CoV-2 antibody prevalence (absolute precision $\pm$ 1%), a design effect of 2, and an 80% response rate.[22]

Prior to the survey, written informed consent was obtained from individuals aged 18 years or older. For individuals aged 1-17 years, consent was obtained from caregivers. The serosurvey study was conducted by the Jakarta Provincial Health Office in collaboration with the US Centers for Disease Control and Prevention (US CDC), the Eijkman Institute for Molecular Biology (EIMB), and with academic support from the pandemic response team from the Faculty of Public Health, Universitas of Indonesia.

All eligible participants were invited to the survey venue at a specified time. Non-attendees were replaced with age-sex matched individuals from a civil registry list. Participants were interviewed for sociodemographic characteristics, records of having contact with a confirmed COVID-19 case or suspect in the past month, and ever been diagnosed with COVID-19. Given the one-year duration of exposure, non-specificity of symptoms, and potential for recall bias, the authors opted not to assess potential COVID-19 symptoms. The weight and height were also measured, and random blood glucose tests were conducted. Body mass index (BMI) was calculated as weight (kg)/height (m^2) and classified for Asian populations.[23]

Finger-prick blood drop samples, approximately 50 microliters of blood per spot, were collected from participants using Whatman 903 protein saver cards. Dried blood spots were tested for SARS-CoV-2 antibodies using the Human IgG Tetracore® FlexImm Array Human IgG test. This multiplex test detected IgG antibodies against three different proteins of the SARS-CoV-2 virus (receptor binding domain (RBD) of SARS-CoV-2 spike protein, nucleocapsid protein, and a recombinant spike RBD and nucleocapsid hybrid protein). The assay utilized seven microspheres sets with three different SARS-CoV-2 antigen detection antibodies and four internal controls. The test performed in a 96-well microtiter plate can be used to test up to 90 samples in one batch. For quality control, a negative control serum, a positive control serum, and a calibrator were tested in duplicate on each plate. For the sample to be reported as seropositive, the sample should show reactivity to all three SARS-CoV-2 antigens above pre-determined cut-off thresholds. This multiplex assay was a research use-only test and has been evaluated in collaboration with the Malaria Branch, US CDC, Atlanta, GA. The sensitivity and specificity of the assay for control specimens from the US reached 100% for each,[24] with additional validation at the EIMB Research Laboratory with serum known to be positive for various endemic diseases, including malaria and other viral infection, showing no cross-reactivity.

Characteristics of study participants are presented as numbers and percentages. The overall prevalence of SARS-CoV-2 antibodies was estimated by using sampling design and poststratification weights derived from the sex and age distributions in the population. Estimates are

presented as percentages and confidence intervals. Analysis was performed using Stata 17 (StataCorp, 2021).

The potential levels of underdetection of the COVID-19 cases were estimated in two ways. First, the self-reported COVID-19 diagnoses were compared to those seropositive by laboratory assessment. Second, to calculate the infection-to-case ratio, the adjusted seroprevalence estimates from the sample to the population aged one year or older residing in the same geographic area was applied. These figures were compared to a database of standard case report forms for all confirmed PCR-positive cases presented to health facilities in the Special Capital Region of Jakarta for one year, from March 2020 to March 2021.

The data analysis consisted of descriptive statistics, and the frequency, percentage, mean, and standard deviation distribution were included. The bivariate analysis using a Chi-square test was also utilized to assess the relationship between healthcare workers' knowledge, attitudes, and sociodemographic characteristics of COVID-19 prevention practices. Multiple logistic regression with a significance level of 0.05 was carried out to identify the odds ratio and factors associated with the COVID-19 prevention practices.

Results

Seroprevalence of SARS-CoV-2 Antibodies

A flow chart of participant enrolment is presented in Figure 1, and the characteristics of 4,919 respondents are shown in Table 1. More than half of respondents (60.1%) resided in an area with a slum neighborhood, and a few respondents (6.4%) had elevated blood glucose. Half of the sample was overweight or obese. Only 4.1% of respondents had a prior COVID-19 diagnosis, and 7.8% had exposure to a known positive case in the past month.

Table 2 profiles SARS-CoV-2 seropositivity by respondent characteristics. A total of 44.5% (95% CI 42.5-46.5) of respondents were tested positive for the SARS-CoV-2 antibody. Seropositive status ranged from one-third among children under five to one-half of adults aged 40-49 years old. Women had a marginally-higher prevalence than men. Respondents residing in areas with slum neighborhoods had a 1.3-fold greater prevalence than non-slum residents. There were no differences between participants with abnormal blood glucose levels relative to those with glucose in the normal range. Respondents who were overweight and obese had a higher prevalence than those with normal BMI or below. Those who had previous contact with a confirmed case or who had confirmed COVID-19 themselves were more likely to test positive for SARS-CoV-2 antibodies.

Figure 2 profiles infection-to-case ratios for the serosurvey sample alongside estimates for the Special Capital Region of Jakarta population. Of 2,185 respondents tested SARS-CoV-2 antibody positive, 92.2% (95% CI = 95.2–93.5) had not received a prior positive diagnosis by RT-PCR, resulting in an infection-to-case ratio of 10.4:1. Based on levels of seroprevalence detected in this study, it was estimated that 4,717,000 residents had a prior infection with SARS-CoV-2 by March 31, 2021. During this period, the Special Capital Region of Jakarta recorded 382,055 cumulative positive COVID-19 cases, suggesting 91.9% of the cases were undetected with an infection-to-case ratio of 11.3:1.

Discussion

This study presented the results of a serological as-

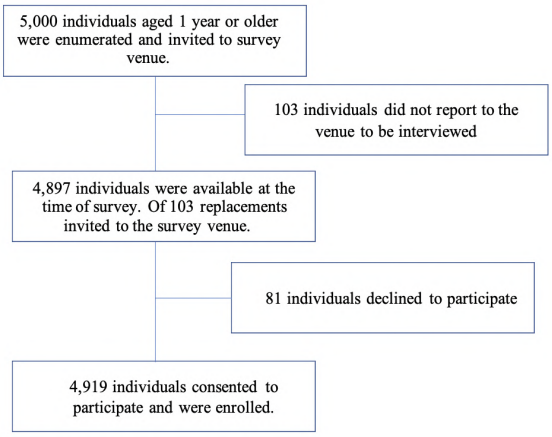

Figure 1. Participant Enrollment Diagram Flow

Table 1. Serosurvey Participant Characteristics (n = 4,919)

Variable	Category	n	%
Sex	Male	2,262	46.0
	Female	2,657	54.0
Age (years)	1-4	187	3.8
	5-14	874	17.8
	15-29	827	16.8
	30-39	714	14.5
	40-49	1,016	20.7
	50-59	723	14.7
	60+	578	11.8
Area of residence	Non-slum	1,964	39.9
	Slum	2,955	60.1
Body mass index	Underweight (<18.5 kg/m^2)	287	7.5
	Normal weight (18.5-25.0 kg/m^2)	1,625	42.4
	Overweight (25.1-27.0 kg/m^2)	574	15.0
	Obesity (>27.0 kg/m^2)	1,344	35.1
Blood glucose level	<200 g/dL	3,431	93.6
	200 g/dL	236	6.4
Contact with COVID-19	Yes	385	7.8
suspects or confirmed	No	4,408	89.6
cases in the past month	Do not know	126	2.6
Previous positive	Yes	201	4.1
COVID-19 diagnosis	No	4,413	89.7
	Do not know	305	6.2

Table 2. Seroprevalence by Population Characteristics (n = 4,919)

Variable	Category	Participants Tested (n)	Unweighted Seroprevalence (%, 95% CI)	Sampling Design Weighted Seroprevalence (%, 95% CI)	Post-stratification Weighted by Sex and Age Distribution in Population (%, 95% CI)
Overall		4,919	45.0 (43.6–46.4)	44.7 (42.7–46.7)	44.5 (42.5–46.5)
Sex	Male	2,262	41.2 (39.2–43.3)	41.1 (38.5–43.7)	41.1 (38.4–43.8)
	Female	2,657	48.2 (46.3–50.1)	48.2 (45.8–50.5)	47.9 (45.6–50.3)
Age group, years	1-4	187	31.7 (25.4–38.8)	32.4 (25.9–39.6)	31.8 (25.4–39.0)
	5-14	874	40.4 (37.2–43.7)	40.1 (36.4–44.0)	40.1 (36.3–44.0)
	15-29	827	42.0 (38.6–45.4)	41.3 (37.6–45.1)	41.2 (37.4–45.0)
	30-39	714	47.8 (44.1–51.4)	49.4 (45.1–53.7)	49.2 (44.8–53.5)
	40-49	1,016	49.9 (46.8–52.9)	49.4 (46.0–52.7)	49.0 (45.7–52.4)
	50-59	723	48.7 (45.1–52.3)	47.8 (43.7–52.0)	47.8 (43.7–51.8)
	60+	578	43.9 (39.9–47.9)	42.5 (37.9–47.3)	43.1 (38.5–47.8)
Area of residence	Non-slum	1,964	38.0 (35.8–40.1)	37.5 (34.0–41.2)	37.5 (34.1–41.1)
	Slum	2,955	49.6 (47.8–51.4)	48.7 (46.4–51.1)	48.4 (45.9–50.8)
Body mass index	Underweight	287	37.3 (31.9–43.0)	35.1 (29.2–41.4)	33.8 (27.9–40.3)
	Normal	1,625	42.5 (40.1–44.9)	42.0 (39.5–44.6)	42.0 (39.5–44.6)
	Overweight	574	52.2 (48.1–56.3)	51.7 (47.2–56.3)	52.9 (48.3–57.4)
	Obesity	1,344	51.1 (48. –53.8)	51.6 (48.4–54.9)	51.6 (48.2–54.9)
Blood glucose level	<200 g/dL	3,431	46.2 (44.5–47.9)	46.0 (43.7–48.3)	45.9 (43.6–48.2)
	≥200 g/dL	236	53.0 (46.6–59.3)	52.3 (45.0–59.4)	53.0 (45.7–60.1)
Contact with COVID-19	Yes	385	59.9 (54.9–64.7)	60.1 (54.3–65.6)	59.8 (53.9–65.5)
suspects or confirmed	No	4,408	43.6 (42.1–45.0)	43.2 (41.2–45.3)	43.1 (41.0–45.2)
cases in the past month	Do not know	126	49.2 (40.6–57.9)	47.7 (37.1–58.4)	46.6 (36.2–57.4)
Previously positive	Yes	201	87.6 (82.2–91.5)	87.7 (81.9–91.8)	87.5 (81.4–91.8)
COVID-19 diagnosis	No	4,413	42.6 (41.2–44.1)	42.3 (40.2–44.4)	42.0 (39.9–44.1)
	Do not know	256	51.2 (45.6–56.7)	48.5 (41.8–55.3)	49.5 (42.7–56.2)

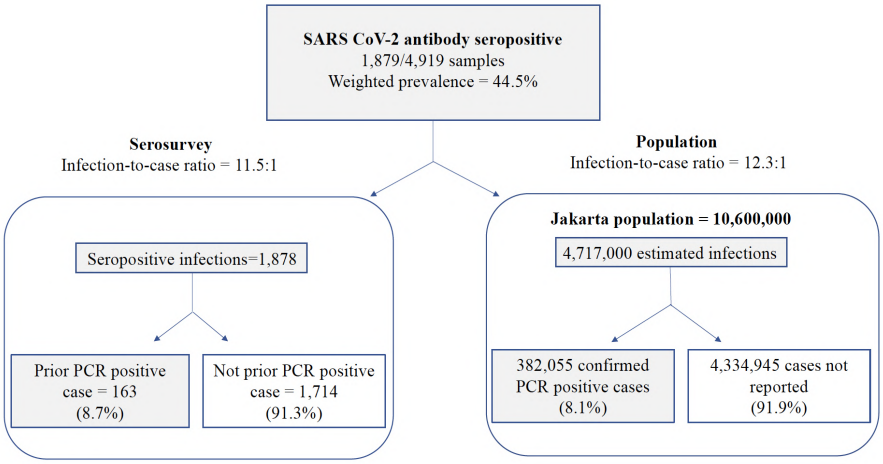

Figure 2. Infection-to-confirmed Case Ratios: Serosurvey and Population

sessment of SARS-CoV-2 antibody prevalence in the Special Capital Region of Jakarta, Indonesia. The findings suggested that within one year since the COVID-19 onset (March 2020 to March 2021), close to half (44.5%) of the population has been infected. By March 2021, there had been 4,717,000 prior infections in this urban center of 10 million people. Despite the Special Capital Region of Jakarta having the highest testing capacity in the country, levels of underdetection remain high. For each confirmed case, it was estimated that approximately ten infections were undiagnosed.

While seroprevalence peaked among working-age adults aged 30-49 years, children (5-14 years) were clearly susceptible, with nearly one-third tested positive for SARS-CoV-2 antibody. A higher seroprevalence was observed among women than men, which has been previously reported in urban centers in India,[25] and potentially linked to exposures resulting from women's household and social roles.[26] The higher seroprevalence among the overweight and obese relative to populations with normal or low BMI and those with COVID-19 diagnosis or contact was also observed. While obesity has been linked to

greater disease severity,[27] the link to the COVID-19 infection has not been previously described. Importantly, seroprevalence among residents in urban slums was 1.3-fold higher than non-slum residents, consistent with reports from LMICs elsewhere.[25]

This study's findings are in contrast with few previous serological assessments in the Southeast Asia, where lower levels of SARS CoV-2 exposure have been reported. These include assessments of hospital specimens in urban Malaysia (0.4%), health workers in Vietnam (0.6%), health workers in Thailand (5.7%), and the general population in Laos PDR (5.2%).[17-19,28] There is, however, strong concordance with population-based assessments from urban centers in South Asia including India and Bangladesh where seroprevalence levels of 54% (slums) and 63.1% respectively were observed.[25,29] Importantly, in all instances, these assessments were done in advance of widespread transmission of the highly contagious SARS-CoV-2 Delta variant in the South and Southeast Asia.

In some instances, observed disparities in seroprevalence are likely explained by the earlier timing studies in the pandemic's trajectory, rural-urban gradients with lower population density in some settings, methodological differences in the sampling strategy, and the quality of antibody assays utilized.[30] The effective introduction of non-pharmaceutical interventions may also contribute to lower observed prevalence. However, most LMICs in the region face similar trade-offs as Indonesia regarding enforcing non-pharmaceutical interventions in the context of high poverty levels. With low testing levels and limited high-quality population-based serosurvey data, statements on the relative success of the Southeast Asia's COVID-19 control efforts should be interpreted cautiously.

This study has several limitations. First, the seroprevalence estimates are likely to be conservative. The multiplex antibody assay requires threshold levels of detection for three separate antibodies for a positive result to be reported. This may lead to false negatives, resulting in an underestimate of seroprevalence. Issues of antibody decay over time may further compound these issues, particularly given that this study took place one year after the first confirmed cases were identified in Indonesia.[16] Second, the assessments regarding the level of underdetection are not likely to be generalizable outside the Special Capital Region of Jakarta, Indonesia. National levels of testing outside the capital are 10-fold lower with correspondingly higher levels of underdetection. Third, while mobility restrictions were mandated in the Special Capital Region of Jakarta and Indonesia during the pandemic, these were loosely enforced. As a result, mobility in and around Jakarta area is likely to contribute to its high prevalence in the capital. Finally, the assessment occurred before accelerated Delta variant transmission between June and August 2021, after which seroprevalence is likely to have increased even further.

Conclusion

In conclusion, the findings of SARS-CoV-2 antibodies in nearly half of the Jakarta population adds to a growing body of evidence, suggesting urban centers in the LMICs remain the places in the world most highly affected by the COVID-19. Despite the high observed prevalence, substantial portions of the population remain vulnerable to infection. Given the rapid transmissibility of the Delta variant, even with vaccination rates in the Special Capital Region of Jakarta approaching 50% as of August 2021, it is unlikely that herd immunity has been achieved. While gradients in transmission between rural and urban settings have been reported worldwide, growing inequalities within urban centers and the concentration of vulnerabilities observed in slums are particularly worrisome. A comprehensive approach to the COVID-19 control in these contexts must combine proven public health interventions with broader approaches that address social determinants, including strategies to guarantee food and livelihood security, well-tailored community awareness efforts, special attention to the needs of homeless populations, and strategies to ensure safe urban mobility.

Abbreviations

SARS CoV-2: Severe Acute Respiratory Syndrome Coronavirus-2; COVID-19: Coronavirus Disease 2019; IgG: Immunoglobulin G; CI: Confidence Interval; LMICs: Low- and Middle-Income Countries; PPS: Probability Proportional to Size; BPS: *Badan Pusat Statistik*; BMI: Body Mass Index; RBD: Receptor Binding Domain; US CDC: US Centers for Disease Control and Prevention; EIMB: The Eijkman Institute for Molecular Biology; RT-PCR: Reverse-Transcriptase Polymerase Chain Reaction.

Ethics Approval and Consent to Participate

The study protocol was approved by the Ethics Committee of the University of Atmajaya (No. 1245A/III/LPPM.PM.10.05/11/2020). Prior to the survey, written informed consent was obtained from individuals aged 18 years or older. For individuals between 1 and 17 years, consent was obtained from caregivers.

Competing Interest

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

Availability of Data and Materials

Data were available upon request.

Authors' Contribution

HJ and PMP led the drafting of the manuscript. IA, HJ, MNF, PR, and

WW designed the survey with substantial inputs from PMP, SGM, RN, and WAH. IA, MNF, HJ, PR, SGM, RN, and WW performed the data analysis and interpretation. LT and NF led the training in sampling procedures, sample handling and management, laboratory assay, data analysis, and interpretation. W, DOTLH, ESW, RD, and RH led the training in data collection procedures and closely monitored the overall data collection process. KSAM, FAY, VU, JM, NV, and KV provided scientific inputs on the manuscript writing. All authors approved the final version for publication.

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References

1. United Nations. The world's cities in 2018-data booklet (ST/ESA/SER.A/417): Department of Economic and Social Affairs, Population Division; 2018.
2. United Nations Human Settlements Programme. UN Habitat COVID-19 response plan. Nairobi, 2020.
3. Rosenberg ES, Tesoriero JM, Rosenthanl EM, Chung R, Barranco MA, Styer LM, et al. Cumulative incidence and diagnosis of SARS-CoV-2 infection in New York. Ann Epidemiol. 2020; 48: 23-9.
4. Pollán M, Pérez-Gómez B, Pastor-Barriuso R, Oteo J, Hernán MA, Olmeda MP, et al. Prevalence of SARS-CoV-2 in Spain (ENE-COVID): a nationwide, population-based seroepidemiological study. Lancet. 2020; 396 (10250): 535-44.
5. Uyoga S, Adetifa IM, Karanja HK, Nyagwange J, Tuju J, Wanjiku P, et al. Seroprevalence of anti–SARS-CoV-2 IgG antibodies in Kenyan blood donors. Science. 2021; 371(6524): 79-82.
6. Firstpost. ICMR's second nationwide serosurvey shows big jump in COVID-19 exposure, better testing rates in August vs May. Firstpost; 2020.
7. Fang W, Wahba S. Urban density is not an enemy in the coronavirus fight: Evidence from China. Washington: World Bank Blogs; 2020.
8. Chu DK, Akl EA, Duda S, Solo K, Yaacoub D, Schunemann HJ, et al. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. Lancet. 2020; 395 (10242): 1973-87.
9. Beale S, Johnson AM, Zambon M, Hayward A, Fragaszy EB. Hand and respiratory hygiene practices and the risk and transmission of human coronavirus infections in a UK community cohort. Preprints with the Lancet, SSRN; 2020.
10. Islam N, Sharp SJ, Chowell G, Shabnam S, Kawachi I, Lacey B, et al. Physical distancing interventions and incidence of coronavirus disease 2019: natural experiment in 149 countries. BMJ. 2020; 370 (m2743).
11. Lasry A, Kidder D, Hast M, Poovey J, Sunshine G, Winglee K, et al. Timing of community mitigation and changes in reported COVID-19 and community mobility — four US metropolitan areas, February 26–April 1, 2020. Morbidity and Mortality Weekly Report. 2020; 69 (15): 451-7.
12. Anderson R, Heesterbeek H, Klinkenberg D, Hollingsworth T. How will country-based mitigation measures influence the course of the COVID-19 epidemic? Lancet. 2020; 395 (10228): 931-4.
13. Chirisa I, Mutambisi T, Chivenge M, Mabaso E, Matamanda AR, Ncube R. The urban penalty of COVID-19 lockdowns across the globe: manifestations and lessons for Anglophone Sub-Saharan Africa. GeoJournal. 2020; 87: 815-28.
14. The World Bank. World Bank Country and Lending Groups. The World Bank; 2021.
15. Sachs JD, Karim SA, Aknin L, Allen J, Brosbøl K, Barron GC, et al. Lancet COVID-19 commission statement on the occasion of the 75th session of the UN General Assembly. Lancet. 2020; 396 (10257): 1102-24.
16. Worldometers. COVID-19 Corona virus pandemic. Worldometers; 2021.
17. Hasan T, Pham TN, Nguyen TA, et al. Sero-prevalence of SARS-CoV-2 antibodies in high-risk populations in Vietnam. Int J Environ Res Public Health. 2021; 18 (12): 6353.
18. Nopsopon T, Pongpirul K, Chotirosniramit K, Hiransuthikulm N. COVID-19 antibody in Thai community hospitals. MedRxiv; 2020.
19. Sam IC, Chong YM, Tan CW, Chan YF. Low post pandemic wave SARS-CoV-2 seroprevalence in Kuala Lumpur and Selangor, Malaysia. J Med Virol. 2021; 93 (2): 647-8.
20. Jakarta's COVID-19 Response Team. COVID-19 tests in Jakarta. Jakarta's COVID-19 Response Team; 2021.
21. Lemeshow S, Hosmer DW, Kanggwa S. Adequacy of sample size in health studies. New York: Wiley; 1990.
22. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet. 2004; 363 (9403): 157-63.
23. Venkataramani N, Drabner J, Matlick B, et al. Validation of FlexImmArray SARS CoV-2 human IgG antibody test, a high performance and multiplex serological assay: TetraCore; 2020.
24. Malani A, Shah D, Kang G, Lobo GN, Shastri J, Mohanan M, Jain R, et al. Seroprevalence of SARS-CoV-2 in slums versus non-slums in Mumbai, India. The Lancet Global Health 2021; 9 (2): e110-e1.
25. Gupta AH. Why women may face a greater risk of catching coronavirus. The New York Times; 2020.
26. Mohammad S, Aziz R, Al Mahri S, et al. Obesity and COVID-19: what makes obese host so vulnerable? Immun Ageing. 2021; 18 (1): 1.
27. Virachith S, Pommelet V, Elodie C, Khounvisith V, Somphou S, Kounnavong S, et al. Low Seroprevalence of COVID-19 in Lao PDR, Late 2020. Preprints with the Lance, SSRN; 2021.
28. Bhuiyan TR, Hulse JD, Hegde ST, Akhtar M, Islam MT, Khan ZH, et al. SARS-CoV-2 seroprevalence in Chattogram, Bangladesh before a National Lockdown, March-April 2021. MedRxiv; 2021.
29. Liu G, Rusling JF. COVID-19 Antibody tests and their limitations. ACS Sens. 2021; 6 (3): 593-612.
30. Burgess S, Ponsford MJ, Gill D. Are we underestimating seroprevalence of SARS-CoV-2? BMJ. 2020; 370: m3364.

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A Stunting Prevention Risk Factors Pathway Model for Indonesian Districts/Cities with a Stunting Prevalence of ≥30%

Nina Fentiana[1], Endang L Achadi[2], Besral[3], Abram Kamiza[4], Trini Sudiarti[5*]

[1]Student of Doctoral Program in Public Health, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia, [2]Prosperous Family Research Center, Universitas Indonesia, Depok, Indonesia, [3]Department of Biostatistics and Population Studies, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia, [4]Kamuzu University of Health Science, Blantyre, Malawi, [5]Department of Public Health Nutrition, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia

Abstract

The prevalence of stunting in Indonesian children aged 0-23 months is a public health problem caused by direct and indirect factors. This study aimed to discover the path of the relationship between various risk factors and the stunting prevalence of ≥30% in 165 districts/cities in Indonesia. Data were obtained from the 2018 National Basic Health Research, National Socioeconomic Survey, and the Statistics Indonesia with a cross-sectional approach. The secondary data on stunting and risk factors were aggregated at the district/city level from individual data; children aged 0-23 months. The path analysis used to determine a stunting prevention model showed that antenatal care at the district/city level decreased stunting rates by at least 2.56% (b = -0.16; p-value = 0.04). A contraceptive user at the district/city level decreased stunting rates by 2.25% (b = -0.15; p-value = 0.05), and handwashing with soap at the district/city level by 5.76%, (b = -0.24; p-value = 0.003). Antenatal care, contraceptive use, and handwashing with soap contributed to the reduction of stunting prevalence by 18.18%. The study results suggested that districts/cities can play an important role in reducing stunting.

Keywords: children under two, handwashing with soap, path analysis, prevention risk factors, stunting

Introduction

The stunting prevalence in Indonesian children aged 0-23 months was 32.9% in 2013, 26.1% in 2016, and 29.9% in 2018.[1] The high prevalence of stunting in Indonesia is also accompanied by a vast disparity in stunting prevalence between districts/cities.[2] The 2018 National Basic Health Research/*Riset Kesehatan Dasar* (*Riskesdas*) and the integrated results from the 2019 National Socioeconomic Survey/*Survei Sosial Ekonomi Nasional* (*SUSENAS*) and Indonesian Toddler Nutritional Status Survey/*Survei Status Gizi Balita Indonesia* (SSGBI) found that stunting rates varied significantly among regions in Indonesia.[3,4] The highest prevalence of stunting was found in the Western and Eastern parts of Indonesia and is more widespread in rural areas than urban areas.[5,6]

Many cases demonstrate that the stunting condition of children in the first 1,000 days of life—children aged 0-23 months—cannot be changed.[7] The negative health and socioeconomic impacts of stunting can last a lifetime and even affect the next generation.[7] A study of 2,443 children aged 6-16 years spread across 20 primary schools in Cambodia showed that stunted children had significantly lower scores than those not stunted on all intelligence tests.[8] A case-control study in the Southern Iran on children aged 6-7 years reported that stunting was significantly associated with chronic disease.[9] A study in Nigeria reported that stunted children under five had experienced diarrhea in the two weeks before the survey.[10] Another study in Cambodia noted that stunting in children was associated with infections caused by *Strongyloides stercoralis* and had chronic effects.[11] Stunting in children carries a three-fold risk of death from other infections, including sepsis, meningitis, tuberculosis, hepatitis, and cellulitis. This indicates an abnormal immune condition in children with poor linear growth.[11] Therefore, stunting prevention is a top priority in Indonesia.

The experiences of Peru, Ethiopia, Senegal, Nepal, and Kyrgyzstan in stunting prevention showed that maternal education, maternal nutrition, maternal and newborn care, and decreased fertility/reduction in the interval between pregnancies are strong contributors to stunting prevention.[12] Ethiopia reported that the key factors in reducing stunting were an increase in total edible crop yields (32%), an increase in the number of health work-

Correspondence: Trini Sudiarti, Department of Public Health Nutrition, Building F 2nd Floor, Faculty of Public Health, Universitas Indonesia, Kampus Baru UI Depok 16424, Indonesia, E-mail: trini@ui.ac.id, Phone: +62 815 8715 343*

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ers (28%), a decrease in open defecation (13%), parental education (10%), maternal nutrition (5%), economic improvement (4%), and decreased incidence of diarrhea (4%).[13] Peru has reduced child stunting by making socioeconomic improvements, implementing sustainable changes inside and outside the health sector, and implementing health interventions.[14]

Stunting prevention efforts are associated with several risk factors. According to the United Nations International Children's Emergency Fund (UNICEF), the conceptual framework for stunting, which is adapted to Indonesian conditions, states that access to nutritious food, access to health care facilities, infant and child feeding, hygiene, education, access to clean water in households, and good sanitation facilities are factors that affect child stunting.[15] Studies in India have suggested that the leading risk factor for stunting is the low birth weight (LBW),[16] while in the Republic of the Congo, poor nutrition and failure to implement early initiation of breastfeeding (EIB) are the main risk factors for stunting.[17] Low household food diversity, food insecurity, poor feeding practices, and poverty are stunting factors in Lao PDR.[18] A poor environment is also expected to significantly impact stunting in the South Asia, Sub-Saharan Africa, East Asia, and the Pacific.[19]

Data analysis of the 2013 National Basic Health Research consisting of 24,657 children aged 0-23 months reported that the risk of child stunting increases if children live in households with more than three children under five, children live in a household with more than seven members, the mother visited health care facilities less than four times during pregnancy, the child is male, the child is aged 12-23 months, and birth weight is less than 2,500 grams. This study also found that stunting in children aged 0-23 months in Indonesia occurred due to differences in subdistrict/district/province as well as individual and household characteristics.[20]

The stunting prevention program running in Indonesia is reported not to have significantly contributed to stunting reduction because the stunting rate is not below 20%.[21] The high stunting rate in Indonesia impacts children's height growth being less than maximal, and the potential for irreparable loss of children's cognitive development is a major threat to child development.[22] To accelerate the prevention of stunting and reduce the stunting gap at the district or city level in Indonesia, an analysis of the direct and indirect relationships between various risk factors for stunting at the district/city level was carried out.

The analysis aimed to determine the stunting prevention pathway model in Indonesian districts/cities with a stunting prevalence of ≥30% (very high saturation category). The selection of a stunting prevalence threshold of ≥30% was based on the World Health Organization (WHO) threshold in classifying stunting as a moderate and severe public health problem.[23,24] The analysis was carried out using a conceptual framework for the causes of stunting problems adapted to Indonesian conditions.

Method

This study used a cross-sectional design to determine the mechanism of the relationship between various risk factors and stunting prevalence in children aged 0-23 months at the district/city level in Indonesia. The stunted children's data was retrieved from the 2018 National Basic Health Research, a nationally-representative health survey conducted by the Indonesian Ministry of Health. Indonesia has a total of 514 districts and cities within 34 provinces, and the stunted children's data were aggregated at the district/city level.[3]

The target sample of the 2018 National Basic Health Research was 300,000 households from 30,000 census blocks from the 2018 National Socioeconomic Survey with two-stage sampling. First, the survey team selected 180,000 census blocks using probability proportional to size (PPS) from 720,000 census blocks listed in the population census from 2010. Additionally, the team selected 30,000 census blocks in each urban dan rural using the PPS.

Next, the team systematically chose ten households using implicit stratification of the education level of household heads (to maintain the variation among households). The team interviewed each household member and examined participants who met the inclusion criteria (data criteria from the 2018 National Basic Health Research). The interview response rate for the 2018 National Basic Health Research was relatively high at 95% of target households nationally.[25] The sample included 165 districts/cities with a prevalence of stunting of ≥30% from a total of 514 districts/cities in Indonesia.

Indicators of stunting risk factors were obtained from the 2018 National Basic Health Research, National Socioeconomic Survey, and the Statistics Indonesia. The variables of early childhood education, complete basic immunization, access to health care facilities, food, safe drinking water, basic sanitation, and handwashing with soap were taken from the 2018 National Basic Health Research. The variables of LBW and access to health care facilities and food were taken from the 2018 National Socioeconomic Survey. Gross Regional Domestic Product (GRDP) per capita was taken from the Statistics Indonesia in 2018. All variables were presented at the district/city level.

Stunting was used as a dependent variable—the cut-off values (Z-score < -2.0 SD) were compared to the WHO child growth standards median.[26] The results of measuring each child's body length (cm) were converted into a standardized value (Z-score) using the WHO

Anthro 2018 version 3.2. Furthermore, based on the Z-score of the body length/age indicator with a stunting limit (Z-score < -2.0 SD), the percentage of stunted children was calculated using the number of children with a Z-score of < -2.0 SD divided by the number of children whose body length was measured multiplied by 100%.[27] Stunting prevalence was calculated as the number of stunted children divided by the number of children in the same period.[25]

Before the analysis was carried out, the completeness of data was first checked according to the study variables. All variables were presented in percentages at the district/city level and Indonesian Rupiah (IDR) for the per capita GRDP variable. Quantitative analyses were performed using descriptive statistics and path analysis. Descriptive statistics included the prevalence of stunting by district/city. Path analysis is a statistical method applied to see the direct and indirect relationships of a variable hypothesized as a cause to a variable acting as an effect.[28]

Path analysis proceeded through several stages. Model specifications used a research concept framework involving path diagrams to determine the relationship between variables to be tested, in which the relationship between constructs (X1-X15) was expressed through arrows. Straight arrows indicated a direct causal relationship between constructs, with arrows at each end indicating a correlation between constructs.

The next stage was the model identification, characterized by the degree of freedom (df). Path analysis could be done if df≥0. After determining the path analysis of all observed variables (X1-X15), the path coefficients for parameter estimation could be obtained.

The final stage was the goodness of fit model feasibility test, consisting of the value of significance probability (p) Chi-square = 0.05, Tucker-Lewis Index (TLI) = 0.90, Comparative Fit Index (CFI) = 0.90, Standardized Root Mean Square Residual (SRMR) less than 0.05, and Root Mean Square Error of Approximation (RMSEA) = 0.08. The goodness-of-fit index was used to test the suitability of the path model obtained using the data.[29]

All variables contained in the fit model were calculated according to the percentage of their contribution to the reduction in stunting prevalence, based on the path coefficients of each variable. The results of the descriptive analysis were presented in tables. While, the analysis path was shown in tables and figures.

Result

Based on the 2018 National Basic Health Research, the percentage of stunted children aged 0-23 months in Indonesia was 29.9%, spread across all provinces with wide variations. The East Nusa Tenggara and West Sulawesi Provinces were the two provinces reported as having stunting more than 40%.[3] While, Papua Province and Special Region of Nanggroe Aceh Darussalam were recorded having most districts/cities with a stunting prevalence of more than or equal than 40%.[3]

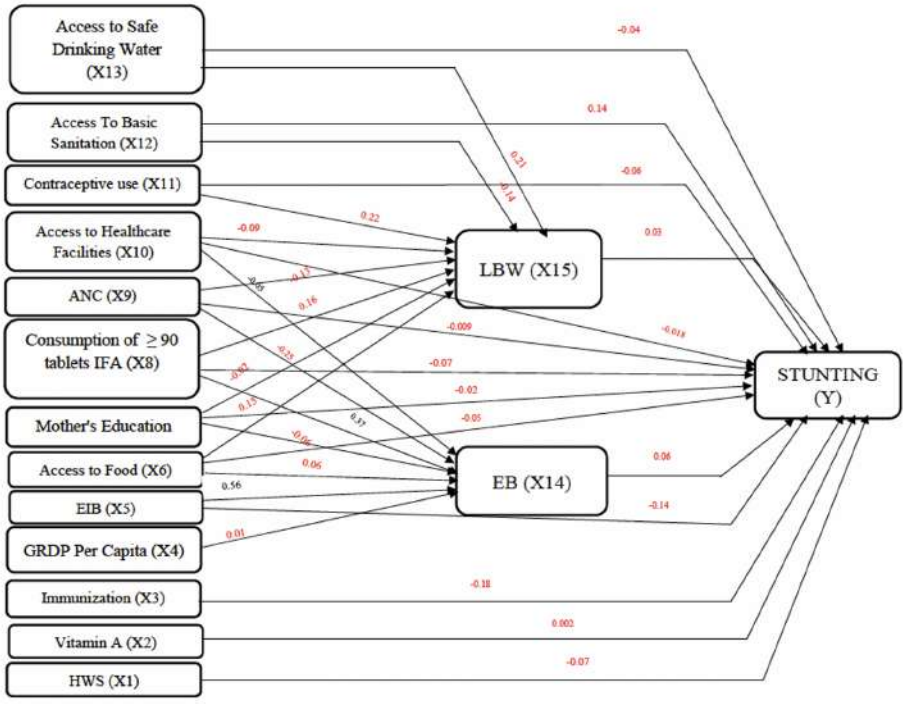
The characteristics of the risk factors for stunting in Table 1 show that access to safe drinking water was well distributed (87.19%) in all districts/cities with a stunting prevalence of ≥30%. However, it was found that only 12.85% of households with children aged 0-23 months had access to food that was sufficiently safe and nutritious to live a physically, socially, and economically active and healthy life.

Path analysis resulted in identifying the path model by referring to the degree of freedom (df) number, which, at 35, showed that the model was over-identified (df>0), meaning that there were more data points than parame-

Table 1. Description of Stunting Risk Factors at the District/City Level with a Stunting Prevalence of ≥30% in Indonesia, 2018 (n = 165)

Variable	Mean	SD	Min-Max
Stunting	37.03	6.07	30.00–66.67
Consumption of 90 tablets of iron-folic acid (%)	26.94	17.32	0.00–80.55
Antenatal care (%) (1-1-2)	59.04	19.54	0.00–92.86
Contraceptive use (%)	59.47	21.18	0.00–93.02
Low birth weight (less than 2,500 gram) (%)	12.96	6.58	0.00–31.13
Exclusive breastfeeding (%)	49.87	15.39	12.5–90.28
Vitamin A supplementation (2x a year) (%)	29.00	12.21	0.00–58.70
Early initiation of breastfeeding (%)	53.41	16.58	12.5–87.04
Complete basic immunization (%)	46.78	24.16	0.00–88.67
Access to health care facilities (%)	66.04	15.58	18.37–100.0
Access to basic sanitation (%)	36.85	18.43	0.00–86.30
Access to food (%)	12.85	13.60	0.00–88.24
Access to safe drinking water (%)	87.19	14.12	25.00–100.0
Handwashing with soap (%)	73.42	21.01	0.00–100.0
Mother's education (≥ senior high school) (%)	15.47	8.18	0.00–43.68
GRDP per capita (thousand rupiahs) (%)	41.761	42.265	9.435–337.450

Notes: SD = Standard Deviation, GRDP = Gross Regional Domestic Product



Notes: The red-printed path coefficient has a p-value of >0.05, X1-X13: Exogenous constructs are independent variables that were not predicted by other variables in the model.
X14-X15, Y: Endogenous or endogenous constructs are factors predicted by one or more constructs.
LBW = Low Birth Weight, EB = Exclusive Breastfeeding, ANC = Antenatal Care, IFA = Iron-Folic Acid, EIB = Early Initiation of Breastfeeding, GRDP = Gross Regional Domestic Product, HWS = Handwashing with Soap.

Figure 1. The First Model of the District/City Level Stunting Risk Prevention Pathway with a Stunting Prevalence of ≥30%

ters. Thus, path analysis could be completed on this model. The path diagram presented in Figure 1 tested the model's assumptions (homoscedasticity, existence, independence, linearity, and normality), and the model fulfilled five types of assumption tests (Table 2).

The path analysis model showed that variables were not significantly related to the stunting prevalence (Table 2). Therefore, to arrive at the best model, variables that were not significantly related to stunting prevalence were omitted from the model, starting with removing the variable with the largest p-value, so that a model with a variable with a p-value of less than 0.05 was obtained (Figure 2).

Simultaneous relationships between exclusive breastfeeding (EB), low birth weight (LBW), GRDP per capita, maternal education, consumption of ≥90 iron-folic acid (IFA) tablets by pregnant women, antenatal care (ANC), family planning, vitamin A supplementation, complete basic immunization, access to health care facilities, food, safe drinking water, sanitation, and handwashing with soap were related to stunting prevalence in district/city level with a stunting prevalence of ≥30% at R2 = 0.5151. The variable contribution of EB, LBW, GRDP per capita, maternal education, IFA tablets for pregnant women, pregnancy check-ups, family planning, vitamin A supplementation, complete basic immunization, access to health care facilities, food, safe drinking water, sanitation, and handwashing with soap towards stunting prevalence in district/city level with stunting prevalence of ≥30% was 0.5151 x 100% = 51.51%. The remainder (residual) was 1 - 0.5151 = 0.4849 x 100% = 48.49% influenced by other factors.

The complete model that was built fulfilled the model fit test with the data using a fit index. The next stage involved removing the variable with the largest p-value from the model to obtain a fit and significance model (Figure 2). The final path model obtained was a suitable and significant model. This means that the path model obtained was acceptable and fit the theory and data well. Simultaneous relationship between pregnancy check-ups,

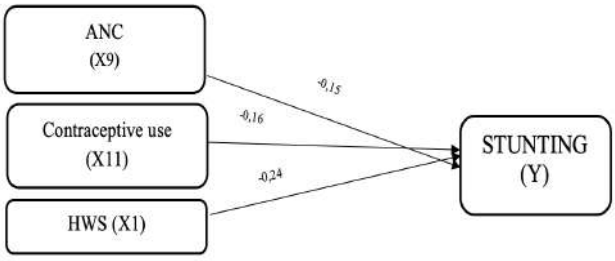
Table 2. Direct, Indirect, and Total Relationships of Stunting Risk Factors at District/City Level with a Stunting Prevalence of ≥ 30%, 2018 (n = 165)

	Relationship				
	Direct	Indirect		Total	Contribution (%)
		Through EB Variable	Through LBW Variable		
Stunting (Y) ← EB (X14)	0.06	-	-	0.06	0.36
Stunting (Y) ← LBW (X15)	-0.19	-	-	-0.19	4.0
Stunting (Y) ← GRDP Per Capita (X4)	-	0.001	-	0.001	0.001
Stunting (Y) ← Maternal Education (X7)	-0.02	-0.003	0.004	-0.018	4.0
Stunting (Y) ← Consumption of ≥90 tablets of IFA (X8)	-0.06	0.02*	-0.03	-0.070.49	
Stunting (Y) ← ANC (X9)	-0.009	-0.014	0.03	0.002	0.04
Stunting (Y) ← Contraceptive use (X11)	-0.06	-	-0.04	-0.11	1.21
Stunting (Y) ← Vitamin A (X2)	0.002	-	-	0.002	0.001
Stunting (Y) ← EIB (X5)	-0.15	0.03*	-	-0.12	1.44
Stunting (Y) ← Immunization (X3)	-0.19	-	-	-0.19	3.61
Stunting (Y) ← Access to health care facilities (X10)	-0.18	-0.001	0.01	-0.16	2.56
Stunting (Y) ← Access to food (X6)	-0.05	0.003	-0.03	-0.08	0.64
Stunting (Y) ← Access to safe drinking water (X13)	-0.04	-	-0.04	-0.08	0.25
Stunting (Y) ← Access to basic sanitation (X12)	0.14	-	-	-0.07	2.56
Stunting (Y) ← HWS (X1)	-0.07	-	-	-0.07	0.49

Notes: *p-value<0.05, EB = Exclusive Breastfeeding, LBW = Low Birth Weight, GRDP = Gross Regional Domestic Product, IFA = Iron-Folic Acid, ANC = Antenatal Care, EIB = Early Initiation of Breastfeeding, HWS = Handwashing with Soap.

family planning, and handwashing with soap and the stunting prevalence at the district/city level with a stunting prevalence of ≥30% was R2 = 0.1818. The magnitude of the contribution of the variables of pregnancy check-ups, family planning, and handwashing with soap with the stunting prevalence at the district/city level in the stunting category of ≥30% was 0.1818 x 100% = 18.18%. The rest (residual) was 1 - 0.1818 = 0.8182 x 100% = 81.82% influenced by other factors.

Based on the fit test index for the stunting risk prevention pathway model at the district/city level (Table 3), the stunting prevalence of ≥30% tested met four of the five existing fit index criteria. Thus, the stunting risk prevention pathway model at the district/city level with a stunting prevalence of ≥30% can be statistically fit. While, the stunting risk prevention pathway model showed that the risk factors that significantly contributed to the stunting prevalence at the district/city level were ANC (2.56%), contraceptive use (2.25%), and HWS (5.76%) (Figure 3).



Notes: ANC = Antenatal Care, HWS = Handwashing with Soap.
X1, X9, X11: Exogenous constructs were independent variables not predicted by other variables in the model. Y: Endogenous or endogenous constructs were factors predicted by one or more constructs.

Figure 2. The Best District/City Level Risk Prevention Pathway Model with a Stunting Prevalence of ≥30%

Discussion

District/City Level Stunting Prevalence

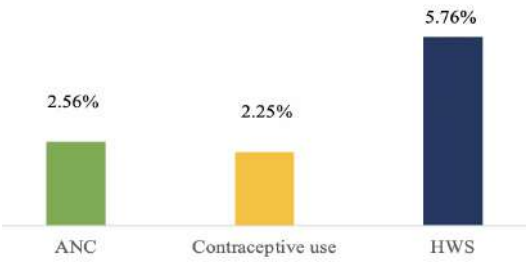
Referring to the WHO classification regarding the magnitude of the public health problem, which is stunting,[24] from the data of 165 districts/cities in Indonesia that were analyzed, 40 districts/cities (24.24%) had a stunting prevalence of >40%. Although there has been a decline in stunted children under five in Indonesia, it has not yet reached 14%, which is the National Medium-Term Plan 2024 target.[30] The 2018 National Socioeconomic Survey and 2019 Indonesian Toddler Nutritional Status showed that stunting was reported only in children aged 0-59 months (30.8% in 2018 and 27.67% in 2019).[4] Therefore, this study focused on analyzing the stunted children aged 0-23 months at the district/city level and various risk factors for stunting to find a pathway model to help reduce stunting at the district/city level.

Relative to the percentage values of several stunting handling indicators in the Special Index for Handling Stunting 2018-2019,[31] and expert's opinion,[32] it is understood that promotional and preventive efforts at stunting prevention are effective if they reach 90% of the goals. This study results found that 20 districts/cities had

Table 3. The Goodness of Fit Test Pathway Model for Risk Prevention at Indonesian District/City Level with a Stunting Prevalence of ≥30%

Fit Index		First Model		Best Model		Fit Criteria
		Value	Conclusion	Value	Conclusion	
Absolute	p-value (Chi-square)	0.40	Fit	0.001	Not Fit	>0.05
	RMSEA	0.028	Fit	0.001	Fit	0.08
	SRMR	0.037	Fit	0.001	Fit	<0.05
Incremental	CFI	0.964	Fit	1.0	Fit	>0.9
	TLI	0.9	Threshold	1.0	Fit	>0.9

Notes: RMSEA = Root Mean Square Error of Approximation, SRMR = Standardized Root Mean Square Residual, CFI = Comparative Fit Index, TLI = Tucker-Lewis Index.



Notes: ANC = Antenatal Care, EIB = Early Initiation of Breastfeeding, HWS = Handwashing with Soap.

Figure 3. The Contribution of Antenatal Care, Contraceptive Use, and Handwashing with Soap at the District/City Level with a Stunting Prevalence of ≥30%

100% access to safe drinking water, while 59 districts/cities had below 87.19%. This means that most of children aged 0-23 months in districts/cities with a stunting prevalence of ≥30% had access to and used drinking water that met the quality requirements (branded bottled water, tap water, or local water company, borehole wells or pumps, wells protected digging, protected springs, recharged water, or rainwater reservoir). Following the Regulation of the Minister of Health of the Republic of Indonesia No. 32 of 2017 Concerning Water Requirements for Sanitation Hygiene Purposes, the physical quality of drinking water must meet health requirements, which must be not cloudy, clear, tasteless, odorless, not contaminated with chemicals, and free of various microorganisms that can cause harm.[33] The 2014 Indonesian Family Life Survey data reported that children under five living in households with inadequate drinking water sources were at 1.21 times higher risk of stunting than children living in households with access to better drinking water sources.[34]

Access to food as a risk factor for stunting in districts/cities with a stunting prevalence of ≥30% was recorded at 12.85%, meaning that a total of 114 (69.09%) districts/cities had below 12.85% access to food. Thus, in general, there were a few households with children aged 0-23 months in districts/cities with a stunting prevalence of ≥30% that had physical, social, and economic access to sufficient, safe, and nutritious food based on the food needs of household members for an active and healthy life. In other words, children in families with limited access to food tended not to meet their intake needs, which impacted stunting. Food-insecure households tend to provide less intake to children. Study on stunted and non-stunted children in the coastal area of the Probolinggo District, East Java Province, Indonesia found a difference in the amount of intake given to stunted and non-stunted children. Stunted children tend to be given less intake, and the children's nutritional needs are not met.[35] Families of stunted children are also reported to dislike diverse foods, especially vegetables and foods from the sea.[36]

District/City-Level Stunting Risk Prevention Pathway Model

The stunting risk prevention pathway model in districts/cities with a stunting prevalence of ≥30% was based on the model explaining the causal relationship between research variables. The path model also fulfilled six assumption tests in path analysis: normality, linearity, multicollinearity, independence, existence, and homoscedasticity. The path model at the district/city level with a stunting prevalence of ≥30% showed that there were direct and indirect relationships between various endogenous variables and the stunting prevalence at the district/city level. The final path model showed that standard ANC, contraceptive use, and handwashing with soap had a significant relationship with the stunting prevalence at the district/city level and had a negative path coefficient value. This means that an increase in the percentage of ANC, contraceptive use, and handwashing with soap according to standards (path coefficient = -0.15, -0.16, and -0.24, respectively) will result in a decrease in the stunting prevalence in districts/cities with a

stunting prevalence of ≥30%.

Handwashing with soap contributed significantly to the reduction in stunting prevalence at the district/city level. Stunting prevalence was ≥30%, and the most significant contribution was stunting prevalence of 5.76%. A previous study described the association of handwashing with soap and the incidence of stunting.[37] Handwashing with soap can eliminate bacteria and viruses on the hands. Since the mother is active with the child, handwashing with soap can prevent the spread and transmission of disease. Deaths of children under five in Indonesia can be prevented by better hygiene, especially handwashing with soap. Moreover, handwashing with soap can potentially prevent diarrheal diseases, especially in developing countries.[37] The 2018 National Basic Health Research reported that 12.3% of diarrhea occurred in children under five in Indonesia.[3] Diarrhea is the cause of 18% of all deaths of children under five in Indonesia.[3] Although this study cannot prove the relationship between handwashing with soap and infectious diseases (diarrhea), referring to the United Nations Children's Emergency Fund (UNICEF) stunting conceptual framework, which states that repeated infections are the direct cause of stunting, an increase in the percentage of handwashing with soap will reduce stunting prevalence.[38]

The National Basic Health Research in 2018 reported that ANC in Indonesia increased compared to the 2013.[3] In 2018, 96.1% of expectant mothers had first ANC visit (K1), compared to 95.2% in 2013. The fourth pregnancy check-up visit (K4) was 74.1% in 2018 and 70% in 2013. Although there has been an increase in the percentage of pregnancy check-ups nationally, the distribution at the provincial level shows a significant disparity. The Eastern Indonesia regions (Maluku and Papua) have lowest rates of ANC. The Sumatra region has a distribution of ANC one level above it. In contrast, the best ANC distribution is concentrated in Indonesia's central regions (Java and Bali).[39] This study's result also found a significant variation in the distribution of prenatal care at the district/city level. Districts/cities with a stunting prevalence ≥30% found the highest percentage of ANC in Sukoharjo District, Central Java Province, Indonesia (92.86%) and the lowest (0%) in Nduga and Puncak Districts, Papua Province.

The stunting prevention pathway model suggests that contraceptive use is directly related to reducing stunting prevalence at the district/city level. The use of modern contraceptives aimed at regulating the birth of children, achieving an ideal spacing between childbirths, regulating pregnancy, and creating a quality family.[40] Planning birth spacing may give mothers enough time to recover after giving birth to provide good parenting for their children.[41] Analysis of the 2013 National Basic Health Research data showed that the risk of child stunting increased if the child lived in a household with more than three toddlers.[20] Maintaining birth spacing is important in preventing stunting in children aged 0-23 months at the district/city level with a stunting prevalence ≥30%.

There were certain limitations to this study. First, the data used were cross-sectional. Hence, the analysis could not provide evidence of a significant relationship between stunting prevalence and the success of the intervention. Furthermore, data on private practice were based on mothers' memories, which was likely biased. Despite its limitations, this study achieved a model of the stunting risk prevention pathway for children aged 0-23 months at the district/city level that can be taken into consideration by policymakers at the district/city level in an effort to accelerate the reduction in stunting prevalence in Indonesia.

Conclusion

The stunting risk prevention pathway model at the district/city level shows that stunting ini districts/cities with a stunting prevalence of ≥30% is caused by many factors as evidenced by the direct and indirect relationship of various stunting risk factors with stunting prevalence. The path model showed a direct relationship between antenatal care visit, contraceptive use, and handwashing with soap with stunting. A high number of ANC visits, high contraceptive use, and regular handwashing with soap are directly related to a reduction in stunting prevalence at the district/city level with a stunting prevalence of ≥30% by 18.18%.The path model meets all the goodness of fit criteria, so the model obtained is in accordance with the theoretical framework.

Abbreviations

Riskesdas: *Riset Kesehatan Dasar*; *SUSENAS*: *Survei Sosial Ekonomi Nasional*; SSGBI: *Survei Status Gizi Balita Indonesia*; UNICEF: the United Nations Children's Emergency Fund; LBW: Low Birth Weight; EIB: Early Initiation of Breastfeeding; WHO: World Health Organization; PPS: Probability Proportional to Size; GDRP: Gross Regional Domestic Product; SD: Standard Deviation; IDR: Indonesian Rupiah; df: Degree of Freedom; TLI: Tucker-Lewis Index; CFI: Comparative Fit Index; SRMR: Standardized Root Mean Square Residual; RMSEA: Root Mean Square Error of Approximation; IFA: Iron-folic Acid; EB: Exclusive Breastfeeding; ANC: Antenatal Care; HWS: Handwashing with Soap.

Ethics Approval and Consent to Participate

This study was conducted with an ethical permit from the Research Ethics Committee and Community Engagement of Faculty of Public Health University of Indonesia, number: Ket-09/UN2.F10. D11/PPM.00.02/2022 dated January 27, 2022. The 2018 Indonesian Basic Health Research data were obtained with an ethical permit from the Commission on Health Research Ethics, National Institute of Health

Research and Development, No. LB.02.01/2/KE.024/2018, Ref: Approval No: LB.02.01/2/KE.267/2017 dated July 27, 2017.

Competing Interest

This paper is important because the path model can be used to predict the magnitude of the relationship between risk factors and stunting at the district/city level to find an evidence-based prevention model to accelerate the achievement of the stunting reduction target of 14% in 2024, according to the National Medium-Term Plan. The paper should be of particular interest to readers in public health nutrition.

Availability of Data and Materials

The data were retrieved from the 2018 National Basic Health Research, National Socioeconomic Survey, and Statistics Indonesia.

Authors' Contribution

NF conceptualized the data analysis, interpreted data, and composed and completed manuscripts. TS and AK contributed to interpreting the data and drafting the manuscript. ELA and B contributed to the design and draft of the manuscript, while all authors read and approved the final version of the manuscript and agreed to be responsible for all aspects of the work.

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References

1. Kementerian Kesehatan Republik Indonesia. Buku saku pemantauan status gizi tahun 2017. Jakarta: Kementerian Kesehatan Republik Indonesia; 2018.
2. Ayuningtyas D, Hapsari D, Rachmalina R, et al. Geographic and socioeconomic disparity in child undernutrition across 514 districts in Indonesia. Nutrients. 2022; 14 (4): 843.
3. Kementerian Kesehatan Republik Indonesia. Laporan Nasional Riskesdas 2018. Jakarta: Badan Penelitian dan Pengembangan Kesehatan; 2019.
4. Kementerian Kesehatan Republik Indonesia. Pedoman pelaksanaan integrasi Susenas Maret 2019 dan studi status gizi balita Indonesia tahun 2019. Jakarta: Badan Pusat Statistik; 2018.
5. United Nations Children's Fund (UNICEF). Situasi anak di Indonesia - Tren, peluang, dan tantangan dalam memenuhi hak-hak anak. Jakarta: Unicef Indonesia; 2020.
6. Humas Litbangkes. Materi launching hasil studi SSGI tahun 2021. Kementerian Kesehatan Republik Indonesia; 2021.
7. Global Nutrition Report. Inequalities in the global burden of malnutrition. In: Global Nutrition Report; 2020. pp. 32–60.
8. Perignon M, Fiorentino M, Kuong K, Burja K, Parker M, Sisokhom S, et al. Stunting, poor iron status and parasite infection are significant risk factors for lower cognitive performance in Cambodian school-aged children. PLoS One. 2014; 9 (11): e112605.
9. Fatemi MJ, Fararouei M, Moravej H, Dianatinasab, M. Stunting and its associated factors among 6-7-year-old children in southern Iran: A nested case-control study. Public Health Nutr. 2018; 22: 55–62.
10. Akombi BJ, Agho KE, Hall JJ, et al. Stunting and severe stunting among children under-5 years in Nigeria: a multilevel analysis. BMC Pediatr. 2017; 17: 15.
11. Prendergast AJ, Humphrey JH. The stunting syndrome in developing countries. Paediatr Int Child Health. 2014; 34 (4): 250–65.
12. Akseer N, Vaivada T, Rothschild O, et al. Understanding multifactorial drivers of child stunting reduction in Exemplar countries: a mixed-methods approach. Am J Clin Nutr. 2020; 112 (2): 792S-805S.
13. Tasic H, Akseer N, Gebreyesus SH, et al. Drivers of stunting reduction in Ethiopia: a country case study. Am J Clin Nutr. 2020; 112 (Suppl 2): 875S-93S.
14. Huicho L, Tavera M, Huayanay-Espinoza CA, et al. Drivers of the progress achieved by Peru in reducing childhood diarrhoea mortality: A country case study. J Glob Health. 2019; 9 (2): 020805.
15. Tim Percepatan Pencegahan Anak Kerdil (Stunting) (TP2AK). Strategi nasional percepatan pencegahan anak kerdil (stunting). Edisi Kedua. Jakarta: Sekretariat Percepatan Pencegahan Stunting, Sekretariat Wakil Presiden Republik Indonesia; 2019.
16. Singh A, Upadhyay AK, Kumar K. Birth size, stunting and recovery from stunting in Andhra Pradesh, India: evidence from the young lives study. Matern Child Health J. 2017; 21 (3): 492–508.
17. Kismul H, Acharya P, Mapatano MA, Hatløy A. Determinants of childhood stunting in the Democratic Republic of Congo: further analysis of Demographic and Health Survey 2013-14. BMC Public Health. 2018; 18: 74.
18. Boulom S, Essink DR, Kang MH, et al. Factors associated with child malnutrition in mountainous ethnic minority communities in Lao PDR. Glob Health Action. 2020; 13 (sup2): 1785736.
19. Smith Fawzi MC, Andrews KG, Fink G, et al. Lifetime economic impact of the burden of childhood stunting attributable to maternal psychosocial risk factors in 137 low/middle-income countries. BMJ Glob Heal. 2019; 4 (1): e001144.
20. Titaley CR, Ariawan I, Hapsari D, et al. Determinants of the stunting of children in Indonesia: a multilevel analysis of the 2013 Indonesia Basic Health Survey. Nutrients. 2019; 11 (5): 1106.
21. Tim Percepatan Pencegahan Anak Kerdil (Stunting) (TP2AK). Laporan baseline program percepatan pencegahan stunting 2018-2024. Jakarta: Sekretariat Wakil Presiden Republik Indonesia; 2021.
22. Djauhari T. Gizi Dan 1000 HPK. Saintika Med. 2017; 13 (2): 125.
23. de Onis M, Branca F. Childhood stunting: a global perspective. Matern Child Nutr. 2016; 12 (Suppl 1): 12–26.
24. World Health Organization. Nutrition landscape information system (NLiS); 2022
25. Badan Penelitian dan Pengembangan Kesehatan Republik Indonesia. Pedoman pengisian kuesioner Riskesdas 2018. Jakarta: Kementerian Kesehatan RI, Badan Penelitian dan Pengembangan Kesehatan; 2018.
26. World Health Organization. The WHO child growth standards. World Health Organization.
27. Kementerian Kesehatan Republik Indonesia. Peraturan Menteri Kesehatan Tentang Standar Antropometri Anak. Jakarta: Kementerian Kesehatan Republik Indonesia; 2020.
28. Sarwono J. Analisis jalur untuk riset. Yogyakarta: Andi; 2007.
29. Haryono S. Metode SEM untuk penelitian manajemen dengan AMOS

LISRE PLS. Jakarta Timur: Luxima Metro Media; 2017.
30. Presiden Republik Indonesia. Rencana Pembangunan Jangka Menengah Nasional (RPJMN) 2015-2019. Jakarta: Kementerian Perencanaan Pembangunan Nasional/Badan Perencanaan Pembangunan Nasional; 2014.
31. Badan Pusat Statistik. Laporan indeks khusus penanganan stunting 2018-2019. Jakarta: Badan Pusat Statistik; 2021.
32. Achadi EL, Achadi A, Aninditha T. Pencegahan stunting pentingnya peran 1000 hari pertama kehidupan. Jakarta: PT. RajaGrafindo Persada; 2020.
33. Kementerian Kesehatan Republik Indonesia. Peraturan Menteri Kesehatan Tentang Standar Baku Mutu Kesehatan Lingkungan dan Persyaratan Kesehatan Air Untuk Keperluan Higiene Sanitasi, Kolam Renang, Solus Per Aqua, dan Pemandian Umum. Jakarta: Kementerian Kesehatan Republik Indonesia; 2017.
34. Irianti S, Prasetyoputra P, Dharmayanti I, Azhar K, Hidayaningsih PS. The role of drinking water source, sanitation, and solid waste management in reducing childhood stunting in Indonesia. IOP Conf Ser Earth Environ Sci. 2019; 344: 012009.
35. Femidio M, Muniroh L. Perbedaan pola asuh dan tingkat kecukupan zat gizi pada balita stunting dan non-stunting di wilayah pesisir Kabupaten Probolinggo. Amerta Nutr. 2020; 4 (1): 49.
36. Ningrum V. Akses pangan dan kejadian balita stunting: kasus pedesaan pertanian di klaten. Pangan. 2019; 28 (1): 73–82.
37. Kementerian Kesehatan Republik Indonesia, United Nations Children's Fund (UNICEF). Intervensi perubahan perilaku untuk penguatan cuci tangan pakai sabun (HWWS) di Indonesia: panduan orientasi untuk fasilitator dan praktisi. Jakarta: UNICEF Indonesia; 2021.
38. United Nations Children's Fund (UNICEF). Strategy for improved nutrition of children and women in developing countries. Indian J Pediatrics. 1991; 58: 13-24.
39. Laksono AD, Rukmini R, Wulandari RD. Regional disparities in antenatal care utilization in Indonesia. PLoS One. 2020; 15 (2): e0224006.
40. Kementerian Kesehatan Republik Indonesia. Situasi dan Analisis Keluarga Berencana.
41. Nurjanah N, Septiani TD. Hubungan jarak kelahiran dan jumlah balita dengan status gizi di RW 07 wilayah kerja Puskesmas Cijerah Kota Bandung. J Keperawatan Anak. 2013; 1 (2): 120–6.

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Model Autonomy of Self-Finance Management for Primary Health Care to Enhance Workers' Satisfaction

Ahmad Jet Alamin[1]*, Ossama Issac[1], Lina Teo[1], Atikah Adyas[2]

[1]Department of Business and Accounting, Faculty of Management, Lincoln University College, Selangor Darul Ehsan, Malaysia, [2]Magister Program of Department of Public Health, Faculty of Health Science, Universitas Mitra Indonesia, Bandar Lampung, Indonesia

Abstract

This study aimed to find an appropriate model of autonomous self-finance management in primary health care (PHC) to enhance workers' satisfaction. This was a cross-sectional study in which data were collected through self-administered questionnaires from 204 workers in ten Regional Public Service Agency for Primary Health Care (RPSAPHC)/*Badan Layanan Umum Daerah Pusat Kesehatan Masyarakat* (*BLUD Puskesmas*) in Tangerang District, Banten Province, Indonesia using the partial least squares and structural equation model (PLS-SEM). A total of 73 indicators were used to examine the PHC transformation process to enhance workers' satisfaction. The indicators were grouped into three variables depending on workers' satisfaction: intrinsic, extrinsic, and general satisfaction. In addition, there were five independent variables: financial accountability, generating income, structuring human resources, increasing service quality, and consumer satisfaction. Model autonomy was reflected by all the indicators (cross-loading > 0.70, Cronbach's alpha > 0.70, average variance extracted > 0.5) affecting workers' satisfaction (path coefficient = 0.196, p-value = 0.002). The management should apply five indicators (financial accountability, increasing income, structuring human resources, improving service quality, and customer satisfaction) affecting workers' satisfaction to transform the PHC.

Keywords: *BLUD Puskesmas*, unified component, workers' satisfaction

Introduction

The new public management concept was implemented and reformed in primary health care (PHC), predominantly in local government. This concept has shown improvement; however, public service reform still faces obstacles toward transformation processes; these obstacles are mainly related to human resources.[1–4] Human resources need to be considered as they play an important role in the success of operational management to achieve organizational goals. A previous study showed that three-quarter of the respondents were dissatisfied with their working conditions.[5] Doctors working in public health care facilities feel burdened with higher administrative work compared to those who work in private ones.[6] Furthermore, health workers in the first-level services complain that their salaries are not worth the services they provide.[7,8]

Since 2007, PHC has been granted the autonomy to manage its budget in Indonesia. This regulation is called Regional Public Service Agency for Primary Health Care (RPSAPHC)/*Badan Layanan Umum Daerah Pusat Kesehatan Masyarakat* (*BLUD Puskesmas*).[9] However, less than 50% of the PHC comprehend this autonomy's philosophy and flexibility.[10] Human resources departments are not yet (in terms of reforms) ready for autonomy.[11,12] Some inhibiting factors of autonomy in PHC lie in the transformation process of the operational management and the challenges in terms of fairness as perceived by employees.[11] An evaluation showed that the reform was not balanced to accommodate its function; thus, PHC policies require a comprehensive review.[13] The new autonomy is needed to improve the operational management of public services through an effective transformation process.[14] In organizational environments, such as education, experience, and government support must be considered because they can influence the achievement of organizational goals.[15] Similarly, PHC reform requires key elements as specific indicators to improve performance.[16]

Some components reflecting autonomy are important in the transformation process of PHC management: financial accountability, generating income, structuring human resources, increasing quality services, and customer satisfaction.[17] The PHC needs to reflect financial

***Correspondence**:* *Ahmad Jet Alamin, Department of Business and Accounting, Faculty of Management, Lincoln University College, No.2, Alan Stadium, SS 7/15 Kelana Jaya 47301, Petaling Jaya, Selangor Darul Ehsan, Malaysia, E-mail: jet.alaminadyas@gmail.com, Phone: +62 813 1019 6390*

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accountability and gain income that will increase revenue and incentivize their workers.[18,19] For health services to change, improving human resources is really important.[20] Whereas improving the quality of health services is increasingly vital, health centers must also pay attention to patient's satisfaction.[21] Ultimately, the satisfactory results of the transformation process may be generated by satisfied workers, which in turn will result in satisfied consumers.[22] The partial least squares method created a structural model that can map paths with many variables.[23] This study aimed to find an appropriate model of PHC autonomy by examining components in the transformation process through the operational management of autonomous self-finance management (SFM) to enhance workers' satisfaction, with the following moderation effects: educational background, working experience, and government support in the Tangerang District, Banten Province, Indonesia.

Method

This study used a cross-sectional method. Data were collected from self-administered questionnaires consisted of 78 questions filled out by health care workers in ten RPSAPHC of Tangerang District, Banten Province, Indonesia, from January to February 2019. The population of this study consisted of 289 health care workers,[24] and following the Morgan's table, the sample size in this study was 244, with a confidence of 99% and a margin of error of 3.5%.[25] Several steps were taken to ensure there was no missing data.[26] This study used a partial least square for structural equation modeling (PLS-SEM) composite scheme with the SmartPLS 3.0 software (free version),[27] to analyze variables on autonomous SFM toward workers' satisfaction and the moderation effect, which consisted of 73 indicators. The theoretical model adopted in this study was associated with the operational management of RPSAPHC, workers' satisfaction, and organizational environment (Figure 1).[16,17,22]

This study consisted of two main variables, eight subvariables, and three modifier variables measuring 73 indicators. The following constructs made up this model: workers' satisfaction was the dependent variable, which referred to the degree to which individuals felt positive or negative about their jobs (Table 1). The workers'

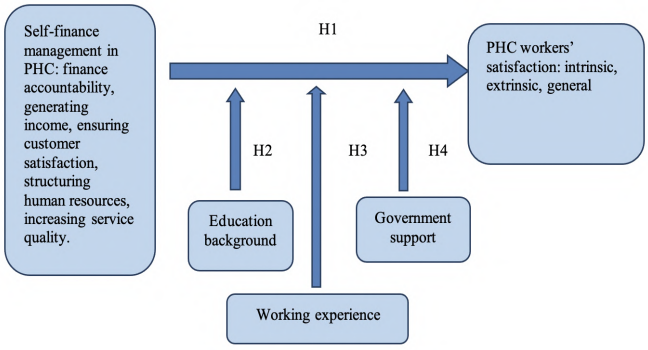

Figure 1. Hypothesized Structural Relationships of Self-Finance Management and Workers' Satisfaction

Table 1. Data Description

Variable	Composite	Indicator	Definition
SFM	Financial accountability	FA	Policy support, technical assistance, bookkeeping, financial reports, training finance, specific system, transparency, finance management, capitation funds, monitoring, and evaluation.
	Generating income	GI	Vision mission, business plans, asset management, ticket fees, price setting, capitation payment, expenses flexibility, entrepreneurship and innovation, increasing income, benchmarking.
	Structuring human resources	HR	Recruitment and placement, work performance, planning participation, overseeing the job, courses opportunity, work compensation, improved communication, community assessment, casual meeting, and understanding management.
	Improving service quality	ISQ	Fast and precise procedures, appropriate treatment, service schedules, operational standards, exact diagnosis, trained personnel, service security, cleanliness tools, quality standard, and patient satisfaction.
	Satisfying consumers	SC	Variety of services, no complicated procedures, response complaints, clear information, fast action, polite and friendly, patient attention, regardless of social status, comfort room and staff appearance, right path schedule.
Workers' satisfaction	Intrinsic satisfaction	Intri	Activity, independence, variety, social status, spiritual-moral value, security, social service, authority, ability, responsibility, creativity, and achievement.
	Extrinsic satisfaction	Extri	Supervising human relations, technical companies' policies and practices, compensation, advancement, and recognition.
	General satisfaction	General	Working conditions, coworkers' relationships.
Sociodemographic characteristics	Educational background	Edu	Level of formal education from elementary school to college.
	Working experience	Work	Working period since becoming an employee at a prmary health care.
	Government support	Govt	Government decisions on the minimum wage.

Notes: SFM = Self-Finance Management, FA = Financial Accountability, GI = Generating Income, HR = Structuring Human Resources, ISQ = Increasing Service Quality, SC = Satisfying Consumers, Intri = Intrinsic Satisfaction, Extri = Extrinsic Satisfaction, General = General Satisfaction, Edu = Education, Govt = Government.

satisfaction was measured using 20 indicators, which were divided into 12 intrinsic indicators, six extrinsic indicators, and two general indicators. Intrinsic job satisfaction reflects the tasks and how people feel about their job. Extrinsic job satisfaction paid attention to aspects indirectly or only slightly related to doing the duties. General job satisfaction refers to working conditions and working with coworkers. The independent variable consisted of five sub-variables: financial accountability (FA), generating income (GI), structuring human resources (HR), increasing service quality (ISQ), and satisfying consumers (SC). Each component had ten indicators; thus, 50 indicators were consolidated into the SFM. In modifier effects, there were three indicators: educational background, working experience, and government support. Respondents were asked to indicate their level of agreement with the indicators of the SFM, as stated in a five-point Likert scale questionnaire ranging from 1 ("not good") to 5 ("best"). The questionnaires related to workers' satisfaction were asked on another five-point Likert scale ranging from 1 ("very dissatisfied") to 5 ("very satisfied"), which referred to the Minnesota Satisfying Questionnaire.[28] The respondents filled out the characteristics, education, working experience, and government support.

Results

Table 2 shows the sociodemographic data of the health care workers of ten RPSAPHC in the Tangerang District, Banten Province, Indonesia. The 204 respondents were aged 18–40 years (64.7%). In terms of the characteristics of sex, education level, working experience, and monthly income, 84.3% were females, 84.3% attained senior high school, 65.3% had more than five years of working experience, and 71.5% earned above the minimum wage of Tangerang District, which amounted to Indonesian Rupiah (IDR) 3,555,834.67. The permanent and non-permanent employment statuses were 55.4% and 44.6%, respectively. As much as 80% of health care workers were satisfied with the intrinsic indicators, and 60% were dissatisfied with the extrinsic and general indicators.

The results of the analysis of the outer model are presented in Table 3. The composite validity in Table 3 shows that the building indicator of the variable is feasible because of the strong correlation between variables and indicators (original sample >0.70 and p-value<0.05).

The discriminant validity in Table 4 shows that the indicators are a makeup variable. The results of the cross-loading of intrinsic, extrinsic, and general variables indicate that the correlation with workers' satisfaction is more substantial than the SFM variable. Another indicator that can be used as a determinant of convergent validity is the average variance extracted (AVE); both latent variables should be ≥0.50. Composite reliability (CR) was used to determine the construct measures' internal consistency reliability, which must be greater than 0.7. Cronbach's alpha was applied to measure the reliability

Table 2. Sociodemographic Data of Health Care Workers in Ten Regional Public Service Agency of Tangerang District, Banten Province, Indonesia (n = 244)

Variable	Category	n	%
Age	18-40	132	64.7
	41-57	72	35.3
Sex	Male	32	15.7
	Female	172	84.3
Education level	Primary education	5	2.5
	Secondary education	27	13.2
	High education	172	84.3
Working experience	0-2 years	36	17.6
	3-5 years	35	17.2
	6-10 years	44	21.6
	11-15 years	35	17.2
	>15 years	54	26.5
Employment status	Permanent government officer	113	55.4
	Non-permanent government officer	91	44.6
House-office distance	Close (<2km)	91	44.6
	Far (>2 km)	112	55.4
Working hours	8 hours	137	67.2
	>8 hours	67	32.8
Monthly income (IDR)	>4.6 million	98	48
	3.6–4.6 million	48	23.5
	<3.6 million	58	28.4

Table 3. The Validity of the Outer Model

Relationship Validity of Variable and Indicator	Original Sample (Loading Value) (O)	Sample Mean (M)	Standard Deviation (SD)	T Statistics (|O/SD|)	p-value
Extri on workers' satisfaction	0.885	0.878	0.046	19.329	<0.001
Intri on workers' satisfaction	0.912	0.908	0.029	31.157	<0.001
General on workers' satisfaction	0.907	0.905	0.032	28.069	<0.001
FA on SFM	0.835	0.83	0.069	12.092	<0.001
GI on SFM	0.867	0.865	0.056	15.352	<0.001
HR on SFM	0.898	0.887	0.051	17.521	<0.001
ISQ on SFM	0.813	0.807	0.068	12.012	<0.001
SC on SFM	0.752	0.748	0.089	8.494	<0.001

Notes: SFM = Self-Finance Management, FA = Financial Accountability, GI = Generating Income, HR = Human Resources, ISQ = Increasing Service Quality , SC = Satisfying Consumers, Intri = Intrinsic Satisfaction, Extri = Extrinsic Satisfaction.

Table 4. The Cross-Loading Factor in Discriminant Validity

Variable Indicators	Self-Finance Management	Workers' Satisfaction
Extri	0.175	0.885
Intri	0.165	0.912
General	0.188	0.907
FA	0.835	0.197
GI	0.867	0.190
HR	0.898	0.169
ISQ	0.813	0.120
SC	0.752	0.103

Notes: Intri = Intrinsic Satisfaction, Extri = Extrinsic Satisfaction, General = General Satisfaction, FA = Financial Accountability, GI = Generating Income, HR = Human Resources, ISQ = Increasing Service Quality, SC = Satisfying Consumers.

Table 5. Validity and Reliability Measurement

Composite	AVE	CR	Cronbach's Alpha
Self-finance management	0.697	0.920	0.893
Workers' satisfaction	0.813	0.929	0.885

Notes: AVE = Average Variance Extracted, CR = Composite Reliability.

model, and the minimum value was 0.7. Table 5 shows that the measurement model fits the criteria.

Regarding the inner model evaluation, the coefficient of influence showed the positive effect of SFM on workers' satisfaction (O = 0.196, t = 3.114 (>1, p-value less than 0.05). The structural model was assessed to analyze the effect of SFM on workers' satisfaction. The SFM was found to have a positive effect on workers' satisfaction (O = 0.201, p-value = 0.002). Education, experience, and government support did not affect workers' satisfaction (O<0.196, p-value>0.05).

This model explains that autonomous SFM, which consists of five unify, has a positive effect on workers' satisfaction, with a coefficient of 0.201 and p-value of 0.002. Education, length of experience, and government support did not affect the relationship between SFM and workers' satisfaction (O<0.196).

Discussion

The implementation of public service reform is still experiencing obstacles, especially related to human resources,[1–4] including reforms in the autonomy of PHC in Indonesia, otherwise called RPSAPHC,[7] which were authorized for SFM. In this cross-sectional study,[29] PLS-SEMs were used to examine the suitability of the model of autonomous self-finance management in PHC to enhance workers' satisfaction. All workers with at least two years of experience from the ten RPSAPHC in Tangerang District, Banten Province, Indonesia, were employed to demonstrate the transformation process of autonomy at each PHC and their satisfaction.

This study analyzed a total of 70 indicators grouped into independent variables of SFM (FA, GI, HR, ISQ, CS: 50 indicators) and dependent variables of workers' satisfaction (intrinsic, extrinsic, general: 20 indicators), which were significant enough constitute the model. These indicators aligned with the need to evaluate the autonomy of RPSAPHC reform, based on public administration and local systems that can produce a synergistic effect.[30] The indicator of FA and GI were part of the institutional reforms in public facilities that aimed to realize public accountability in budgeting, strengthening legislative oversight, and modernization of internal and external audits.[31,32] Strengthening HR followed experts' opinions, which stated that improving the appearance of PHC assessments with specific indicators was necessary.[33] Likewise, indicators of ISQ were in line with the review of PHC reform.[34] While, the importance of SC was in accordance with the review of RPSAPHC autonomy reform that reported patients' low satisfaction in which most were National Health Insurance (NHI) participants expecting good service.[35] In terms of workers' satisfaction, its indicators were in accordance with that of healthcare providers, who agreed that job satisfaction is a category for the performance-measuring domain.[36] Workers' satisfaction is part of a series of services that must not be interrupted, as it is interconnected with the other parts of the services.

After all the indicators were found to be significant, this study examined the relationship between autonomous SFM and workers' satisfaction. This model explained that autonomous SFM influences workers' satisfaction. This study followed the need to apply key performance indicators to influence the transformation of local governments at the district level.[37] Similarly, the weakness of the RPSAPHC implementation lay in human resources.[38] Semarang District, Central Java Province, Indonesia, showed that job satisfaction of the health care workers in RPSAPHC was higher in non-RPSA ones, but only in terms of the indicators of coworkers. Workers in both the non and RPSAPHC had the same high satisfaction regarding spirituality.[39] The results of this study strengthen the policy of the Tangerang District Government to extend the autonomy of the current RPSAPHC to all 43 PHCs in the district.[17] Similarly, policies at the central level seek to implement RPSAPHC at all PHCs in Indonesia.[40] Although the current implementation of the RPSAPHC autonomy cannot run optimally.[41,42]

Most respondents had a high level of education (higher than senior high school), had more than five years of work experience, and earned an income above the minimum wage according to regulations issued by the Tangerang District Government (Table 2). These three

indicators of modifier variables had been shown not to affect the relationship between RPSAPHC and workers' satisfaction. These findings differ from a previous study reporting that the level of education was significantly associated with physicians' job satisfaction.[43] Government support in setting salaries is related to work motivation, which impacts job satisfaction.[44] Likewise, government support in the form of job control, such as in this study, had a modifier effect on the relationship between workload and job satisfaction.[45] Finally, while work experience was not an effect modifier, it was found to affect workers' performance alongside workers' satisfaction.[46]

The data revealed that the number of respondents with permanent status as government officers was approximately the same as the non-permanent ones. Therefore, the Tangerang District Government and the Central Government need to take special considerations to determine the salary of workers. For the continuity of an organization, it is necessary to pay attention to human resources, as workers' salaries assess their attitude and job satisfaction.[47,48]

The PLS-SEM analysis can be carried out quickly in specific populations through a cross-sectional approach. This model is designed to determine the respondents' reactions to autonomous SFM's ability to enhance workers' satisfaction at specific times. The RPSAPHC that is not fully ready for the autonomy process needs to be strengthened regarding its operational management, improving services, and satisfying workers.[49] Therefore, it is necessary to carry out a further study with a longitudinal approach to facilitate the comparison of changes in autonomous SFM and workers' satisfaction within the observation period.[50]

Strengths and Limitations

The strengths of this study were determined through measuring the indicators of RPSAPHC: FA, GI, HR, ISQ, and CS, to enhance workers' satisfaction. These indicators of autonomy in PHC can influence workers' satisfaction resulting from policies that transform the PHC to be autonomous. This study is limited to the PHC in the Tangerang District, which has a specific environment that differs from PHC all over Indonesia. Even so, the Tangerang District is not very specific, considering that it is not far (about 19 km) from the Special Capital Region of Jakarta; thus, it has more access to changes. In addition, the Tangerang District includes the 11 most advanced regions in Indonesia. Lastly, similar changes at the district level can be considered for implementation.

Policy Implications and Future Study

This study is useful for policymakers, especially in developing autonomous SFM in PHC to enhance workers' satisfaction. The autonomy model developed in this study aligns with the statement on the urgency of political decentralization and regional autonomy through local perspectives by using a political decentralization/local democracy model approach.[20] The implementation of key performance indicators for government officers affected the provincial government's transformation (at the district level) in term of increasing the efficiency of its services to the public.[49,50] The results of this study have several implications for developing autonomy in PHC, particularly in supporting the policy of NHI in Indonesia, as RPSAPHC is needed because health care providers implement the NHI in Indonesia. Furthermore, people need high-quality services from PHC, and satisfied workers can provide this. This study contributes to the academic literature by applying PLS-SEM to explore the relationship between autonomous SFM and workers' satisfaction in public health centers. Subsequent studies can be conducted in other health centers to control the indicators of the autonomous SFM model in enhancing workers' satisfaction and ensure that the effect is clear compared to autonomy without SFM indicators.

Conclusion

This study shows that improving the management of autonomous health centers should be carried out comprehensively, covering at least five indicators: financial accountability, increasing income, structuring human resources, improving service quality, and customer satisfaction. The improvement of RPSAPHC should be followed by evaluating workers' satisfaction, including intrinsic, extrinsic, and general indicators. It is important to note that improvements in the management of RPSAPHC should also be reviewed concerning workers' satisfaction, which could later be used as an input for further policies by taking into the notion that education, work experience, and government support do not affect workers' satisfaction.

Abbreviations

PLS-SEM: Partial Least Squares and Structural Equation Model; PHC: Primary Health Care; RPSAPHC: Regional Public Service Agency for Primary Health Care; *BLUD Puskemas*: *Badan Layanan Umum Daerah Pusat Kesehatan Masyarakat*; SFM: Self-Finance Management; FA: Financial Accountability; GI: Generating Income; HR: Human Resources; ISQ: Increasing Service Quality; SC: Satisfying Consumers; AVE: average Variance Extracted; CR: Composite Reliability; IDR: Indonesia Rupiah; O: Original Sample; M: Sample Mean; SD: Standard Deviation; NHI: National Health Insurance.

Ethics Approval and Consent to Participate

This study involving human participants as health care workers were reviewed and approved by the Faculty of Management Science, Lincoln University College, Malaysia, and the Tangerang District Government. The workers/participants provided their written informed consent to

participate in the study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this manuscript.

Competing Interest

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

Availability of Data and Materials

Derived data supporting the findings of this study are available from the corresponding author on request. Requests to access the datasets should be directed to the authors.

Authors' Contribution

AJA developed a draft proposal and study design, collected data, and revised the results. While, OI, LT, and AA made study drafts, study designs, collected data, and revised the results. All authors contributed to the manuscript and approved the submitted version.

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References

1. Winengan W. Menakar penerapan new public management dalam birokrasi Indonesia. J Ilm Adm Publik. 2018; 4 (1): 66–74.
2. Al Khashan H, Abogazalah F, Alomary S, Nahhas M, Alwadey A, Al-Khudhair B, et al. Primary health care reform in Saudi Arabia: progress, challenges and prospects. East Mediterr Health J . 2021; 27(10): 1016–26.
3. Nunes AM, Ferreira DC. The health care reform in Portugal: Outcomes from both the New Public Management and the economic crisis. Int J Health Plann Manage. 2019; 34 (1): 196–215.
4. Indrayathi PA, Ulandari LPS. Basis for development of local public service primary health care business strategic plan in Gianyar District, Bali. Kesmas. 2016; 11 (2): 86–93.
5. Singh T, Kaur M, Verma M, Kumar R. Job satisfaction among health care providers: A cross-sectional study in public health facilities of Punjab, India. J Family Med Prim Care. 2019; 8 (10): 3268-75.
6. Ab Rahman N, Husin M, Dahian K, Mohamad Noh K, Atun R, Sivasampu S. Job satisfaction of public and private primary care physicians in Malaysia: analysis of findings from QUALICO-PC. Hum Resour Health. 2019; 17: 82.
7. Wasson JH, Sox HC, Miller HD. Aligning payments, services, and quality in primary care. JAMA. 2021; 326 (9): 805–6.
8. Fein O. Primary care physicians, health promotion and health care reform. J Healthc Commun. 2017; 2 (4): 1–2.
9. Menteri Dalam Negeri Republik Indonesia. Peraturan Menteri Dalam Negeri (Permendagri) Tentang Pedoman Teknis Pengelolaan Keuangan Badan Layanan Umum Daerah. Jakarta: Kementerian Dalam Negeri Republik Indonesia; 2007.
10. Burhan FA. Syncore Indonesia dorong puskesmas jadi BLUD. Jogjapolitan; 2018.
11. Espinosa-González AB, Normand C. Challenges in the implementation of primary health care reforms: a qualitative analysis of stakeholders' views in Turkey. BMJ Open. 2019; 9 (7): e027492.
12. Widaningtyas E. Kesiapan tata kelola puskesmas menjadi badan layanan umum daerah (BLUD). J Manaj Inf Kesehat Indones. 2018; 6 (1): 20-6.
13. Mahmoud MH, Othman R, Taher Mahmoud M Al. Performance Management System of Jordanian Public Sector Organizations: Greater Amman Municipality's (GAM) Experience. International Journal of Human Resource Studies. 2020; 10 (2): 308329-3083.
14. Irawan T, Latif RVN, Wahyuningsih W. Analisis existing dan forecasting Puskesmas BLUD Kota Pekalongan: upaya menuju kemandirian pengelolaan layanan kesehatan primer. J LITBANG KOTA PEKALONGAN. 2016; 11.
15. Jones GR. Organizational theory, design, and change. London: Pearson Education; 2010.
16. Waheduzzaman W. Challenges in transitioning from new public management to new public governance in a developing country context. Int J Public Sect Manag. 2019; 32 (7): 689–705.
17. Adyas AJ. An Implementation of self-financed management in Public Health Centre (Puskesmas Blud) to enhance workers satisfaction in Indonesia: moderation effect of demographic factors [Dissertation]. Malaysia: Lincoln College University; 2021.
18. BPPKD. Kementrian Dalam Negeri Republik Indonesia. Permendagri No.79 Tahun 2018 Tentang Badan layanan Umum Daerah; 2018.
19. Susanti G, Rifany R. Public service bureaucratic reform: a case study on coordination in one stop services (KPTSP) in Takalar Regency. Publik (Jurnal Ilmu Adm. 2020; 9 (2): 125–31.
20. Nilsen P, Seing I, Ericsson C, Birken SA, Schildmeijer K. Characteristics of successful changes in health care organizations: an interview study with physicians, registered nurses and assistant nurses. BMC Health Serv Res. 2020; 20: 147.
21. Mahdavi M, Parsaeian M, Jaafaripooyan E, Ghaffari S. Recent Iranian health system reform: an operational perspective to improve health services quality. Int J Heal Policy Manag. 2018; 7(1): 70–4.
22. Schroeder RG, Goldstein SM, Rungtusanatham MJ. Operations management in the supply chain: decisions & cases, 7th ed. New York: McGraw-Hill Education; 2017.
23. Ringle CM, Sarstedt M, Mitchell R, Gudergan SP. Partial least squares structural equation modeling in HRM research. Int J Hum Res Manag. 2018; 31 (12): 1617–43.
24. Badan Pusat Statistik Kabupaten Tangerang. Kabupaten Tangerang Dalam Angka 2019. Badan Pusat Statistik Kabupaten Tangerang; 2019.
25. Krejcie RV, Morgan WD. Determining sample size for research activities. Educ Psychol Meas. 1970; 30 (3): 607–10.
26. Kang H. The prevention and handling of the missing data. Korean J Anesthesiol. 2013; 64 (5): 402-6.
27. SmartPLS GmbH. SmartPLS 3 Free 30-days trial; 2022.
28. Weiss DJ, Dawis R, England G. Manual for the Minnesota Satisfaction Questionnaire. Minnesota Stud Voc Rehab. 1967; 22.
29. Levin KA. Study design III: Cross-sectional studies. Evid Based Dent.

2006; 7 (1): 24–5.
30. Hinson RE, Madichie N, Adeola O, Nyigmah Bawole J, Adisa I, Asamoah K. The new public management and the way forward in Africa. New Public Manag Africa. 2022; 317–26.
31. Apeloko OD, Jombo CO. Institutional reforms and mechanisms for public financial accountability in Nigeria: finding a recourse to horizontal arrangement. Int J Res Innov Soc Sci. 2019; 3 (3): 1–10.
32. Nilasari D. Pola Pengelolaan Keuangan Badan Layanan Umum Daerah (PPK-BLUD) Puskesmas di Wilayah Kota Mojokerto [Undergraduate Thesis]. Universitas Jember: 2021.
33. Kringos D, Nuti S, Anastasy C, Barry M, Murauskiene L, Siciliani L, et al. Re-thinking performance assessment for primary care: Opinion of the expert panel on effective ways of investing in health. European J Gen Pract. 2018; 25 (1): 55–61.
34. Li X, Krumholz HM, Yip W, Cheng KK, De Maeseneer J, Meng Q, et al. Quality of primary health care in China: challenges and recommendations. Lancet. 2020; 395 (10239): 1802–12.
35. Suryawati C, Nandini N, Handayani N. Kepuasan Pasien Terhadap Layanan Puskesmas BLUD di Kota Semarang. J Manaj Kesehat Indonesia. 2019; 7 (1): 39–45.
36. Owili PO, Hsu YHE, Chern JY, Chiu CHM, Wang B, Huang KC, Miriam AM. Perceptions and attitudes of health professionals in Kenya on National Health Care Resource allocation mechanisms: a structural equation modeling. PloS One; 2015.
37. Mahmoud M, Othman R. New public management in the developing countries: effects and implications on human resource management. J Gov Integr. 2021; 4 (2): 73–87.
38. Riambodo RM, Suryawati C, Arso SP. Analisis perencanaan anggaran pada Badan Layanan Umum Daerah (BLUD): studi kasus pada Puskesmas Halmahera dan Ngesrep di Kota Semarang. J Kebijak Kesehat Indonesia. 2020; 9 (1): 44–50.
39. Gumilang AA, Mahanggoro TP, Aini Q. Motivasi dan kepuasan kerja pegawai puskesmas BLUD dan non-BLUD Kabupaten Semarang. Heal Sci Pharm J. 2018; 2 (3).
40. Menteri Kesehatan Republik Indonesia. Peraturan Menteri Kesehatan Tentang Pedoman Pelaksanaan Program Jaminan Kesehatan Nasional. Jakarta: Kementerian Kesehatan Republik Indonesia; 2014.
41. Oktavia DA, Jati SP, Budiyanti RT. Hambatan penggunaan dana sisa perhitungan anggaran studi kasus di Puskesmas Kota Semarang. J Kesehat Masy. 2020; 8 (3): 304–10.
42. Cashin C, Bloom D, Sparkes S, Barroy H, Kutzin J, O'dougherty S. Aligning public financial management and health financing: sustaining progress toward universal health coverage. World Health Organization; 2017.
43. Liu D, Wu Y, Jiang F, Wang M, Liu Y, Tang YL. Gender differences in job satisfaction and work-life balance among Chinese physicians in tertiary public hospitals. Front Public Heal. 2021; 9: 635260.
44. Ayudia NPC, Hidayat AC, Setiawan Z. Analisis perbedaan motivasi kerja perawat Pegawai Negeri Sipil (PNS), perawat Badan Layanan Umum Daerah (BLUD) dan perawat Tenaga Harian Lepas (THL) di RSUD Dr. Soedirman Kebumen Berdasarkan Teori Dua Faktor Herzberg. J Ilm Ekon Glob Masa Kini. 2020; 11 (2): 103–8.
45. Rostami F, Babaei-Pouya A, Teimori-Boghsani G, Jahangirimehr A, Mehri Z, Maryam FA. Mental Workload and Job Satisfaction in Healthcare Workers: The Moderating Role of Job Control. Front Public Heal. 2021; 9: 683388.
46. Wahyudi W. The influence of job satisfaction and work experience on lecturer performance of Pamulang University. Sci J Reflect Econ Accounting Manag Bus. 2018; 1 (2): 221–30.
47. Dixit J, Goel S, Sharma V. A comparative study on the level of satisfaction among regular and contractual health-care workers in a Northern city of India. J Fam Med Prim Care. 2017; 6 (2): 416-23.
48. Robbins SP, Odendaal A, Roodt G. Organisational behaviour: global and Southern African perspectives. Cape Town: Pearson Education South Africa; 2003.
49. Insani N. Apparatus professionalism and public service ethics. J La Soc. 2020; 1 (1): 25–8.
50. Eranov A, Nuraliev S. Performance management in the civil service: evidence from Uzbekistan. Int J Civ Serv Reform Pract. 2021; 6 (2).

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Determinants of Type 2 Diabetes Mellitus among Passive Smokers

Adinda Rahma Triyaniarta[1], Santi Martini[2*], Kurnia Dwi Artanti[2], Sri Widati[2], Rizma Dwi Nastiti[2]

[1]Department of Environmental Health, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia, [2]Department of Epidemiology, Biostatistics, Population and Health Promotion, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia

Abstract

Type 2 diabetes mellitus (T2DM) leads to complications of other diseases. The modifiable risk factors for T2DM are overweight, physical activity, hypertension, unhealthy diet, and smoking. This study aimed to analyze determinants of T2DM incidence in passive smokers among various factors. This study was conducted at Hospital X in Surabaya City, East Java Province, Indonesia, from September 2019 to April 2020. The variables were univariate, bivariate, and multivariate. Case samples were T2DM patients and passive smokers, while control samples were non-T2DM patients and passive smokers, with 52 respondents per group, of 104 total respondents. Variables statistically significant related to the incidence of T2DM in passive smokers were age >45 years, level of education (not attaining primary school), lack of physical activity, and hypertension. While, the variables having no relation were sex, occupation, sedentary lifestyles, income, and genetics. The multivariate analysis showed that age was a major factor contributing to the incidence of T2DM in passive smokers at Hospital X Surabaya. In brief, age is the most dominant risk factor for the incidence of T2DM in passive smokers.

Keywords: determinants, passive smoker, type 2 diabetes mellitus

Introduction

Type 2 diabetes mellitus (T2DM) accounts for about 90% of all cases of diabetes. In T2DM, there is a decrease in insulin's ability to stimulate glucose uptake by peripheral tissues and inhibit glucose production by the liver, which is defined as insulin resistance.[1] The cause of insulin resistance is often due to obesity, lack of physical activity, and aging. Another cause leading to T2DM is pancreatic cell dysfunction. The cells will show a disturbance in the first phase of insulin secretion, where insulin secretion fails to compensate for insulin resistance. If not treated properly, pancreatic cells will be damaged. This will occur progressively and cause insulin deficiency, hence patients eventually require exogenous insulin. If pancreatic cells cannot produce insulin secretion immediately and quickly to compensate for insulin resistance, fasting hyperglycemia and diabetes will appear.[2] Diabetes mellitus can cause complications to other diseases, such as blindness, heart attack, stroke, kidney failure, and leg amputation.[3] According to the World Health Organization (WHO), arterial hypertension and T2DM are the two most common cardiovascular risk factors in the global population.[3] Despite their single roles as independent cardiovascular risk factors, hypertension and T2DM often coexist in the same patient. This coexistence multiplies the patient's risk of experiencing major acute cardiovascular events and accelerates the development of chronic heart and kidney failure.[4] Diabetes mellitus and the complications can be managed and prevented, especially when detected early. It is even better to take precautions by making lifestyle changes, such as improving diet and physical exercise.

In recent years, men have been considered a risk factor for T2DM. The reason that men are more prone than women to the development of this disease is not known yet. The development of T2DM results from the interaction between environmental factors and a strong genetic component. Environmental risk factors that influence the development of T2DM include obesity, sedentary lifestyle, birth weight, and stress.[5] In addition, diabetes is a disease with a high socioeconomic pattern, favoring the beneficiary group, especially in developed countries. According to a systematic review on socioeconomic positions and incidence of diabetes, low education is most

Correspondence:* *Santi Martini, Department of Epidemiology, Biostatistics, Population and Health Promotion, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia, E-mail: santi-m@fkm.unair.ac.id, Phone: +62 812 3261 228*

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consistently associated with an increased risk of diabetes compared to other socioeconomic indicators. The knowledge and skills acquired through education determine the responsiveness to health information.[6]

Physical activity is one of the risk factors for diabetes mellitus. Physical activity is body movement produced by skeletal muscles that release energy. The physical activity consists of strenuous, moderate, and light activity. Lack of physical activity is estimated to be the main cause of around 21-25% of breast and colon cancers, 27% of diabetes, and about 30% of the global burden of ischemic heart disease.[7] In addition, smoking is also a risk factor for diabetes. This is in line with a cohort study by Wang, *et al.*, which found that being either an active or a passive smoker increases the likelihood of developing T2DM.[8]

While, 28.11% of the population aged >10 years in East Java are classified as smokers with the intensity of smoking daily.[9] With the increasing number of smokers, the problem of passive smoking is also increasing; 85% of households in Indonesia are exposed to cigarette smoke, with an estimated eight smokers dying from active smoking and one passive smoker dying from exposure to other people's cigarette smoke.[10] In passive smokers, exposure to cigarette smoke can increase the risk of T2DM by several mechanisms almost the same as those in active smokers. This mechanism involves 5,000 chemicals, including 50 types of carcinogenic and toxic materials. Endothelial function disorders due to smoking cause changes in blood circulation, resulting in decreased blood flow to skeletal muscles, leading to insulin resistance.[8]

Cigarette smoke can increase blood sugar levels. The effect of nicotine stimulates the adrenal glands and can increase glucose levels.[11] Nicotine can also inhibit insulin secretion. The mechanism of nicotine in inhibiting insulin secretion is when nicotine attaches to the nicotinic acetylcholine receptor (nAChR) on pancreatic cells. Nicotine attached to these receptors causes an increase in oxidative stress (ROS) in cells, leading to changes in cell mitochondria's function and structure.[12] These changes will interfere with the adenosine triphosphate (ATP) formation process in secreting insulin, resulting in pancreatic cell apoptosis.[13] Pancreatic cell apoptosis is the death of cells in the pancreas, so that the function of insulin secretion in the pancreas decreases and insulin decreases in the body.[14]

Diabetes mellitus is a serious problem in Indonesia and the world. Based on the 2018 National Basic Health Research/*Riset Kesehatan Dasar* (*Riskesdas*),[9] East Java is the fifth highest province for diabetes mellitus incidence in Indonesia, by 2.6%. This number has increased compared to the results of 2013 National Basic Health Research,[10] by 2.1%. Surabaya, the capital city of East Java Province, has the highest diabetes cases, by 3.4% in the 2018 National Basic Health Research results.[9] In the continuous year, the number of the diabetics in Surabaya continues to increase. Likewise, with the prevalence of physical activity. Based on the 2018 National Basic Health Research results, 61.5% of the population had sufficient physical activity, and 33.5% had less physical activity in East Java Province.[9] This number illustrates an increase compared to the percentage of physical activity in the 2013 National Basic Health Research, by 26.1% of the population doing less physical activity.[10] The increasing number of smokers in Indonesia tends to increase the risk of developing T2DM. This study aimed to analyze the determinants of T2DM incidence in passive smokers among factors of age, sex, education, occupation, income, heredity, sedentary lifestyle, physical activity, and hypertension.

Method

This study used an analytical observational study design with a case-control approach. This study was conducted in outpatient and inpatient polyclinic at Hospital X in Surabaya City, East Java Province, Indonesia. The population of this study consisted of a case population of T2DM and all passive smoker patients at Hospital X. At the same time, the control population in this study were all the non-T2DM and other smoking-related diseases at Hospital X who were passive smokers. The sample of this study was all patients classified as passive smokers at Hospital X. In this study, the sample was divided into two; case samples were patients with T2DM and passive smokers, and the control sample was the non-T2DM and patients of other smoking-related diseases but were passive smokers.

The sampling technique used was simple random sampling. The inclusion criteria for this study were patients diagnosed with T2DM or non-smokers with smoking-related diseases at Hospital X participating in the study. In addition, the second inclusion criterion was passive smokers with a family member or coworkers smoke at work every day. The total population obtained was 400 people consisting of 300 population cases of smoking-related diseases and 100 population control. According to the study criteria, the sample size was 159 T2DM patients who were passive smokers as the case population and 52 non-T2DM patients who were passive smokers as the control population. This amount was then adjusted by simple random sampling with a lottery method to 159 case populations to obtain 52 respondents per the number of control samples. The final sample for each group consisted of 52 respondents, and the total sample in this study was 104.

Data retrieval was through secondary data. The data collected were then inputted and cleaned, so that they could be analyzed. These variables were univariate, bi-

variate, and multivariate. Univariate analysis was done for each variable with the proportional results of each. Bivariate analysis was done with Chi-square, and the results showed a relationship between each independent variable and the dependent variable; if the p-value was less than 0.05, it was considered to have statistical significance. Multiple logistic regressions with backward determinant modeling showed multivariate results to find significant determinant factors.

The study was conducted at Hospital X from September 2019 to April 2020. This study used secondary data from interviews with T2DM patients conducted in the second author's study group.[15] The lack of physical activity measurement questionnaire consisted of questions taken from the 2018 National Basic Health Research, a modification of the WHO Global Physical Activity Questionnaire (GPAC)—a part of the WHO STEPS instrument for measuring and monitoring risk factors for non-communicable diseases.[9]

Results

From January to June 2019, the number of DM patients at Hospital X of Surabaya was 8,060, while T2DM patients were 7,875. The average one-month visit was 1,313 people, representing the number of DM patients in general. The study was conducted on T2DM patients who made outpatient visits at the Outpatients and Inpatients Internal Medicine Polyclinic at Hospital X at Surabaya.

Most of the respondents were at the age range above 45 years, as many as 58 people (44.2%). The sex distribution of respondents showed that the majority (80.8%) were females. The education level was classified as uneducated/attaining elementary school, junior high school, senior high school, and higher education, and most respondents attained high school level (31.7%). These data indicated that most of the respondents were classified as having a low level of education. It was also found that

Table 1. Characteristics of Passive Smoker Patients at the Hospital X of Surabaya in 2019 (n = 104)

Characteristic	Category	n	%
Age (year)	18–45	46	44.23
	≥46	58	55.77
Sex	Male	20	19.23
	Female	84	80.77
Education	Uneducated/Elementary school	31	29.81
	Junior high school	17	16.35
	High school	33	31.73
	Higher education	23	22.11
Occupation	Unemployed	48	46.15
	Employed	56	53.85
Physical activity	Not enough	19	18.30
	Enough	85	81.7
Sedentary lifestyle	≥6 hours	32	30.80
	<6 hours	72	69.20
Income	>Minimum wage	34	32.70
	<Minimum wage	70	67.30
Genetic	Yes	41	39.42
	No	63	60.58
Hypertension	Yes	30	28.85
	No	74	71.15

Table 2. Results of Bivariate Analysis of Type 2 Diabetes Mellitus Incidence in Passive Smokers

Variable	Category	Disease Incidence X				p-value	OR (95%CI)
		Yes		No			
		n	%	n	%		
Age (year)	8-45	4	7.7	43	82.7	<0.001	57.3 (16.4–199.6)
	≥46	48	92.3	9	17.3		
Sex	Male	14	26.9	6	11.5	0.082	2.825 (0.99–8.059)
	Female	38	73.1	46	88.5		
Education	Uneducated/Elementary school	26	50	5	9.6	<0.001	8.09 (2.268–28.853)
	Junior high school	5	9.6	12	23.1	>0.05	0.65 (0.170–2.470)
	High school	12	23.1	21	40.4		0.89 (0.297–2.663)
	Higher education	9	17.3	14	26.9		1
Occupation	Unemployed	26	50	22	42.3	0.555	1.364 (0.629–2.955)
	Employed	26	50	30	57.7		
Physical activity	Insufficient	14	26.9	5	9.6	0.042	3.463 (1.1145–10.477)
	Sufficient	38	73.1	47	90.4		
Sedentary lifestyles	≥6 hours	15	28.8	17	32.7	0.832	0.835 (0.362–1.922)
	<6 hours	37	71.2	35	67.3		
Income	>Minimum wage	35	67.30	35	67.30	1.000	1.000 (0.441–2.269)
	<Minimum wage	17	32.70	17	32.70		
Genetic	Yes	23	44.23	18	34.52	0.422	0.668 (0.303–1.472)
	No	29	55.77	34	65.38		
Hypertension	Yes	30	57.69	0	00.00	<0.001	0.423 (0.308–0.581)
	No	22	42.31	52	100.00		

Notes: OR = Odds Ratio, CI = Confidence Interval, *Variables that were significantly related, p-value<0.05

Table 3. Multivariate Analysis of Variable Associated with Type 2 Diabetes Mellitus Incidence in Passive Smokers

Variable	Category	β	p-value	OR	95% CI
Step 1[a]	Age	3.992	0.001	54.143	4.866–602.418
	Sex	-3.035	0.013	0.048	0.004–0.521
	Physical activity	0.841	0.507	2.318	0.193–27.793
	Education	0.098	0.954	1.103	0.039–30.904
	Hypertension	22.747	0.997	~	~
	Constant	-27.384	0.996	<0.001	
Step 2[a]	Age	4.010	<0.001	55.122	12.218–248.673
	Sex	-1.519	0.077	0.219	0.041–1.178
	Physical activity	1.482	0.123	4.404	0.668–29.029
	Education	0.680	0.506	1.974	0.266–14.631
	Constant	-7.800	0.001	<0.001	
Step 3[a]	Age	4.301	<0.001	73.768	17.635–308.569
	Sex	-1.317	0.137	0.268	0.047–1.518
	Physical activity	1.465	0.108	4.327	0.724–25.882
Step 4[a]	Age	4.189	<0.001	65.987	16.975–256.509
	Physical activity	1.694	0.058	5.442	0.943–31.389
	Constant	-9.014	<0.001	<0.001	
Step 5[b]	Age	3.937	<0.001	51.250	9.360–280.613
	Physical activity	1.506	0.145	4.509	0.595–34.199
	Hypertension	21.503	0.997	~	~
	Constant	-29.018	0.997	<0.001	–

Notes: OR = Odds Ratio, CI = Confidence Interval.
[a]Variable(s) entered in step 1: Age, Physical activity, Education, Hypertension, Sex.
[b]Variable(s) entered in step 5: Hypertension.

Table 4. Multivariate Final Model of Variable Associated with Type 2 Diabetes Mellitus Incidence in Passive Smokers

Variable	β	p-value	OR	95% CI
Age (>45)	3.937	<0.001	51.250	9.360–280.613
Insufficient of physical activity	1.506	0.145	4.509	0.595–34.199

Notes: OR = Odds Ratio, CI = Confidence Interval.

most respondents were passive smokers on their way to work.

While, the income of the respondents was balanced between below and above the Surabaya minimum wage. Most respondents were passive smokers with sufficient physical activity and excessive sedentary behavior (69.20%). Most respondents had no records of diabetes in the family (60.58%) or a record of hypertension (71.15%) (Table 1).

Table 2 shows the distribution of study participants according to the incidence of T2DM in passive smokers. Bivariate analysis showed that age (p-value<0.001, OR = 57.3), uneducated/elementary school graduate (p-value<0.001, OR = 8.09), physical activity (p-value<0.042, OR = 3.463), and hypertension (p-value<0.001, OR = 0.423) variables were significantly correlated with the incidence of T2DM in passive smokers. It also showed that sex, junior high school, senior high school, higher education graduates, occupation, sedentary lifestyle, income, and genetics variables were not significantly correlated with T2DM in passive smokers (p-value>0.05).

Based on Table 4, age, sex, and physical activity variables are significant with the incidence of T2DM with a p-value of <0.25. Multivariate analysis was applied to determine the dominant factors of T2DM incidence in passive smokers. The Backward Wald method was carried out on all independent variables that met the requirements included in the model. The insignificant variables were excluded gradually, starting from the variable with the highest p-value. In Table 4, the age variable (p-value<0.001) is a factor significantly related to T2DM incidence in passive smokers after being controlled with age, sex, education, hypertension, and physical activity. In the final stage of logistic regression, results obtained that age was the most important risk factor for T2DM incidence in passive smokers (OR = 51.520, 95% CI = 9.360–280.613).

Discussion

Most of respondents with T2DM and passive smokers

were more than 45 years old (54.8%) with a p-value<0.001, meaning that there was a significant relationship between age in passive smoking and the incidence of T2DM, classified as elderly. Along with increasing age, diabetes mellitus and heart disease risk increase.[16] This result is in accordance with the report from the International Diabetes Federation in 2017 stated that along with increasing age, the prevalence of diabetes mellitus also gets higher.[17] This is because diabetes mellitus often appears after a person enters a vulnerable age, especially after the age of 45, and those who are overweight. Hence, the body is no longer sensitive to insulin. The aging process results in changes in the body's anatomical, physiological, and biochemical systems that can cause insulin resistance. This condition will get worse if it is accompanied by complications of other diseases, especially in the elderly group.[18] The body's metabolism slows down naturally as the human ages, which causes decreased physical activity. Low mobility will speed up the replacement of muscle mass with body fat. This condition can lead to obesity, which is one of the risk factors for T2DM.

Most T2DM patients in this study had no education or graduated from elementary school (50%) (Table 2). The data processing results also showed tthat the education level of uneducated/graduated from elementary school was related to the incidence of T2DM (p-value<0.001). While, respondents with junior high and senior high education levels had a p-value of >0.05, hence there were no significant relationship between the junior high school, senior high school, and higher education levels than those uneducated/graduated from elementary school. This result followed previous study by Sacerdote, *et al.*, stating that people with a low level of education were 1.77 times at risk of suffering from DM than those with higher education.[19] Although elementary and junior high school education levels were included in the type of primary education, both have differences in the level of competence and knowledge taught. The level of education is believed to be an important factor for someone to understand the management of blood sugar control, overcome symptoms that arise with appropriate treatment, and prevent complications generally related to knowledge. The high-educated patients are believed to have better knowledge of diabetes and its effects on health than the low educated hence the patients will respond positively and try to recover.[20]

This study also revealed that physical activity was associated with the incidence of T2DM in passive smokers (p-value = 0.042). This showed a significant relationship between physical activity of passive smoking and the incidence of T2DM. In the physical activity variable, the OR value was 3.4, showing that people with less physical activity had a 3.4 times greater risk of T2DM than people with sufficient physical activity. These data found that most of the respondents were passive smokers who did sufficient physical activity. These results were the same as Sipayung, Siregar, and Nurmaini's study which showed that 82.8% of 120 respondents did sufficient physical activity.[21]

When human rest, glocuse absorption by body tissues requires insulin. While, in active muscles, the increasing need of glucose is not followed by the increase of insulin levels. This is due to an increase in sensitivity insulin receptor when a person is physically active causing active muscles.[22] The condition of insulin resistance makes glucose cannot enter the cells. However, when a person does a physical activity, the muscles are contracting. This condition makes the entrance of glucose easier. That is why, when a person does a physical activity, there will be a decrease in insulin resistance and it ultimately reduces blood sugar levels.[22] Based on the study by Himmah, *et al.*, it was found that physical activity was an influential variable in T2DM.[23] Patients with high physical activity experienced the most significant decrease in sugar levels of 53.6 mg/dL. The blood sugar level decrease in patients with moderate physical activity was 6.73 mg/dL. In comparison, the decrease in blood sugar levels in patients having low physical activity was 4.3 mg/dL.[23]

The result of this study found that hypertension had no significant relationship (p-value<0.001, OR = 0.423) with the T2DM in passive smokers. It may occur because the case group mostly had a record of hypertension (57.69%). These results were the same as the study by Nainggolan, *et al.*, stating that hypertension was significantly associated with the incidence of T2DM (p-value<0.001). Respondents with no hypertension had a protective value of 0.423 times compared to those with hypertension for diabetes. Hypertension is a factor that causes DM disease.[24] Hypertension and DM are closely related health problems that need to be handled carefully. High blood pressure causes the distribution of sugar blood in the cells not to run optimally, so that accumulation of sugar and cholesterol in the blood occurs. The point is that if blood pressure is good, blood sugar will also be good. Insulin acts as a substance controlling blood pressure and water levels in the body, so insulin levels are enough to maintain blood pressure.[25]

While, the sex variable did not significantly correlate with the incidence of T2DM in passive smokers. However, Table 1 shows that the majority of respondents are 84 (80.8%) female passive smokers. The results in the field showed that more women were affected by T2DM than men. In addition, the p-value = 0.082 is almost close to significant, indicating a possible relationship between the sex of passive smokers and the incidence of T2DM. This result is also in accordance with two previous studies. Nordström, *et al.,* stated that the prevalence of T2DM in men was higher than in women.[5]

The 2017 International Diabetes Federation report also stated that the prevalence of T2DM in the world in males was more significant than in females.[17]

The data processing results also showed that some variables were not associated with the occurence of T2DM, such as the occupation of passive smokers (p-value = 0.431), the excessive sedentary behavior (≥6 hours) in passive smokers (p-value = 0.832), the income of passive smokers (p-value = 1.000), and the genetics of passive smoker (p-value = 0.422). While, age is a major factor contributing to T2DM incidence in passive smokers at Hospital X Surabaya in 2019. Respondents older than 45 years old and passive smokers had a 51.52 times higher risk of developing T2DM compared to those under 45 years old and were passive smokers (OR = 51.52, 95% CI = 9.360–280.613). American Diabetes Association stated that the risk of T2DM increases with age. The underlying higher risk of T2DM in older individuals is increased body fat composition which accumulates in the abdomen, leading to central obesity. Central obesity further triggers insulin resistance in the initial process of T2DM.[26] The WHO also stated that after a person reaches the age of 40, blood glucose levels rise 1–2 mg% per year during fasting and rise approximately 5.6–13 mg% at couple hours after eating. Regarding that statement, it is not surprising if the age factor is a major factor in the increasing prevalence of diabetes mellitus especially T2DM and impaired glucose tolerance.[27]

Based on previous study by Wei, *et al.*, passive smoking is also one of the T2DM risks.[28] The study by Pan, *et al.,* also stated that both active and passive smoking are associated with significantly increased risks of T2DM. The risk of diabetes is increased in new quitters but decreases substantially as the time since quitting increases.[29] Therefore, interventions to prevent exposure to secondhand smoke remain an urgent priority.[30]

There are some limitations in this study, which include the absence of data regarding the length of smoke exposure by the passive smokers' coworkers, so the influence of the length of the smoke exposure variable on the respondent's age cannot be seen whether it is associated with the incidence of T2DM or not. Since the method of the present study use a case-control design, there is a high potential for recall bias to happen.

Conclusion

Age is the most dominant risk factor for the incidence of T2DM in passive smokers. People under the age of more than 45 have 57 times the risk of developing T2DM than those in 18-45 years. The aging process results in changes in the body's anatomical, physiological, and biochemical systems that can cause insulin resistance. This condition will get worse if it is accompanied by complications of other diseases, especially in the elderly group.

Recommendation

According to this study's results, the following suggestions are given by the authors for the Government of Surabaya City to reduce the incidence of T2DM. First, the government is expected to improve the health promotion and education programs about the effects of smoking, especially related to passive smokers who are affected by cigarette smoke and aged above more than 45 years or among the elderly. Second, increasing and activating the efforts to establish nonsmoking Areas in various public places and facilities. Lastly, providing sports facilities or jogging tracks in every area, such as parks or green open spaces, so that people, especially passive smokers, can be motivated to do physical activity.

Abbreviations

T2DM: Type 2 Diabetes Mellitus; WHO: World Health Organization; nAChR: Nicotinic Acetylcholine Receptor; ROS: Oxidative Stress; ATP: Adenosine triphosphate; *Riskesdas*: *Riset Kesehatan Dasar*; GPAC: Global Physical Activity Questionnaire; DM: Diabetes Mellitus; OR: Odds Ratio, CI: Confidence Interval.

Ethics Approval and Consent to Participate

This research was approved by the ethics committee of RSUD dr. Soetomo Surabaya with letter number 0727/KEPK/X/2018 and has received research permission from Hospital X in Surabaya. All subjects in the study also agreed to be respondents.

Competing Interest

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

Availability of Data and Materials

All datasets generated and analyzed are available in the article.

Authors' Contribution

SM designed the study and wrote the protocol, and all authors did the study. SM supervised all the steps in the review process, and all authors interpreted the findings. ART and RDN drafted the manuscript, SM supervised the writing, and KDA, SW, and RDN provided feedback.

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References

1. Siegel JD, Rhinehart E, Jackson M, Chiarello L. Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings 2007. Hosp Infect. 2009; 1–232.
2. Tjandrawinata RR. Patogenesis diabetes tipe 2: resistensi defisiensi insulin—a working review paper. Dexa Medica Group; 2016.
3. World Health Organization. Global Report on Diabetes. World Health

Organization; 2016.
4. Colussi GL, Da Porto A, Cavarape A. Hypertension and type 2 diabetes: lights and shadows about causality. J Hum Hypertens. 2020; 34 (2): 91–3.
5. Nordström A, Hadrévi J, Olsson T, Franks PW, Nordström P. Higher prevalence of type 2 diabetes in men than in women is associated with differences in visceral fat mass. J Clin Endocrinol Metab. 2016; 101 (10): 3740–6.
6. Chung GKK, Lai FTT, Yeoh EK, Chung RYN. Gender-specific trends of educational inequality in diagnosed diabetes from 1999 to 2014 in Hong Kong: a serial cross-sectional study of 97,481 community-dwelling Chinese adults. Popul Health Metr. 2021; 19 (1): 37.
7. World Health Organization. Global recommendations on physical activity for health. World Health Organization; 2010.
8. Wang Y, Ji J, Liu Y jian, Deng X, He Q qiang. Passive smoking and risk of type 2 diabetes: a meta-analysis of prospective cohort studies. PLoS One. 2013; 8 (7): 1–6.
9. Kementerian Kesehatan Republik Indonesia. Laporan Nasional Riskesdas 2018. Badan Penelitian dan Pengembangan Kesehatan; 2018.
10. Kementerian Kesehatan Republik Indonesia. Laporan Nasional Riskesdas 2013. Badan Penelitian dan Pengembangan Kesehatan; 2013.
11. Fitriyani. Universitas Indonesia faktor risiko diabetes melitus tipe 2 di Puskesmas Kecamatan Citangkil dan Puskesmas Kecamatan Pulo Merak, Kota Cilegon [Undergraduate Thesis]. Universitas Indonesia; 2012.
12. Artese A, Stamford BA, Moffatt RJ. Cigarette smoking: an accessory to the development of insulin resistance. Am J Lifestyle Med. 2019; 13 (6): 602–5.
13. Tomita T. Apoptosis in pancreatic β-islet cells in type 2 diabetes. Bosn J Basic Med Sci. 2016; 16 (3): 162–79.
14. Morimoto A, Tatsumi Y, Deura K, Mizuno S, Ohno Y, Watanabe S. Impact of cigarette smoking on impaired insulin secretion and insulin resistance in Japanese men: the saku study. 2013; 4 (3): 274-80.
15. Martini S, Artanti KD, Widati S. Beban penyakit akibat rokok di Jawa Timur [Report]. Universitas Airlangga; 2019.
16. Purnama A, Sari N. Aktivitas fisik dan hubungannya dengan kejadian diabetes mellitus. Wind Heal J Kesehat. 2019 Oct; 2 (4): 368–81.
17. International Diabetes Federation. IDF Diabetes Atlas 8th edition 2017. International Diabetes Federation; 2017.
18. Rosyada A, Trihandini I. determinan komplikasi kronik diabetes melitus pada lanjut usia determinan of diabetes mellitus chronic complications on elderly. Kesmas J Kesehat Masy Nas. 2013; 7: 395–401.
19. Sacerdote C, Ricceri F, Rolandsson O, Baldi I, Chirlaque MD, Feskens E, et al. Lower educational level is a predictor of incident type 2 diabetes in European countries: The EPIC-interact study. Int J Epidemiol. 2012; 41 (4): 1162–73.
20. Pahlawati A, Nugroho PS, Kalimantantimur UM, Melitus D. Hubungan tingkat pendidikan dan usia dengan kejadian diabetes melitus di wilayah kerja Puskesmas Palaran Kota Samarinda tahun 2019. 2020; 1 (3): 1–5.
21. Sipayung R, Siregar, Aguslina F, Nurmaini. Hubungan aktivitas fisik dengan kejadian diabetes melitus tipe 2 pada perempuan usia lanjut di wilayah kerja Puskesmas Padang Bulan Medan tahun 2017. J Muara Sains, Teknol Kedokteran, dan Ilmu Kesehat. 2017; 1: 78–86.
22. Paramitha GM. Hubungan aktivitas fisik dengan kadar gula darah pada pasien diabetes melitus tipe 2 di Rumah Sakit Umum Daerah Karanganyar [Undergraduate Thesis]. Universitas Muhammadiyah Surakarta; 2014.
23. Himmah SC, Irawati DN, Triastuti N, Ambar NS. Pengaruh pola makan dan aktifitas terhadap penurunan kadar gula pada pasien diabetes melitus tipe 2 di Klinik Aulia Jombang. 2020; 7 (1).
24. Nainggolan O, Kristanto AY, Edison H. Determinan diabetes melitus analisis baseline data studi kohort penyakit tidak menular Bogor 2011. Bul Penelit Kesehat. 2013; 16 (2): 331–9.
25. Zhou MS, Wang A, Yu H. Link between insulin resistance and hypertension: What is the evidence from evolutionary biology? Diabetol Metab Syndr. 2014; 6 (1): 1–8.
26. Trisnawati S, Widarsa IKT, Suastika K. Faktor risiko diabetes mellitus tipe 2 pasien rawat jalan di Puskesmas Wilayah Kecamatan Denpasar Selatan. Public Heal Prev Med Arch. 2013; 1 (1): 69.
27. World Health Organization and International Diabetes Federation. Definition and diagnosis of diabetes mellitus and intermediate hyperglycaemia : report of a WHO/IDF consultation. World Health Organization; 2006.
28. Wei X, E. M, Yu S. A meta-analysis of passive smoking and risk of developing Type 2 Diabetes Mellitus. Diabetes Res Clin Pract. 2015; 107 (1): 9–14.
29. Pan A, Wang Y, Talaei M, Hu FB, Wu T. Relation of active, passive, and quitting smoking with incident type 2 diabetes: a systematic review and meta-analysis. Lancet Diabetes Endocrinol. 2015; 3 (12): 958–67.
30. Zhu B, Wu X, Wang X, Zheng Q, Sun G. The association between passive smoking and type 2 diabetes: a meta-analysis. Asia-Pacific J Public Heal. 2014; 26 (3): 226–37.

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The Effect of Health Promotion Program on Perceived Self-Efficacy and Self-Care Practices among Elderly with Multimorbidity in Chiang Mai, Thailand

Jukkrit Wungrath[1]*, Nuttida Khumai[1], Phinphot Phrommasen[2]

[1]Department of Public Health, Faculty of Public Health, Chiang Mai University, Chiang Mai, Thailand, [2]Health Promotion Center Region 1, Department of Health, Ministry of Public Health, Chiang Mai, Thailand

Abstract

Multimorbidity in the elderly is a major public health issue with serious consequences. This study investigated the effects of health promotion programs on perceived self-efficacy and self-care practices among the elderly with multimorbidity using a quasi-experimental study design from February to July 2021. The study samples were the elderly from Doi Saket District, Chiang Mai Province, Thailand, selected by a multistage random sampling technique. The experimental and control groups each comprised 40 elderlies with multimorbidity. All elderly participants took part in a 12-week health promotion program. The perceived self-efficacy and self-care practices of the study samples were assessed using interviews, and the group results were compared using the independent t-test. Repeated measures analysis of variance (ANOVA) was applied at a significance level of 0.05 for three different periods. Follow-up results after the intervention showed that the experimental group had significantly higher mean scores of perceived self-efficacy and self-care practice than the control group (p-value<0.05). The health promotion program enhanced perceived self-efficacy and self-care practices in the elderly with multimorbidity. It can also be applied to improve the quality of life of people in other age groups.

Keywords: elderly, health promotion, multimorbidity, perceived self-efficacy, self-care practices

Introduction

With improved health care, aging population has become a worldwide phenomenon. Thailand ranked the third most rapidly aging population in the world.[1] Thailand became an aging society in 2005, with 10.4% of the population aged 60 years and older, increasing to 14.4% ten years later, and reaching 18.6% (around 13 million people) by the end of January 2022.[2] If the aging population continues to grow at the current rate,[3,4] Thai's elderly population will reach 20 million by 2050 (35.8% of the population).[3] In an aging society, caregivers and government agencies (e.g. the Ministry of Public Health) should pay more attention to the availability of utilities to help the elderly live their lives.[5] The majority of the elderly in Thailand suffer from frailty and chronic diseases and need daily care from their family members and healthcare providers.[5]

The elderly are more exposed to both physical and psychological vulnerabilities and at risk of developing a wide range of diseases.[6] As a high-risk group for multimorbidity,[7,8] the presence of two or more chronic diseases is more likely. Previous studies reported that 24-83% of the elderly had multimorbidity depending on the definition of multimorbidity itself (how many chronic noncommunicable diseases (NCDs) an elderly have), age of the population, and data source.[9,10] Multimorbidity is associated with lower disability-adjusted life year (DALY),[7] an increase in mortality and disability, and a decrease in functional capacity and life quality. Multimorbidity also increases health care utilization (costs, length of hospital stays, and number of physician visits).[11,12]

The occurrence of multimorbidity was 11.5% and 25.3% of the Thai elderly population in 2010 and 2014, respectively,[13,14] as one of the most pressing issues confronting Thailand's health care system with increasing prevalence and incidence of chronic NCDs such as hypertension, diabetes, stroke, and coronary artery disease.[4] These diseases seriously disrupt the well-being of the elderly and may render them completely dependent.[4] The elderly with multimorbidity require more primary health care (PHC) than all other age

***Correspondence**: Jukkrit Wungrath, Department of Public Health, Faculty of Public Health, Chiang Mai University, Chiang Mai, Thailand 50200, E-mail: jukkrit.w@cmu.ac.th, Phone: +66(81) 595 9638*

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groups.[6,15]

Thailand has established the 20-year Thai National Strategy (2017–2036) and the second Thai National Plan for the Elderly (2002–2021) to increase health awareness, basic self-care, and self-prevention, strengthening organizations that care for the elderly.[16] Furthermore, as the senior population increases, Thailand faces a scarcity of workers with necessary skills and experience to care for the elderly.[16] Therefore, encouraging the elderly with multimorbidity to take charge of their health behaviors to reduce complications and improve the quality of their lives presents a worthwhile challenge.

Bandura's self-efficacy theory,[17] can be applied to the elderly with chronic diseases to reduce complications, impairment, and early mortality and allow them to live normal lives in society. This also reduces the burden of family and government spending. However, there are still a few studies on health promotion programs for the elderly with multimorbidity in Thailand. Therefore, this study investigated the effects of health promotion programs on perceived self-efficacy and self-care practices in the elderly with multimorbidity. This study's findings can be used to improve health and modify self-care behaviors in the elderly with multimorbidity, allowing them to enjoy a decent quality of life as part of community with dignity.

Method

This quasi-experimental study was conducted in February-July 2021 with participants split into experimental and control groups. Each measurement was performed in triplicate. The study samples were the elderly with multimorbidity residing in Doi Saket District, Chiang Mai Province, Thailand. The sample size was calculated using statistical power analyses with a power of 0.95, an alpha of 0.05, and an effect size of 0.80. Based on the conditions of 40 samples in each group, the eligible sample size was 80 people with an additional 10% dropout rate, resulting in 40 participants per group. Simple random sampling without replacement was used to select the participants. Inclusion criteria were people aged over 60 years with more than one non-communicable disease diagnosed by a physician for at least one year, no difficulties in speaking, hearing, or sight, and willing to participate in the entire program.

A total of 80 participants were recruited from two PHC in Choeng Doi and Luang Nuea Subdistricts in Doi Saket District. The experimental group was assigned to one subdistrict, whereas the control group was assigned to the other. The distance of the subdistricts was 10 km to prevent information contamination between the two groups. This study's data was collected using a questionnaire (delivered offline) categorized into three sections. Section one comprised demographic characteristics involving sex, age, marital status, education level, occupation, and monthly income. Section two asked about perceived self-efficacy, using Bandura's self-efficacy theory,[17] and 17 questions with answers on a three-point scale (regularly practice, sometimes practice, and never practice). Cronbach's alpha was determined at 0.88, with the item objective congruence (IOC) index higher than 0.67 for all items. Section three, examining self-care practices based on the previous study, consisted of 25 questions divided into five dimensions: healthy eating, physical activity, exercise, stress management, and medication adherence. Answers ranged from 1 (never or rarely) to 4 (always). Cronbach's alpha was 0.75, and the IOC index was higher than 0.67 for all items.

The experimental group followed a set of activities designed to promote perceived self-efficacy and self-care practices in the elderly with multimorbidity. The study duration was 12 weeks, with face-to-face interventions conducted once a week. During week 1 (2.0 hours) as the beginning of the program, the participants were welcomed, made to feel comfortable with the program, and provided with knowledge through discussions on overall elderly health, perceived self-efficacy, and self-care practices. Participants were also given a developed handbook on elderly health care to read at home. During weeks 2-5 (2.5-3.0 hours per week), the participants engaged in educational activities focusing on perceiving self-efficacy. These included judging whether a situation may cause harm and in what way, determining what can be done to control the situation, and analyzing barriers to effective self-management, adherence to treatments, disease management ability, and self-care management ability.[18] The patients were also given opportunities to analyze, discuss, and share their health issues and healthy behaviors.

During weeks 6-9 (2.5-3.0 hours per week), the participants attended teaching and demonstrations in addition to practice activities focusing on five dimensions of self-care: healthy eating, physical activities, exercise, stress management, and medication adherence.[19] The participants also took part in games. At the end of each session, the participants were asked to review self-care practices and instructed to self-observe other activities ahead of the next session. Each activity involved video media and teaching materials, including pictures, food models, and PowerPoint presentations by easy language. The follow-up program at 10–12 weeks comprised 10–15 minutes phone calls once a week. The participants were encouraged to engage in self-care practices regularly.

Following the intervention, healthcare providers gave all the participants in the experimental group a standard routine program. The participants were asked to com-

plete a questionnaire before the intervention (pre-test in week 1), immediately after the intervention (post-test in week 12), and one month after the intervention was completed (follow-up in week 16). Participants in the control group followed normal activities from healthcare providers in their communities and did not receive the 12-week health promotion program. The same intervention was administered to the control group members after completing the experimental group, intervention platform, and data collection. The program ran for 12 weeks. After one month of intervention, a follow-up was undertaken to ascertain behavioral changes, and both groups completed the same assessment test.

STATA 16 software (Stata Corp LP, College Station, Texas) was used to clean, check for completeness, and analyze the data, with normality determined using the Kolmogorov-Smirnov test. Descriptive demographic statistics were computed as frequencies and percentages to categorize the variables, while means and standard deviations to classify the metric variables. Differences in participant demographics between the experimental and control group baselines were determined using Chi-square and Fisher's exact tests. The before and after effects of the program were analyzed using repeated measures analysis of variance (ANOVA), with statistical significance levels for all tests set at a p-value of less than 0.05.

Results

The baseline demographic characteristics of the participants are reported in Table 1. Sex, age, education level, occupation, and monthly income were not statistically different between the two groups (p-value>0.05). In the experimental group, 60% were female with a mean age of 68.25 (SD = 5.78), 97.50% had primary school education, 35% were employed, and 95% had a monthly income of lower than 140 USD/month. In the control group, most were females (75%) with a mean age of 68.58 (SD = 5.80), 85% had primary school education, 30% were employed, and 92.60% had a monthly income lower than 140 USD/month.

When considering post-intervention and follow-up scores, the experimental group's perceived self-efficacy and self-care practices improved considerably compared to the control group. Repeated ANOVA measures revealed statistically significant differences in mean scores of perceived self-efficacy and self-care practices between the elderly in the experimental and control groups (p-value<0.001 and p-value<0.001, respectively)

Table 1. Demographic Characteristics of the Participants

Variable	Category	Experimental Group (n = 40)		Control Group (n = 40)		p-value
		n	%	n	%	
Sex	Male	16	40.00	10	25.00	0.152
	Female	24	60.00	30	75.00	
Age (year)	Average	68.25 (5.78)		68.58 (5.80)		0.904
	Min-max	60–80		60–81		
	60-69	25	62.50	27	67.50	
	70-79	14	35.00	12	30.00	
	>80	1	2.50	1	2.50	
Education level	Primary school	39	97.50	34	85.00	0.108
	High school	1	2.50	6	15.00	
	Vocational/University	0	0.00	0	0.00	
Occupation	Employed	14	35.00	12	30.00	0.633
	Unemployed	26	65.00	28	70.00	
Monthly income (USD/month)*	<140	38	95.00	37	92.60	1.000
	140-280	2	5.00	3	7.50	

Note: *Calculated at an exchange rate of 35.70 Baht per 1 USD.

Table 2. Comparison of Mean Scores of Perceived Self-Efficacy and Self-Care Practices Before, After, and at Follow-up (1-Month Post-Intervention)

Variable	Category	Mean (SD)		p-value	Repeated Measures ANOVA	
		Experimental Group	Control Group		F	p-value
Perceived self-efficacy	Pre-test	23.50 (1.54)	23.45 (1.43)	0.009	527.57	<0.001
	Post-test	27.88 (1.52)	23.55 (1.36)			
	Follow-up	31.45 (0.93)	23.10 (1.50)			
Self-care practices	Pre-test	33.80 (2.31)	33.85 (2.05)	0.000	173.15	<0.001
	Post-test	43.40 (3.00)	33.58 (1.70)			
	Follow-up	48.53 (5.16)	33.45 (1.87)			

at baseline, post-intervention, and follow-up (Table 2).

Discussion

The health promotion intervention demonstrated a significant improvement in perceived self-efficacy, with participants in the experimental group showing higher perceived self-efficacy than those in the control group. In addition, the health promotion program enhanced perceived self-efficacy in the elderly with multimorbidity. These findings agreed with previous studies,[20-23] demonstrating that systematically-planned health promotion programs can improve perceived self-efficacy toward self-care practices. The program applied in this study contained well-planned activities, including video demonstrations for self-care practice, model representations, and encouragement from peers. All these activities increased participants' confidence in self-care practice management.[20,21] The outcome of this study concurred with Supasri, *et al.*,[22] who studied the effect of health promotion programs on perceived self-efficacy. Their study results indicated that the experimental group's self-care among the elderly with hypertension significantly improved compared to the control group.[22] It was also consistent with a study by Ahmad, *et al.,*[23] examining the influence of promotion and educational programs on self-efficacy, self-care behavior, and blood pressure in elderly hypertensives. Their results demonstrated that intervention significantly improved self-efficacy in the experimental group.

The study results were also in line with Bandura's self-efficacy theory stating that increased self-efficacy positively affects self-care practices and promotes health benefits.[24] Hejazi, *et al.*,[25] observed statistical significance between self-efficacy and self-care behaviors in patients with type 2 diabetes mellitus (T2DM) indicating that self-efficacy was a significant predictor of self-care behaviors. According to Bandura's theory,[17] when self-efficacy increases, the elderly are more likely to engage in health promotion self-care behaviors, thereby improving their quality of life and well-being.[25,26] Reisi, *et al.*,[27] found that individuals with higher self-efficacy were more motivated to improve their self-care practices. Noticeably, the study results indicated that the elderly with multimorbidity receiving the intervention showed significantly improved self-care practices in healthy eating, physical activity, exercise, stress management, and medication. From baseline to intervention and one month after, the experimental group had higher scores for self-care practices than the control group. This result was consistent with a study by Sun, *et al.*,[28] discovering that health educational intervention improved quality of life as well as self-care behaviors in elderly patients with cardiovascular diseases, also was supported by Evangelista, *et al.*,[29] who demonstrated that health promotion interventions for the elderly diagnosed with heart failure decompensation were feasible. Compared to the control group, the elderly in the experimental group had more excellent self-care knowledge, skills, and self-efficacy, as well as improved inactivation over time.[29] Thus, health promotion is an essential and useful intervention in the context of self-care practices, favorably empowering the elderly with chronic conditions and, consequently, improving functional capacity.[30]

Limited studies support the association between perceived self-efficacy and self-care practices in the elderly with multimorbidity.[31,32] Nevertheless, the findings of this study were consistent with the one conducted in the United States, which reported that the elderly with hypertension who practiced good self-efficacy showed improved self-care behavior.[31] A similar study by Yasaratna and Wijesinghe reported that targeted health promotion interventions to improve self-efficacy had a beneficial effect on self-care practices and disease control factors such as blood pressure in the elderly with chronic diseases.[32] Effects of interventions on the increase in self-efficacy and self-care practices in the elderly have been investigated in other dimensions. Park and Chang,[33] investigated the effect of a health counseling self-management program for the elderly with multimorbidity. This program was effective in adjusting self-care behaviors and enhancing perceived health conditions.[33] Previous studies identified that the elderly gained essential knowledge and skills to actively participate in the self-management of their condition when they achieved higher levels of activation.[29,34] Similarly, the elderly who acknowledged that they could improve their health participated more in making health decisions and adhered to behaviors that improved health conditions.[29] Therefore, to improve perceive self-efficacy and self-care behaviors of the elderly with multimorbidity, it is essential to have an effective health promotion program.

Strengths and Limitations

The strength of this study included focusing on the elderly with multimorbidity and following up more than once to ensure that the patients showed improved health literacy. This discussion enhanced patient engagement in proper self-care activities, enabling them to control their health outcomes better. Furthermore, no follow-up cases were lost in this study. To the best of the authors' knowledge, few studies on the effects of health promotion intervention programs have been conducted to determine improvements in perceived self-efficacy and self-care practices in the elderly with multimorbidity in Thailand. This study is the first research conducted in Chiang Mai Province, Thailand. The findings are applicable to other locations both in Thailand and worldwide with similar characteristics and situations for the elderly.

This study has some significant limitations. First, the study was conducted using a small sample size; thus, the results might not represent the elderly with multimorbidity in population aspects of race, education, and socioeconomic status, thus limiting generalization. Future study should employ more samples for a more accurate analysis. Second, the close-ended questions limited the authors' ability to investigate details of participants' emotions. Third, this study found no significant association between perceived self-efficacy and self-care practices. Therefore, the link between these two factors cannot be clearly stated. Fourth, this study did not control variables affecting perceived self-efficacy and self-care practices, such as personal characteristics or environmental factors. Finally, self-care practices were measured by self-report that might induce response bias due to the desire for social acceptance.

Conclusion

Implementing a health promotion program is feasible, potentially improving perceived self-efficacy and self-care practices in the elderly with multimorbidity. Multidisciplinary health care providers in PHC can apply this program to make the elderly with multimorbidity more responsible for their self-care practices by modifying or maintaining healthy habits and strengthening self-efficacy. Further study should be conducted using a large-scale randomized controlled trial and other settings to validate the findings. Therefore, the health promotion program from this study can be practically applied as a guide to enhance the perceived self-efficacy and self-care practices in the elderly with multimorbidity. Relevant agencies should implement the program to promote the health and life quality of the elderly with similar conditions.

Abbreviations

ANOVA: Analysis of Variance; DALY: Disability-Adjusted Life Year; NCDs: Noncommunicable Diseases; PHC: Primary Health Care; IOC: Item Objective Congruence; USD: United States Dollars; SD: Standard Deviation; T2DM: Type 2 Diabetes Mellitus.

Ethics Approval and Consent to Participate

The Ethics Research Committee of the Faculty of Public Health, Chiang Mai University, approved this study (approval code: ET008/2021). All participants were provided with an informed consent form for signature. The consent form contained detailed information regarding the study's objectives, risks, and benefits.

Competing Interest

The authors declare that there are no significant competing financial, professional, or personal interests that might have affected the performance.

Availability of Data and Materials

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

Authors' Contribution

JW was responsible for conceptualization and methodology. JW and NK collected the data and conducted the investigation. PP contributed to data curation and analysis. JW wrote the original draft and critically reviewed the manuscript. JW supervised this study. All authors have read and approved the final manuscript.

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References

1. Tejativaddhana P, Chuakhamfoo NN, Hue Vo MT. A review of the long-term care policies under COVID-19 in Thailand's aging society: implications for ASEAN Countries. Pub Admin Pol: Asia-Pacific J. 2022; 25 (1): 37-49.
2. Charoenwisal R, Dhammasaccakarn W. Ageing society development strategy from a marginalised elderly group in Southern Thailand. Develop Practic; 2022.
3. Foundation of Thai Gerontology Research and Development Institute. Report on the situation of the elderly in Thailand in 2019. Thaitgri.org; 2021.
4. Tantirat P, Suphanchaimat R, Rattanathumsakul T, Noree T. Projection of the number of elderly in different health states in Thailand in the next ten years, 2020–2030. Int J Environ Res Public Health. 2020; 17 (22): 8703.
5. Nillaor P, Sriwichian A, Wanichsombat A, Kajornkasirat S, Boonjing V, Muangprathub J. Development of elderly life quality database in Thailand with a correlation feature analysis. Sustainability. 2022; 14 (8): 4468.
6. Tonboot S, Wattanadumrong B. Situation of inequality in health utilization among Thai elderly in 2020.
7. Bao J, Chua KC, Prina M, Prince M. Multimorbidity and care dependence in older adults: a longitudinal analysis of findings from the 10/66 study. BMC Public Health. 2019; 19 (1): 1-10.
8. Gu J, Chao J, Chen W, Xu H, Zhang R, He T, Deng L. Multimorbidity and health-related quality of life among the community-dwelling elderly: a longitudinal study. Arch Gerontol Geriatr. 2018; 74: 133-40.
9. Pati S, Swain S, Hussain MA, Van Den Akker M, Metsemakers J, Knottnerus JA, et al. Prevalence and outcomes of multimorbidity in South Asia: a systematic review. BMJ Open. 2015; 5: 6–8.
10. Melis R, Marengoni A, Angleman S, Fratiglioni L. Incidence and predictors of multimorbidity in the elderly: a population-based longitudinal study. PloS one. 2014; 9 (7): e103120.
11. Prados-Torres A, Calderón-Larrañaga A, Hancco-Saavedra J, Poblador-Plou B, van den Akker M. Multimorbidity patterns: a systematic review. J Clin Epidemiol. 2014; 67 (3): 254-66.
12. Sambamoorthi U, Tan X, Deb A. Multiple chronic conditions and healthcare costs among adults. Expert Rev Pharmacoecon Outcomes

Res. 2015; 15 (5): 823-32.
13. Sihapark S, Kuhirunyaratn P, Chen H. Severe disability among elderly community dwellers in rural Thailand: prevalence and associated factors. Ageing Int. 2014; 39 (3): 210-20.
14. Intarut N, Srihatrai P, Chantawang N. Prevalence of multimorbidity in Thailand: a multilevel analysis of a population-based survey. Int J Community Med Public Health. 2021; 8 (8): 3750-55.
15. Vrhovec J, Tajnikar M. Population ageing and healthcare demand: the case of Slovenia. Health Policy. 2016; 120 (11): 1329-36.
16. Sriwisathiyakun K, Dhamanitayakul C. Enhancing digital literacy with an intelligent conversational agent for senior citizens in Thailand. Edu Info Tech. 2022; 27: 6251-71.
17. Bandura A. Self-efficacy: The exercise of control. New York: Springer; 1999.
18. Liou HL, Chen HI, Hsu SC, Lee SC, Chang CJ, Wu MJ. The effects of a self-care program on patients with heart failure. J Chin Med Assoc. 2015; 78 (11): 648-56.
19. Pimnada K, Sunee L, Kwanjai A. Effects of health literacy improvement program on self-care behaviors and health outcomes in older adults with type 2 diabetes and hypertension comorbidities. J Public Health Develop. 2022; 201: 32-42.
20. Choowanthanapakorn M, Seangpraw K, Ong-artborirak P. Effect of stress management training for the elderly in rural Northern Thailand. Open Public Health J. 2021; 14: 62-70.
21. Wungrath J, Autorn N. Effectiveness of Line application and telephone-based counseling to improve medication adherence: a randomized control trial study among uncontrolled type 2 diabetes patients. Health Promot Perspect. 2021; 11 (4): 438-43.
22. Supasri S, Wungrath J, Boonchieng W. Effects of a health promotion program on perceived self-efficacy and outcome expectations on self-care among elderly with hypertension, Chiang Rai Province, Thailand. Thai J Public Health. 2021; 51 (1): 33-42.
23. Ahmad Sharoni SK, Abdul Rahman H, Minhat HS, Shariff-Ghazali S, Azman Ong MH. The effects of self-efficacy enhancing program on foot self-care behaviour of older adults with diabetes: a randomised controlled trial in elderly care facility, Peninsular Malaysia. PloS one. 2018; 13 (3): e0192417.
24. Hosseini H, Torkani S, Tavakol K. The effect of community health nurse home visit on self-care self-efficacy of the elderly living in selected Falavarjan villages in Iran in 2010. Iran J Nurs Midwifery Res. 2013; 18 (1): 47-53.
25. Hejazi S, Peyman N, Tajfard M, Esmaily H. The impact of education based on self-efficacy theory on health literacy, self-efficacy and self-care behaviors in patients with type 2 diabetes. Iran J Health Educ Health Promot. 2017; 5 (4): 296-303.
26. Putra MM, Kusnanto K, Asmoro CP, Sukartini T. Application of health promotion model for better self-care behavior in patients with diabetes mellitus. Belitung Nurs J. 2019; 5 (6): 239-45.
27. Reisi M, Mostafavi F, Javadzade H, Mahaki B, Tavassoli E, Sharifirad G. Impact of health literacy, self-efficacy, and outcome expectations on adherence to self-care behaviors in Iranians with type 2 diabetes. Oman Med J. 2016; 31 (1): 52-9.
28. Sun Y-Q, Jiang A-L, Chen S-M, Li H, Xing H-Y, Wang F. Quality of life and self-care in elderly patients with cardiovascular diseases: The effect of a Traditional Chinese Medicine health educational intervention. Appl Nurs Res. 2017; 38: 134-40.
29. Evangelista LS, Lee J-A, Moore AA, Motie M, Ghasemzadeh H, Sarrafzadeh M, Mangione CM. Examining the effects of remote monitoring systems on activation, self-care, and quality of life in older patients with chronic heart failure. J Cardiovasc Nurs. 2015; 30 (1): 51-7.
30. Marques MB, Coutinho JFV, Martins MC, Lopes MVdO, Maia JC, Silva MJd. Educational intervention to promote self-care in older adults with diabetes mellitus. Rev Esc Enferm USP. 2019; 53: e03517.
31. Warren-Findlow J, Seymour RB, Brunner Huber LR. The association between self-efficacy and hypertension self-care activities among African American adults. J Community Health. 2012; 37 (1): 15-24.
32. Yasaratna NR, Wijesinghe MSD. Perceived self-efficacy and self-managing of chronic diseases among elderly patients in a clinic setting: how capable are elders in promoting their own health? J Coll Community Physic Sri Lanka. 2020; 25 (4): 168-74.
33. Park Y-H, Chang H. Effect of a health coaching self-management program for older adults with multimorbidity in nursing homes. Patient Prefer Adherence. 2014; 8: 959-70.
34. Sahar J, Rekawati E, Wati DNK. Improving the health and functional status of institutionalized older adults through the nurse, caregiver, and older-adults partnership model (Miradasia). J Keperawatan Indonesia. 2019; 22 (2): 101-9.

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Predictors of Anxiety toward COVID-19 Delta Variant: A Cross-Sectional Study among Healthcare Providers in Java and Bali, Indonesia

I Ketut Swarjana[1], I Gede Putu Darma Suyasa[1*], I Kadek Nuryanto[2]

[1]Graduate Program in Nursing, Faculty of Health, Institute of Technology and Health Bali, Denpasar, Indonesia, [2]Undergraduate Program in Nursing Program, Faculty of Health, Institute of Technology and Health Bali, Denpasar, Indonesia

Abstract

Health facilities are experiencing overcapacity, oxygen scarcity, and a limited number of healthcare providers due to the coronavirus disease 2019 (COVID-19), thus impacted on anxiety. This study aimed to determine predictors of anxiety among healthcare providers toward the Delta variant of COVID-19 in Indonesia. A cross-sectional study was conducted with 371 healthcare providers in Java and Bali Islands, and the snowball sampling technique was used. Data were collected using a questionnaire and distributed through social media (WhatsApp), then analyzed using univariate analysis, bivariate analysis (Chi-square test), and multivariate analysis (multiple logistic regression). The results showed that 81 (21.8%) respondents experienced anxiety. The workplace (AOR: = 0.617; p-value = 0.011), records of tested positive for COVID-19 (AOR = 2.965; p-value<0.001), and the respondent's comorbidities (AOR = 8.753; p-value<0.001) were significantly associated with anxiety toward the Delta variant. Healthcare managers must regularly evaluate the psychological condition of their subordinates during the COVID-19 pandemic, so that anxiety can be detected and overcome early through constructive self-adaptation and positive coping mechanisms.

Keywords: anxiety, COVID-19 Delta variant, healthcare providers, Indonesia

Introduction

The World Health Organization (WHO) characterized the coronavirus disease 2019 (COVID-19) outbreak as a pandemic on March 11, 2020.[1-3] The pandemic has significantly impacted the global economy,[4] and health system,[5] and thus lockdowns and social distancing were implemented.[6-8] Daily cases and deaths in some countries have increased tremendously, but others have seen a decline in daily cases and deaths.[9] However, those data continue to fluctuate along with the changes and developments in new variants of COVID-19. The COVID-19 variants create a high concern to the world: 1) the Alpha variant (B.1.1.7), first detected in the United Kingdom and designated as a variant of concern (VoC) in December 2020; 2) the Beta variant (B.1.351), first detected in South Africa and designated as a VoC in December 2020; 3) the Gamma variant (P.1), discovered in Brazil and designated as a VoC in January 2021; 4) the Delta variant (B.1.617.2), discovered in India in May 2021; 5) and the Omicron variant (B.1.1.529), discovered in November 2021 in South Africa.[10,11] Of the many variants of COVID-19, the Delta variant is a major concern,[12] and dominates,[13] for several reasons, including containing the D614G, L452R, T478K, and P681R mutations, which have become a VoC, can increase infectivity, avoid detection by the immune system, and increased ability to trigger disease severity, respectively; also, can avoid damage caused by immune cells.[10,11,14,15]

In addition, a Delta plus variant with additional mutations,[16] was identified in Nepal and carried an additional K417N mutation. The Delta variant is estimated to be 40–60% more infectious than the Alpha variant and twice as contagious as the original Wuhan strain of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The Delta variant is also reportedly twice as likely to cause hospitalization as the Alpha variant,[10] and can potentially make the vaccine less effective at preventing infection.[17,18] However, if the patient with Delta variant is diagnosed and treated quickly, plus fully vaccinated, they can be protected from dangerous conditions.[19]

The SARS-CoV-2, especially the Delta variant, has impacted the world, including Asia.[20] After India experienced a new wave due to the Delta variant, Indonesia experienced a spike in daily cases and deaths.[21] Based on Our World in Data, the peak of daily cases in Indonesia occurred on July 15, 2021, with 56,757 cases; while,

Correspondence: I Gede Putu Darma Suyasa, Graduate Program in Nursing, Faculty of Health, Institute of Technology and Health Bali, Tukad Balian Street No. 180, Renon, Denpasar, Bali 80226, Indonesia,*
E-mail: putudarma.stikesbali@gmail.com, Phone: +62 812 3843 3388

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576,246 daily cases were recorded worldwide.[22] The average fatality case rate reached 5.37% in Indonesia, much higher than worldwide (1.41% on September 12, 2021).[23] Deaths due to the COVID-19 occur among the general public and healthcare providers. Data show that 2,087 healthcare providers died due to COVID-19, especially in June, July, and August 2021. Deaths of healthcare providers were dominated by doctors (751 cases), nurses (670 cases), midwives (398 cases), pharmacists (48 cases), and dentists (46 cases).[24] Other pandemic problems in Indonesia are the crises of oxygen, medicine, healthcare provider, and hospital capacity.[21] These cause a high burden on hospitals and healthcare providers in treating the COVID-19 patients.[25]

A qualitative study found that the high number of COVID-19 cases and the increasing number of deaths among healthcare providers had psychological effects, including anxiety in dealing with the COVID-19 in primary health care (PHC), clinics, and hospitals.[25] The American Psychiatric Association stated that anxiety is a feeling of discomfort, fear, or dread associated with the anticipation of danger, the source of which is often unspecified or unknown.[26] Anxiety is considered a disorder (or pathological) when it is excessive and has a relationship with impaired social and work functioning.[27] Sigmund Freud stated that anxiety is a major component of mental diseases.[28,29]

A study in Malaysia found anxiety in healthcare providers.[30] However, healthcare providers who were not on the front line experienced higher anxiety mean scores (6.9) than those on the front line (5.6).[30] A study in China found that 45% of healthcare providers experienced anxiety,[31] and Dr. Soetomo General Hospital, Indonesia, found that 33% of healthcare providers experienced high anxiety.[32] Another study in Thailand found that 33% of healthcare providers experienced anxiety,[33] and a study in Saudi Arabia found that 43.5%, 28.9%, and 27.5% of healthcare providers experienced mild, moderate, and severe anxiety, respectively.[34] A study in Iran noted that 22.9% of healthcare providers experienced anxiety (the mean anxiety score = 6.64).[35] Previous studies on anxiety during the pandemic have not been specific to any COVID-19 variant and they have found variations in anxiety levels and predictors. Therefore, this cross-sectional study was conducted to determine predictors of anxiety toward the Delta variant of COVID-19 among healthcare providers in Indonesia.

Method

A cross-sectional online study was performed to identify anxiety among healthcare providers during the COVID-19 pandemic in the Java and Bali Islands of Indonesia. The sample of this study was healthcare providers working in health facilities such as PHCs, clinics, and hospitals throughout Java and Bali Islands. This study involved 371 participants, calculated using the Daniel sample size formula.[36,37] The sample size (n) was estimated using a 95% confidence interval (CI) (z value = 1.96), the previous study proportion (p) was 45%, and the precision (d) was 5%. Hence, a minimum sample size of 312 was needed to conduct the study (Formula 1).

$$n = \frac{z^2pq}{d^2} = 311.17 = 312$$

Formula 1. Sample Size Estimation

All respondents were selected using the snowball sampling. This sampling technique began by contacting some healthcare providers in health facilities of the Java and Bali Islands. They were asked to get and share the Google Forms questionnaire link with other healthcare providers until the required number of samples was met. The inclusion criteria were healthcare providers who work in health facilities located in the Java and Bali Islands, with a minimum working period of two years, and who were willing to be a respondent in the study. While, the exclusion criteria were healthcare providers who were sick, on leave, or undergoing quarantine at the data collecting time.

The data collection tool was a questionnaire consisting of 1) the general characteristics of the respondents, such as age, sex, education, occupation, workplace, whether ever confirmed with COVID-19 by polymerase chain reaction (PCR) test ("Yes" or "No"), family ever confirmed with COVID-19 by PCR test ("Yes" or "No"), records of comorbidities ("Yes" or "No"), and family with records of comorbidities ("Yes" or "No"); 2) anxiety, assessed using the Hamilton Anxiety Rating Scale (HARS), consisting of 14 items ("not present," "mild," "moderate," "severe," or "very severe"),[27,38,39] 3) knowledge of the risk of COVID-19 transmission, assessed by 10 items ("correct," "incorrect," or "do not know"); 4) attitudes to the Delta variant of COVID-19, assessed by 10 items using a Likert scale ("strongly agree," "agree," "hesitate," "disagree," or "strongly disagree"); and 5) adherence in implementing health protocol for COVID-19 prevention, assessed by eight items ("always," "often," "sometimes," or "never"). The knowledge, attitude, and adherence were assessed using Bloom's cut-off points (below 60%, 60–79%, and 80–100%), resulting in three categories (poor, moderate, and good) for knowledge, three categories (negative, neutral, and positive) for attitude, and three categories (low, moderate, and high) for adherence. The questionnaires involved 30 respondents and were tested for validity and reliability. The questionnaire was determined to be reliable (Cronbach alpha $\geq$ 0.75).

The data was collected online and distributed through

social media (WhatsApp) during July and August 2021. First, the healthcare providers working in the health facilities in the Java and Bali Islands were listed. Second, these respondents were asked to complete the questionnaire. Third, they were asked to share the questionnaire link with other healthcare providers working in health facilities. Lastly, the distribution of the questionnaire link continued until the required number of samples was met. The data were analyzed using IBM SPSS Statistics ver. 18.0 (SPSS, Somer, NY). The data analysis used descriptive statistics to find the frequency, proportion, mean, median, and standard deviation (SD). Bivariate analysis using the Chi-square test was taken to examine the relationship between the independent and dependent variables and to identify the significant factors (p-value less than 0.25). The significant factors were then included in the multivariate analysis (binary logistic regression model) to determine the predictors of healthcare providers' anxiety towards the Delta variant of COVID-19 in Indonesia, as indicated by the adjusted odds ratio (AOR) and a p-value of less than 0.05.

Results

Table 1 shows that of the 371 respondents, the majority were aged under 45 years (74.1%), females (64.2%), nurses (72.5%) and attained a bachelor's degree (48.8%). Most respondents worked at hospitals (74.1%), had been positive for COVID-19 (62.5%), and had families who had never been positive for COVID-19 (53.4%). Of all respondents, the majority had never had comorbidities (82.2%), and more than half of respondents' families had never had comorbidities (58.2%).

Figure 1 shows that 22% of respondents experienced anxiety. Figure 2 shows that respondents who experience anxiety, have either mild (52%), moderate (34%), or severe anxiety (14%).

Table 2 shows the results of the bivariate analysis. Several factors were associated with anxiety about the Delta variant among health providers, including sex (p-value<0.001), workplace (p-value = 0.033), records of tested positive for COVID-19 (p-value<0.001), family ever tested positive for COVID-19 (p-value = 0.052), records of comorbidities (p-value<0.001), family records of comorbidities (p-value<0.001), knowledge (p-value = 0.037), attitudes (p-value<0.001), and adherence to health protocols (p-value = 0.010).

The results of the multivariate analysis using binary logistic regression in Table 3 show that three variables were associated with anxiety: a workplace (AOR = 0.617), records of being tested positive for COVID-19 (AOR = 2.965), and comorbidities (AOR = 8.753).

Table 1. Demographic Characteristics of Respondents (n = 371)

Variable	Category	n	%
Age (years)	<45	275	74.1
	≥45	96	25.9
Sex	Male	133	35.8
	Female	238	64.2
Education level	Diploma	172	46.4
	Bachelor's degree	181	48.8
	Master's degree	18	4.9
Occupation	Nurse	269	72.5
	Midwife	43	11.6
	Others	59	15.9
Workplace	Hospital	275	74.1
	Health center	43	11.6
	Others	53	14.3
Ever tested positive for COVID-19	Yes	139	37.5
	No	232	62.5
Family ever tested positive for COVID-19	Yes	173	46.6
	No	198	53.4
Records of comorbidities	Yes	66	17.8
	No	305	82.2
Family with records of comorbidities	Yes	155	41.8
	No	216	58.2

Discussion

The results of this study showed that of the 371 healthcare providers involved in this study, 22% experienced anxiety. While, a previous study on anxiety among healthcare providers during the COVID-19 pandemic in Saudi Arabia found that the majority had moderate an-

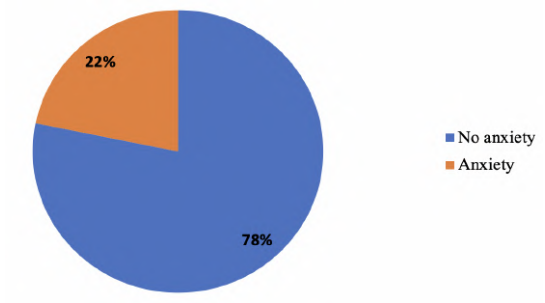

Figure 1. The Proportion of Anxiety among Healthcare Providers in Indonesia (n = 371)

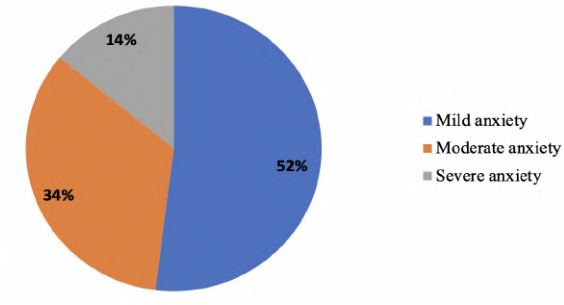

Figure 2. The Proportion of Anxiety Levels among Healthcare Providers in Indonesia (n = 81)

Table 2. Bivariate Analysis of Anxiety toward Delta Variant among Healthcare Providers in Indonesia (n = 371)

Variable	Category	Anxiety Status			p-value
		Anxiety	Not Anxiety	Total	
		n (%)	n (%)	n	
Age (years)	<45	57 (20.7)	218 (79.3)	275	0.466
	45	24 (25.0)	72 (75.0)	96	
Sex	Male	14 (10.5)	119 (89.5)	133	<0.001*
	Female	67 (28.2)	171 (71.8)	238	
Education level	Diploma	36 (20.9)	136 (79.1)	172	0.476
	Bachelor's degree	39 (21.5)	142 (78.5)	181	
	Master's degree	6 (33.3)	12 (66.7)	18	
Occupation	Nurse	57 (21.2)	212 (78.9)	269	0.767
	Midwife	9 (20.9)	34 (79.1)	43	
	Others	15 (25.4)	44 (74.6)	59	
Workplace	Hospital/health center	63 (19.8)	255 (80.2)	318	0.033*
	Others	18 (34.0)	35 (66.0)	53	
Ever tested positive for COVID-19	Yes	46 (33.1)	93 (66.9)	139	<0.001*
	No	35 (15.1)	197 (84.9)	232	
Family ever tested positive for COVID-19	Yes	46 (26.6)	127 (73.4)	173	0.052
	No	35 (17.7)	163 (82.3)	198	
Records of comorbidities	Yes	38 (57.6)	28 (42.4)	66	<0.001*
	No	43 (14.1)	262 (85.9)	305	
Family with records of comorbidities	Yes	48 (31.0)	107 (69.0)	155	<0.001*
	No	33 (15.3)	183 (84.7)	216	
Knowledge	Poor	20 (32.8)	41 (67.2)	61	0.037*
	Moderate	39 (22.2)	137 (77.8)	176	
	Good	22 (16.4)	112 (83.6)	134	
Attitude	Negative	13 (59.1)	9 (40.9)	22	<0.001*
	Neutral	53 (20.1)	211 (79.9)	264	
	Positive	15 (17.6)	70 (82.4)	85	
Adherence	Low	9 (50.0)	9 (50.0)	18	0.010*
	Moderate	22 (22.7)	75 (77.3)	97	
	High	50 (19.5)	206 (80.5)	256	

Note: *Significant (less than 0.05)

Table 3. Multivariate Analysis: Factors Associated with Anxiety toward Delta Variant of COVID-19 among Healthcare Providers in Indonesia

Variable	β	Sig.	Exp (B)	95% CI for Exp (B)	
				Lower	Upper
Working at a hospital/health center	-0.482	0.011	0.617	0.425	0.896
Records of being confirmed positive for COVID-19	1.087	<0.001	2.965	1.663	5.287
Have records of comorbidities	2.169	<0.001	8.753	4.622	16.578

Note: CI = Confidence Interval

xiety (73%).[40] Another study in Iran found that the proportion of anxiety was high in healthcare providers, reaching 51%.[41] Another study found that the anxiety of healthcare providers during the COVID-19 pandemic reached 41.4%.[42] A study in the UK stated that the anxiety of healthcare providers increased from a score of two (before the pandemic) to a score of seven (during the pandemic).[43] Another study in Saudi Arabia found the proportion of mild anxiety in healthcare providers was 28%.[44] Anxiety in health workers working in the COVID-19 unit experienced higher anxiety than those working in other health facilities, including healthcare providers operating in the community. This is reinforced by several previous findings, that midwives working in the COVID-19 unit were more anxious than those working in PHC.[45] The proportion of anxiety among healthcare providers in Indonesia is much lower than in the previous studies in several countries mentioned above. This may be due to several reasons, such as the experience of Indonesia facing the first wave of the COVID-19 pandemic in January 2021,[46] and the healthcare providers have been vaccinated with COVID-19 vaccination.[47]

A study of anxiety among healthcare providers in Vietnam found that 33.5% experienced anxiety. Comparing healthcare providers in hospital and non-hospital settings, the proportion of anxiety was found to be 46% and 13%, respectively. Another problem that healthcare providers face was a decreased in income, while the cost of living has increased.[48] A study in India found that 98% experienced anxiety; 2.37 times more health workers who were single experienced symptoms of depression and anxiety compared to those that married.[49] Another Thai study found that most (90%) Thai healthcare providers experienced fear during the COVID-19 pandemic. At the beginning of the pandemic, the uncertainty of the mode of transmission and symptomatic and asymptomatic patients caused stress to healthcare providers. The anxiety impacts substandard patient care and safety.[50] These impacts may occur because healthcare providers were worried not only about themselves and their families who were at risk of COVID-19, but also thinking about a decrease in income and the unpredictable end of the pandemic.

In this study, three factors (workplace, records of being tested positive for COVID-19, and comorbidities) were identified as predictors for respondents' anxiety towards the Delta variant of COVID-19. Regarding the workplace, the proportion of anxiety among healthcare providers working in health facilities other than hospitals or health centers was higher than those working at hospitals or health centers. This is probably because they rarely have direct contact with COVID-19 patients. Generally, COVID-19 patients or those who experience COVID-19 symptoms come to the health center or hospital for health checks, including rapid antigen or PCR tests. In addition, using incomplete personal protective equipment (PPE) is also likely to cause them to be anxious. While, healthcare providers working at hospitals or health centers are often in contact with suspected, probable, or confirmed COVID-19 patients, have complete PPE and have relatively good understanding and experience of the prevention and treatment of COVID-19 patients in the workplace. Furthermore, some previous studies have revealed that nurses felt higher anxiety with incomplete PPE,[51] and the fear of being exposed to COVID-19 at the workplace was a major risk factor for anxiety.[52] In this study, the proportion of anxiety was higher among healthcare providers with records of confirmed positive for COVID-19 and those with records of comorbidities. This is probably because they are aware that they are at risk of contracting the COVID-19 and more at risk of severe illness or even being hospitalized if testeded positive. This is in line with previous studies that found records of having tested positive for COVID-19 and chronic disease associated with anxiety.[53,54]

In addition, a study on anxiety in Saudi Arabia found that sex was significantly associated with anxiety experienced by health workers.[40] A study in Iran on anxiety reported that marital status, age, employment status, and type of healthcare provider were associated with anxiety.[41] Another study found that job insecurity, infection of family members, and an increase in severe illnesses and deaths were associated with anxiety among healthcare providers.[42] A study in the UK found that patient and family exposure factors, SARS-CoV-2 exposure, insufficient PPE and testing, too much information, job uncertainty, inaccurate information, financial instability, and lack of information were the main reasons for anxiety among healthcare providers.[43] A study in Saudi Arabia found that female and being a frontline healthcare provider were risk factors for anxiety during the COVID-19 pandemic.[44] These varied findings about the predictors of healthcare providers' anxiety are possible because the conditions and levels of impact of COVID-19 vary among countries, and the strategies to handle the pandemic are different and depend on the national policies of each country.

Anxiety in healthcare providers may have negative impacts on individuals and healthcare services. A study in Turkey found that anxiety impacted secondary traumatization.[54] This was confirmed again in study stating that anxiety about contracting the COVID-19 and anxiety in family members from the transmission of COVID-19 contributed to secondary traumatic stress.[55] Individual impact on healthcare providers is also shown by a study in Turkey finding that stress and work fatigue of healthcare providers in caring for COVID patients affected their quality of life.[56] Another study found anxiety was higher among healthcare providers who had children. This is because children during the pandemic take part in online learning at home, increasing the burden and responsibility of healthcare providers as parents, including caring for children at home, while they must continue working at healthcare facilities.[56] During the COVID-19 pandemic, healthcare providers noted several problems, including psychological signs and symptoms, post-traumatic stress, and fatigue.[57] Healthcare providers who treat COVID-19 patients experience higher fear of themselves or their families contracting COVID-19. Sleep quality directly impacts healthcare providers, which is associated with high anxiety and severe depressive symptoms.[58] Therefore, additional studies (especially interventional studies) are also needed to reduce anxiety and improve sleep quality among healthcare providers during the COVID-19 pandemic.

This study has several limitations. The sampling technique applied was non-probability sampling (snowball sampling), so that the results cannot be generalized to the population. This data was collected online, therefore the authors could not directly observe the respon-

dents filling out the questionnaire. Thus, further study needs to use probability sampling and collect data directly by implementing strict health protocols, moreover, concerning the efforts of healthcare providers to reduce anxiety and improve the quality of healthcare services and patient safety during the pandemic. However, this study also has strengths. It is important to identify anxiety and its predictors among healthcare providers, specifically concerning the Delta variant. Therefore, this study can be considered by healthcare facilities in reducing anxiety and is a basis for conducting further study on reducing anxiety among healthcare providers in Indonesia.

Conclusion and Recommendation

This study found that around one-fifth of respondents experienced anxiety toward the Delta variant of COVID-19. The workplace, records of positive COVID-19, and respondents' comorbidities are statistically significant predictors of anxiety among healthcare providers in the Java and Bali Islands. Of the three factors, comorbidities are the most significant predictor of anxiety, followed by a confirmed record of COVID-19 and the workplace, especially those working at health facilities other than hospitals and health centers. Furthermore, healthcare providers can manage anxiety with constructive self-adaptation strategies and positive coping mechanisms. Healthcare facility managers should quickly detect healthcare providers' psychological conditions and overcome the anxiety. In addition, it is important to hold seminars and training on handling anxiety during the COVID-19 pandemic.

Abbreviations

COVID-19: Coronavirus Disease 2019; WHO: World Health Organization; SARS-Cov-2: Severe Acute Respiratory Syndrome Coronavirus 2; VoC: Variant of Concern; CI: Confidence Interval; PHC: Primary Health Care; PCR: Polymerase Chain Reaction; HARS: Hamilton Anxiety Rating Scale; SD: Standard Deviation; AOR: Adjusted Odds Ratio; UK: United Kingdom; PPE: Personal Protective Equipment.

Ethics Approval and Consent to Participate

This study was approved by the Research Ethics Commission of the Institute of Technology and Health Bali (No.04.0472.1/KEPITEKES-BALI/VII/2021).

Competing Interest

The authors declare that there are no significant competing financial, professional, or personal interests that might have affected the performance.

Availability of Data and Materials

The data of this study are not publicly available because they contain information about the respondents' privacy.

Authors' Contribution

IKS and IGPDS were involved in conceptualizing the topic of study, methods, and data analysis. IKS and IKN were involved in data collection. All authors were involved in the writing and final approval of this manuscript.

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References

1. Cucinotta D, Vanelli M. WHO declares COVID-19 a pandemic. Acta Bio Medica: Atenei Parmensis. 2020; 91 (1): 157.
2. WHO. WHO Director-General's opening remarks at the media briefing on COVID19 Geneva: World Health Organization; 2020.
3. Dhama K, Khan S, Tiwari R, Sircar S, Bhat S, Malik YS, et al. Coronavirus disease 2019–COVID-19. Clinical microbiology reviews. 2020; 33 (4): e00028-20.
4. Shehzad K, Xiaoxing L, Bilgili F, Koçak E. COVID-19 and spillover effect of global economic crisis on the United States' financial stability. Frontiers in psychology. 2021; 12: 632175.
5. Kaye AD, Okeagu CN, Pham AD, Silva RA, Hurley JJ, Arron BL, et al. Economic impact of COVID-19 pandemic on healthcare facilities and systems: International perspectives. Best Practice & Research Clinical Anaesthesiology. 2021; 35 (3): 293-306.
6. Hiscott J, Alexandridi M, Muscolini M, Tassone E, Palermo E, Soultsioti M, et al. The global impact of the coronavirus pandemic. Cytokine & growth factor reviews. 2020; 53: 1-9.
7. Nicola M, Alsafi Z, Sohrabi C, Kerwan A, Al-Jabir A, Iosifidis C, et al. The socio-economic implications of the coronavirus pandemic (COVID-19): A review. International journal of surgery. 2020; 78: 185-93.
8. Belitski M, Guenther C, Kritikos AS, Thurik R. Economic effects of the COVID-19 pandemic on entrepreneurship and small businesses. Small Business Economics. 2022; 58 (2): 593-609.
9. Ourworldindata. Daily new confirmed COVID-19 cases. Oxford: Oxford Martin School, University of Oxford; 2022.
10. GAVI. From Alpha to Omicron: Everything you need to know about SARS-CoV-2 variants of concern Geneva: the vaccine alliance; 2021.
11. World Health Organization. Tracking SARS-CoV-2 variants. Geneva: World Health Organization; 2022.
12. Tian D, Sun Y, Zhou J, Ye Q. The global epidemic of the SARS-CoV-2 delta variant, key spike mutations and immune escape. Frontiers in immunology. 2021; 12.
13. Vaughan A. Delta to dominate world. Elsevier; 2021.
14. Hendaus MA, Jomha FA. Delta variant of COVID-19: a simple explanation. Qatar Medical Journal. 2021; 2021 (3): 49.
15. Shiehzadegan S, Alaghemand N, Fox M, Venketaraman V. Analysis of the Delta variant B.1.617.2 COVID-19. Clinics and Practice. 2021; 11 (4): 778-84.
16. World Health Organization. Q and A on CCOVID-19 variants. Geneva: World Health Organization; 2022.
17. Bernal JL, Andrews N, Gower C, Gallagher E, Simmons R, Thelwall S,

et al. Effectiveness of Covid-19 vaccines against the B.1.617.2 (Delta) variant. New England Journal of Medicine. 2021.
18. Bian L, Gao Q, Gao F, Wang Q, He Q, Wu X, et al. Impact of the Delta variant on vaccine efficacy and response strategies. Expert review of vaccines. 2021; 20 (10): 1201-9.
19. Hu Z, Huang X, Zhang J, Fu S, Ding D, Tao Z. Differences in clinical characteristics between Delta variant and wild-type SARS-CoV-2 infected patients. Frontiers in Medicine. 2021; 8.
20. Elbehri A, Temel T, Burcu Ceylan F, Mittal S, Kularatne D, Dawe D. COVID-19 pandemic impacts on Asia and the Pacific. 2022.
21. Dyer O. Covid-19: Indonesia becomes Asia's new pandemic epicentre as delta variant spreads. British Medical Journal Publishing Group. 2021.
22. Ourworldindata. Daily new confirmed COVID-19 cases. Oxford: Oxford Martin School, University of Oxford, Global Change Data Lab; 2022.
23. Ourworldindata. Moving-average case fatality rate of COVID-19. Oxford: Oxford Martin School, University of Oxford; 2022.
24. Laporcovid-19. 2087 tenaga kesehatan Indonesia gugur melawan Covid-19 Jakarta: lapor Covid-19. Pusara Digital Tenaga Kesehatan; 2022.
25. Setiawan HW, Pratiwi IN, Nimah L, Pawanis Z, Bakhtiar A, Fauzinigtyas R, et al. Challenges for healthcare workers caring for COVID-19 patients in Indonesia: a qualitative study. INQUIRY: The Journal of Health Care Organization, Provision, and Financing. 2021; 58: 00469580211060291.
26. American Psychiatric Association. What are Anxiety Disorders?; 2022.
27. Townsend MC, Morgan KI. Psychiatric mental health nursing: Concepts of care in evidence-based practice: FA Davis; 2017.
28. Freud A. The ego and the mechanisms of defence: Routledge; 2018.
29. Swarjana I. Konsep pengetahuan, sikap, perilaku, persepsi, stres, kecemasan, nyeri, dukungan sosial, Kepatuhan, Motivasi, Kepuasan, Pandemi Covid-19, Akses Layanan Kesehatan – Lengkap Dengan Konsep Teori, Cara Mengukur Variabel, dan Contoh Kuesioner. Yogyakarta: Penerbit Andi; 2022.
30. Norhayati MN, Ruhana CY, Azman YM. Anxiety in frontline and non-frontline healthcare providers in Kelantan, Malaysia. International Journal of Environmental Research and Public Health. 2021; 18 (3): 861.
31. Lai J, Ma S, Wang Y, Cai Z, Hu J, Wei N, et al. Factors associated with mental health outcomes among healthcare providers exposed to coronavirus disease 2019. JAMA network open. 2020; 3 (3): e203976-e.
32. Setiawati Y, Wahyuhadi J, Joestandari F, Maramis MM, Atika A. Anxiety and resilience of healthcare workers during COVID-19 pandemic in Indonesia. Journal of Multidisciplinary Healthcare. 2021; 14: 1.
33. Chinvararak C, Kerdcharoen N, Pruttithavorn W, Polruamngern N, Asawaroekwisoot T, Munsukpol W, et al. Mental health among healthcare workers during COVID-19 pandemic in Thailand. PloS one. 2022; 17 (5): e0268704.
34. Al Mutair A, Al Mutairi A, Alabbasi Y, Shamsan A, Al-Mahmoud S, Alhumaid S, et al. Level of anxiety among healthcare providers during COVID-19 pandemic in Saudi Arabia: cross-sectional study. PeerJ. 2021;9:e12119.
35. Motahedi S, Aghdam NF, Khajeh M, Baha R, Aliyari R, Bagheri H. Anxiety and depression among healthcare workers during COVID-19 pandemic: A cross-sectional study. Heliyon. 2021; 7 (12): e08570.
36. Daniel WW, Cross CL. Biostatistics: A Foundation for Analysis in the Health Sciences: Wiley; 2018.
37. Swarjana I. Populasi-Sampel, Teknik Sampling dan Bias dalam Penelitian. Yogyakarta: Penerbit Andi; 2022.
38. Hamilton M. The assessment of anxiety states by rating. British journal of medical psychology. 1959.
39. Ramdan IM. Reliability and validity test of the Indonesian version of the hamilton anxiety rating scale (ham-a) to measure work-related stress in nursing. Jurnal Ners. 2019; 14 (1): 33.
40. Mohsin SF, Agwan MA, Shaikh S, Alsuwaydani ZA, AlSuwaydani SA. COVID-19: fear and anxiety among healthcare workers in Saudi Arabia. a cross-sectional study. INQUIRY: The Journal of Health Care Organization, Provision, and Financing. 2021; 58: 00469580211025225.
41. Javadi MH. Health anxiety and social health among healthcare providers and health volunteers exposed to coronavirus disease in Iran (2020): A structural equation modeling. Journal of Affective Disorders Reports. 2022; 8: 100321.
42. Weibelzahl S, Reiter J, Duden G. Depression and anxiety in healthcare professionals during the COVID-19 pandemic. Epidemiology & Infection. 2021; 149.
43. Siddiqui I, Aurelio M, Gupta A, Blythe J, Khanji MY. COVID-19: Causes of anxiety and wellbeing support needs of healthcare professionals in the UK: A cross-sectional survey. Clinical Medicine. 2021; 21 (1): 66.
44. Al Ammari M, Sultana K, Thomas A, Al Swaidan L, Al Harthi N. Mental health outcomes amongst healthcare providers during COVID 19 pandemic in Saudi Arabia. Frontiers in Psychiatry. 2021: 1550.
45. Yilmaz AN, Altiparmak S, Derya YA. The impact of working unit and being diagnosed with COVID-19 on secondary traumatic stress level in midwives: a cross-sectional and comparative study. Journal of Clinical Medicine of Kazakhstan. 2021; 18 (4): 46-51.
46. ANTARA. Infografik: Gelombang I dan II COVID-19 di Indonesia Jakarta: ANTARA Kantor Berita Indonesia, Satgas COVID-19; 2021.
47. Kementerian Kesehatan Republik Indonesia. Studi terbaru: vaksin COVID-19 efektif mencegah perawatan dan kematian Jakarta: Kementerian Kesehatan Republik Indonesia; 2021.
48. Than HM, Nong VM, Nguyen CT, Dong KP, Ngo HT, Doan TT, et al. Mental health and health-related quality-of-life outcomes among frontline health workers during the peak of COVID-19 outbreak in Vietnam: a cross-sectional study. Risk management and healthcare policy. 2020; 13: 2927.
49. Suryavanshi N, Kadam A, Dhumal G, Nimkar S, Mave V, Gupta A, et al. Mental health and quality of life among healthcare professionals during the COVID-19 pandemic in India. Brain and behavior. 2020; 10 (11): e01837.
50. Apisarnthanarak A, Apisarnthanarak P, Siripraparat C, Saengaram P, Leeprechanon N, Weber DJ. Impact of anxiety and fear for COVID-19 toward infection control practices among Thai healthcare workers. Infection Control & Hospital Epidemiology. 2020; 41 (9): 1093-4.
51. Arnetz JE, Goetz CM, Sudan S, Arble E, Janisse J, Arnetz BB. Personal

protective equipment and mental health symptoms among nurses during the COVID-19 pandemic. Journal of occupational and environmental medicine. 2020; 62 (11): 892-7.
52. Mattila E, Peltokoski J, Neva MH, Kaunonen M, Helminen M, Parkkila AK. COVID-19: anxiety among hospital staff and associated factors. Annals of Medicine. 2021; 53 (1): 237-46.
53. Alzaid EH, Alsaad SS, Alshakhis N, Albagshi D, Albesher R, Aloqaili M. Prevalence of COVID-19-related anxiety among healthcare workers: a cross-sectional study. Journal of Family Medicine and Primary Care. 2020; 9 (9): 4904.
54. Arpacioglu S, Gurler M, Cakiroglu S. Secondary traumatization outcomes and associated factors among the healthcare providers exposed to the COVID-19. International Journal of Social Psychiatry. 2021; 67 (1): 84-9.
55. Yörük S, Acikgoz A, Güler D. The predictors of secondary traumatic stress and psychological resilience in healthcare workers during the COVID‐19 pandemic: a cross‐sectional study in Turkey. Stress and Health. 2022.
56. Çelmeçe N, Menekay M. The effect of stress, anxiety and burnout levels of healthcare professionals caring for COVID-19 patients on their quality of life. Frontiers in psychology. 2020: 3329.
57. Dosil M, Ozamiz-Etxebarria N, Redondo I, Picaza M, Jaureguizar J. Psychological symptoms in health professionals in Spain after the first wave of the COVID-19 pandemic. Frontiers in Psychology. 2020; 11: 606121.
58. Stojanov J, Malobabic M, Stanojevic G, Stevic M, Milosevic V, Stojanov A. Quality of sleep and health-related quality of life among health care professionals treating patients with coronavirus disease-19. International Journal of Social Psychiatry. 2021; 67 (2): 175-81.

Widjanarko, *et al. Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*. 2022; 17 (3): 212-219
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Perspectives on Reproductive Health Education among Javanese Parents

Bagoes Widjanarko, Ratih Indraswari*, Aditya Kusumawati, Novia Handayani

Department of Health Promotion and Behavioral Science, Faculty of Public Health, Universitas Diponegoro, Semarang, Indonesia

Abstract

This study aimed to investigate the perspectives of reproductive health education among Javanese parents of children aged 9-11 years. This cross-sectional study was conducted with 12,306 parents in Semarang City, Central Java Province, Indonesia, using a purposive sampling technique. Some parents agreed that reproductive health education at home was unnecessary (29.5%), taboo (45%), difficult (73.1%), and awkward (41.5%). Most parents (72.7%) were not transparent in providing reproductive health information to their children by using other terms to name the genitals, considering the politeness aspect. Good practices of providing reproductive health information are slightly more common in mothers (54.2%), unemployed parents (52.9%), those with a higher education level (69.5%), and those with a family income above the regional minimum wage (59.8%). As many as 76.9% of parents intensely monitor their children; however, 60.63% of parents have poor communications with their children. Parents believe that reproductive health information is essential for their children, but parents find the topic difficult with their children due to taboos and awkward feelings. Accordingly, the Indonesian Ministry of Health should empower parents to discuss reproductive health issues with their children openly.

Keywords: children, parents, reproductive health education

Introduction

Unwanted pregnancies among adolescents have become a health problem worldwide. Every year, approximately 16 million girls aged 15–19 years and 2.5 million girls under 16 years old in developing countries experience childbirth.[1] Additionally, the World Health Organization (WHO) also stated that three million adolescent girls aged 15–19 years in Asian countries undergo an abortion each year.[2] In developing countries, the abortion rate has increased by about 11%.[3] The increased risk of abortion is influenced by the incidence of unwanted pregnancies.[4] On average, 8% of abortions are performed on girls aged less than 19 years in Indonesia and are caused by unwanted pregnancies yearly.[5]

Based on data from the 2015 Global School-based Health Survey (GSHS), 5.26% of junior and senior high school students in Indonesia have engaged in sexual intercourse, and only 13% of them used condoms.[6] This corroborates data from the Indonesian Ministry of Health, which stated that the incidence of unwanted pregnancies in girls aged 15–19 years in Indonesia continues to increase. Data showed that unwanted pregnancies rose from 1.97% in 2013,[7] to 16.4% in 2017.[8] A pre-assessment by the Indonesian Planned Parenthood Association (IPPA)/*Perkumpulan Keluarga Berencana Indonesia* (PKBI) found that 40.6% of 64 adolescents with unwanted pregnancies in Central Java Province lived in urban areas. Consequently, most resided in Semarang, the capital city of Central Java Province.[9]

According to the Indonesia Demographic and Health Survey (IDHS)/*Survei Demografi dan Kesehatan Indonesia* (SDKI), the percentage of adolescents aged 15–19 years who had sexual intercourse for the first time increased from 59% in 2012 to 74% in 2017.[8] The GSHS shows that 27.35% of junior high and high school students in Indonesia have been sexually active before they turn 14 years old.[6] While, 6% of adolescents reported having sexual intercourse when they were 11–14 years old, the average age at the beginning of puberty or the transition from childhood to adolescence.[8] In addition, the age of menarche (first menstrual cycle) in Indonesia has declined to 11 days younger per year.[10]

Correspondence: Ratih Indraswari, Department of Health Promotion and Behavioral Science, Faculty of Public Health, Universitas Diponegoro, Prof. Soedharto SH Street, Tembalang, Semarang 50275, Indonesia, E-mail: ratih.indraswari@gmail.com, Phone: +62 24 7460 044*

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This indicates that adolescents in Indonesia might experience sexual intercourse for the first time at a younger age.

Sexual behavior is significantly related to access to pornography (p-value<0.001).[11] Access to magazines, books, pornographic films, and porn action causes adolescents to have sexual intercourse at an early age (13–15 years).[12] A previous study reported that 60.6% of adolescents accessed pornography at least once daily, mostly on their cellular phone (59.2%) at home. In fact, 1.2% of adolescents are exposed to pornography from 5-8 years old by their parents' cellular phones.[11] Parental supervision and communications with children influence adolescents' risk of sexual behavior.[13] About 50% of parents did not monitor the activities of their children, and 63% provided free internet access without supervising their children's online activities.[11]

Low parental involvement and supervision likely affect adolescents at risk of sexual behavior. The adolescent reproductive health indicator in the 2017 IDHS showed that peers (57.5%) and mothers (45.2%) likeliest have opportunities to address reproductive health issues with their adolescent daughters.[14] However, some parents refuse to discuss reproductive health because they worry about its effects on their children's behavior. Parents feel that one day the child will learn about the topic independently from teachers at school.[15] A study stated that even teachers feel awkward and embarrassed when they address reproductive health issues with students in class.[16]

Based on the background above, risky premarital sex behavior is critical to prevent and should be done as early as possible, at least when the children enter puberty. Children should have acquired sufficient knowledge of reproductive health at prepubertal age, and parents are responsible for educating their children in preparing for puberty. Still, based on the data mentioned above, it can be seen that parents in Central Java Province are reluctant to share information on reproductive health because the Javanese culture considers it taboo.[17] Using this background on reproductive health education, this study aimed to describe the perspective of reproductive health education among Javanese parents of children aged 9–11 years.

Method

This study employed an explanatory study method with a cross-sectional approach. The population of this study was parents of students at grades 4–6 of elementary schools (aged 9-11 years) in Semarang City, Central Java Province, Indonesia, whose number is uncertain. With purposive technique sampling, this study's final sample comprised 12,306 respondents who met the criteria (parents of students in grades 4–6 (aged 9-11 years) of elementary schools in Semarang City) and completed the entire survey.

The survey was conducted online (e.g., mobile-based data collection) in March 2021 because it was impossible to conduct face-to-face interviews during the large-scale social distancing (LSSR)/*Pembatasan Sosial Berskala Besar* (PSBB) since the beginning of the coronavirus disease 2019 (COVID-19) pandemic. All public elementary schools in Semarang City (327 schools) were visited to obtain verbal informed consent from principals and teachers. Subsequently, teachers from each school's fourth, fifth, and sixth grades were assisted to collect online data from parents by sharing a Google Forms questionnaire link via the class WhatsApp Group between the teacher and parents. The teacher explained the purpose of the survey and encouraged parents to complete the questionnaire. On the first page of the questionnaire form, detailed information on the purpose of the study and informed consent statements were provided. Parents could continue to fill out the form after agreeing to be respondents in the study. The questionnaire responses from all parents were received through the Google Forms system.

The variables in this study were parents' characteristics (age, sex, education level, occupation, and family income), parents' attitudes to reproductive health education for children, parental monitoring of children's activity, parent-child communication, and parents' practices in providing reproductive health education to their children. Age was categorized as adolescent for respondents aged under 26 years, adult for respondents aged 26–45 years, and elderly for respondents older than 45 years. Sex was determined biologically, meaning a female was the mother or a male was the father. Formal education levels were no education, completed elementary school, junior high school, high school, Diploma III, Bachelor's, and Master's degrees. The categories of respondents' occupations were unemployed, civil servant/government official/police/army, private employee, entrepreneur, farmer, fisherman, labor/maid, and others. Family income was categorized by the regional minimum wage (IDR 2,810,025).

The parents' attitude variable consisted of five questions on the permission to date and parents' opinions on delivering reproductive health information to children due to taboo feelings, awkwardness, the necessity of providing information, and the necessity of monitoring children's interactions with friends. The attitude was scored 1 for each more permissive answer and 0 for each less permissive answer. The total score for attitude was 10. An attitude score of 5 or less was categorized as less permissive, and a score of 6 or more was classified as permissive.

The parental monitoring of children's daily activity

was measured by six questions: children's permission to go outside the home, knowing children's friends, time limitations for children playing outside the house, asking children to give detailed explanations if they broke the rules, knowing how children spend money, and knowing the sites or applications accessed or used by children from a cellular phone/laptop. The monitoring was scored 1 for a "yes" and 0 for each "no." The total score for monitoring was 6. A monitoring score of 3 or less was categorized as weak monitoring, and a score of 4 or more was classified as strong monitoring.

A standardized Parent-Child Interaction Questionnaire (PACHIQ),[18] was used to measure parent-child communication. This questionnaire consisted of 28 questions on parents' communications with their children in everyday situations. Communication was scored 1 for a "no" and 0 for each "yes." The total score for communication was 28. A communication score of 19 or less was categorized as bad, and a score of 20 or more was classified as good.

The parents' practice variable in providing reproductive health education to their children consisted of six questions about knowing the pubertal status of children, the content of reproductive health information (organs and functions, menstruation/nocturnal emission, physical changes after puberty, and pregnancy), limiting children's relationships with opposite-sex friends, using slang terms in naming genitals, encountering difficulties in discussions, and parents' responses to children's questions (no response/changing the topic, scolding, and giving an honest or hazy explanation). The practice was scored 1 for each good practice answer and 0 for each bad practice answer. The total score for all practices was 10. A practice score of 5 or less was categorized as bad, and a score of 6 or more was classified as good. Univariate analysis was used on the data to determine the frequency of each variable distribution, performed with the software package used for the analysis of statistical data.

Results

There were 34.6% of fathers and 65.4% of mothers participating in this study (Table 1). Most respondents were adults (26–45 years old), employed, completed senior high school, and earned a family income higher than the regional minimum wage (IDR 2,810,025).

Table 2 shows parents' attitudes toward reproductive health education for their children. Parents thought reproductive health education at home was unnecessary and perceived it taboo. Some parents perceived discussing reproductive health issues with children as awkward and considered monitoring children's daily interactions with friends unimportant. Most parents limit their children's friendships with the opposite sex. Nevertheless, a few parents permitted their children to start dating at age 9-11 years, considering the child's maturity.

Most parents admitted that children always ask for permission to leave the house. Parents knew their children's friends, how they spent pocket money, and what their children access via cellular phone/laptop. Most parents give children a time limit to play outside the house and ask for a more detailed explanation if children come home after that time limit (Table 3).

Based on Table 4, most parents often feel dissatisfied with their children and admit that children often disobey the rules in their house. Some parents did not listen to

Table 1. Respondent's Characteristic (n = 12,306)

Variable	Category	n	%
Age	Adolescent	5	0.04
	Adult	9,717	78.96
	Elderly	2,584	21
Sex	Male (father)	4,260	34.6
	Female (mother)	8,046	65.4
Education level	No education	99	0.8
	Elementary school	1,187	9.6
	Junior high school	1,964	16.0
	High school	6,506	52.9
	Diploma III degree	1,012	8.2
	Bachelor's degree	1,410	11.5
	Master's degree	128	1.0
Occupation	Unemployed	3,664	29.8
	Civil servant/police/army/government official	508	4.1
	Private employees	3,011	24.5
	Entrepreneur	2,094	17.0
	Farmer	35	0.3
	Fisherman	8	0.1
	Laborer/maid	1,610	13.1
	Other	1,376	11.2
Family income	<Minimum wage	8,712	70.8
	>Minimum wage	3,594	29.2

Table 2. Parents' Attitudes in Delivering Reproductive Health Information

Variable	n	%
Feeling unnecessary	3,625	29.5
Feeling taboo	5,543	45.0
Feeling awkward	5,112	41.5
Feeling unimportant to monitor children's interactions with friends	771	6.3
Giving dating permission	1,685	13.7

Table 3. Parental Monitoring

Variable	n	%
Children always ask for permission to leave the house	9,804	79.67
I know who my children go out to play with	6,968	56.62
I give a time limit for children to play outside the house	8,709	70.80
I ask for a more detailed explanation (why, where, and with whom) if the child comes home late	11,739	95.39
I know how my children spend their money	8,936	72.61
I know what my child accesses via cellular phone/laptop	10,921	88.75

Table 4. Parent-Child Communication

Variable	n	%
When my child does not want to clean his room, I will not force him	7,366	59.86
My child often disobeys the rules in our house	9,378	76.21
I have difficulty speaking softly to my child	8,361	67.94
I cannot accept criticism from my child	3,486	28.35
I often feel dissatisfied with my child	9,799	79.65
When my child makes a mistake, (s)he can talk about it with me without fear of punishment	9,391	76.31
I accept my child's strengths and weaknesses as they are	10,389	84.42
I make decisions for my child without involving her/him	6,618	53.83
I do not need to remind my child about her/his homework	1,386	11.26
My child really trusts me	8,353	67.88
I make time to listen to my child	3,491	28.37
My child and I often fight	5,018	40.80
I give gifts (praises, goods, etc.) when the child does something for me	8,120	65.98
My child knows what I'm worried about	6,952	56.60
I like to hear my children when they tell stories	8,230	66.88
Actually, I do not really listen to my child's story	4,541	36.90
My child feels like a boss at home	5,192	42.19
I enjoy physical touch (hugs, kisses, etc.) with my child	8,634	70.16
I calm my child when he is facing problems	8,493	69.02
I hit my child if (s)he does not listen to me	349	2.84
I decide who can be my child's friend	3,801	30.89
I raise my voice (scream) if we disagree	5,022	40.81
I do not care if the child argues or does not do what I ask for	1,084	8.81
My child listens when I explain	9,240	75.09
I always cover my anger in front of children	2,076	16.87
I am proud of my child	9,109	74.02
I often praise my child	3,408	27.69
When my child is angry, I do not really understand what causes her/his anger	6,627	53.85

Table 5. Parent's Practice in Delivering Reproductive Health Information

Variable	n	%
Knowing children's puberty status	11,603	89.9
Reproductive health material that has been delivered:		
Reproductive organs and functions	2,611	21.2
Menstruation/nocturnal emission	3,391	27.6
Physical changes after puberty	5,347	43.5
Pregnancy	910	7.4
Never	5,461	44.4
Limiting children's relationships with opposite-sex friends	10.951	89.0
Using slang terms in naming genitals	8,943	72.7
Encountering difficulties in discussions	8,992	73.1
Parent's response to children's questions:		
No answer/changing the topic	736	6.0
Scolding children	136	1.1
Giving an honest explanation	10,442	84.9
Giving a hazy explanation	166	1.3
Others	826	6.7

their children and did not understand the reason for their children's anger. A few parents admit to hitting their children when they do not listen and find it difficult to speak softly to their children.

In Table 5, most parents knew their children's puberty status, such as menstruation for girls, a nocturnal emission for boys, or the pubescent phase. Almost half of the parents never provided information on reproductive health issues. Still, some parents provided reproductive health information on topics such as reproductive organs and their functions, menstruation, nocturnal emission, physical changes after puberty, and pregnancy. However, most parents substituted the names of genital organs when discussing reproductive health issues. Most parents encountered difficulties in bringing up reproductive health issues with their children, but parents

Table 6. Crosstab between Parent's Characteristic, Attitude, Parental Monitoring, and Parent-Child Communication toward Practices in Delivering Reproductive Health Information

Variable	Category	Bad Practice		Good Practice		Total	
		(n = 6,011)	%	(n = 6,295)	%	(n = 12,306)	%
Age	Adolescent	3	60.0	2	40.0	5	0.04
	Adult	4,765	49.0	4,952	51.0	9,717	78.96
	Elderly	1,243	48.1	1,341	51.9	2,584	21.1
Sex	Male (father)	2,324	54.6	1,936	45.4	4,260	34.6
	Female (mother)	3,687	45.8	4,359	54.2	8,046	65.4
Education level	No education	61	61.6	38	38.4	99	0.8
	Elementary school	664	55.9	523	44.1	1,187	9.6
	Junior school	1,109	56.5	855	43.5	1,964	16.0
	High school	3,291	50.6	3,215	49.4	6,506	52.9
	Diploma III degree	367	36.3	645	63.7	1,012	8.2
	Bachelor's degree	480	34.0	930	66.0	1,410	11.5
	Master's degree	39	30.5	89	69.5	128	1.0
Occupation	Unemployment	1,727	47.1	1,937	52.9	3,664	29.8
	Civil servant/police/army/government official	172	33.9	336	66.1	508	4.1
	Private employees	1,496	49.7	1,515	50.3	3,011	24.5
	Entrepreneur	1,031	49.2	1,063	50.8	2,094	17.0
	Farmer	25	71.4	10	28.6	35	0.3
	Fisherman	3	37.5	5	62.5	8	0.1
	Laborer/maid	912	56.6	698	43.4	1,610	13.1
	Other	645	46.9	731	53.1	1,376	11.2
Family income	<Minimum wage	4,568	52.4	4,144	47.6	8,712	70.8
	>Minimum wage	1,443	40.2	2,151	59.8	3,594	29.2
Feeling unnecessary	Agree	2,384	65.8	1,241	34.2	3,625	29.5
	Disagree	3,627	41.8	5,054	58.2	8,681	70.5
Feeling taboo	Agree	3,596	64.9	1,947	35.1	5,543	45.0
	Disagree	2,415	35.7	4,348	64.3	6,763	55.0
Feeling awkward	Agree	3,374	66.0	1,738	34.0	5,112	41.5
	Disagree	2,637	36.7	4,557	63.3	7,194	58.5
Feeling it is unimportant to monitor children's interactions with friends	Agree	441	57.2	330	42.8	771	6.3
	Disagree	5,570	48.3	5,965	51.7	11,535	93.7
Giving dating permission	Agree	983	58.3	702	41.7	1,685	13.7
	Disagree	5,028	47.3	5,593	52.7	10,621	86.3
Parental monitoring	Weak	2,280	80.20	563	19.80	2,843	23.10
	Strong	3,731	39.43	5,732	60.57	9,463	76.90
Parent-child communication	Poor	5,302	71.06	2,159	28.94	7,461	60.63
	Good	709	14.63	4,136	85.37	4,845	39.37

likely addressed reproductive health issues honestly when the children asked. In addition, a few parents changed the topic, and some scolded the children or gave a hazy explanation when responding to the children's questions.

Good practices in productive health discussions were slightly more common in females/mothers than in males/fathers (Table 6). Parents with higher education levels provide better reproductive health information to their children than the lower ones. On average, unemployed parents provided reproductive health information slightly better than parents working as private employees, entrepreneurs, farmers, and laborers/maids. Delivering good reproductive health information was mainly found in parents with family incomes above the minimum wage. Parents with low socioeconomic levels tended to have poor practices in conveying reproductive health information to their children. Parents perceived reproductive health education as necessary to monitor children's friendships and restricted their children's dating.

Discussion

Most respondents were adults, and a productive age was crucial for improving cognitive and social abilities, meaning that age influenced the level of knowledge. The older a person is, the more mature they think and act regarding problems.[19] This study reported no relationship between age and parental education on reproductive health, though parents aged <26 years had worse attitudes to reproductive health education at home than older parents (adult and elderly). Besides, influencing a cognitive perspective, age also relates to beliefs. Mature individuals will be trusted more than immature ones. Maturity also affects comprehension and mindsets. As people age, their mindsets and knowledge also develop.

There is no report about a decline in intellectual ability, problem-solving, and verbal ability at this age.[20] Hence, parents at a productive age should be able to be good health communicators for their children.

This study involved more female participants/mothers than males/fathers. In the Javanese ethnic group, mothers typically handle household- and child-related affairs. Most Javanese women also encounter the double burden of caring for family and raising money to sustain the family.[21] One-third of parents were unemployed, and most parents had a family income under the regional minimum wage. The patriarchal culture reduces women's equal opportunities to obtain a better education and income than men.[21] Men are the breadwinners for the family, while women focus more on household chores and childbearing.

Consequently, mothers have more responsibility for their children's reproductive health issues than fathers. In the Javanese tradition, mothers monitor their children's growth, such as their weight and height.[21] Children's understanding of and self-efficacy in reproductive health tends to be neglected. Prosperous parents provide health information better than the unprosperous ones due to the sufficiency of family time.

More than half of the parents in this study had graduated from high school. Education level is important in honing skills to create educated humans expected to meet educational goals. Education makes a major contribution to human interaction with the environment.[22] The skills and knowledge acquired at school help advocate for health communication. Community education affects perceptions and conceptual abilities to deliver and receive messages and information. It will also affect the arrangement of thoughts and feelings about responses or feedback given to a communicator or communicant.[22] People with higher education may communicate better in terms of content and attitudes. Human behavior as the result of learning reflects changes due to environmental influences.[23] Therefore, this study reported that parents with higher education levels provide better reproductive health education to their children at home.

Most parents knew the puberty status of their children and limited their children's relationships with opposite-sex friends. In addition, 13.7% of mothers permitted dating early (aged 9-11 years) because it was considered normal, and 6.3% thought monitoring children's friendships was unnecessary. Monitoring, one of the parental roles, could be accomplished by checking children's activities and maintaining positive ones. Children who lack parental monitoring might feel and act freer as their parents do not supply well-defined rules. Several previous studies have also proved that the lack of parental monitoring results in accessing pornography and risky sexual behavior among their children.[11,24,25] Parents who do not supervise and control children tend to make children more daring to violate social norms.[24] Parents play a role in controlling, educating, reminding, and advising children that they display indications of risky behavior.

Children's activities can be monitored by checking their social media use and establishing a good bonding and communication between parents and children. According to Lawrence Green, a person's behavior is influenced by factors that encourage or strengthen the occurrence of the behavior,[26] including the attitudes and behaviors of parents toward children depicted by parental monitoring and parent-child communication. This is due to the psychological control of adolescents, according to which their parents know their whereabouts and activities outside the house. Adolescents having good relationships with their parents (good communication, supervised, and monitored by their parents) affect the psychological control of adolescents when they are outside the house without parental supervision. However, most parents felt the need to convey reproductive health information to their children, though they faced difficulties starting discussions and considered it taboo or awkward. This corroborates other studies stating that parents feel embarrassed and unconfident when discussing reproductive health issues.[27,28] Most parents consider reproductive health an adult, private affair, and taboo.[29] In fact, many parents immediately refused to participate in this study after learning the research topic. Correspondingly, children will seek reproductive health information without parental control and may obtain misleading information or even engage in sexual intercourse.

Previous study found that parents mostly did not receive reproductive health education when they were young. Hence, parents step back from reproductive health education, and children might be curious to experiment with reproduction.[27] Parents often do not properly answer children's questions about reproductive health. Some parents may change the topic, give no response, or even scold the child for asking about that topic. This kind of response makes children misinterpret the message and stimulates them to seek information from other sources that might not be valid.

Almost half of the parents had never provided reproductive health education to understand their children's beliefs. As much as 84.9% avoided providing health information honestly to help their children understand, but 72.7% of parents used slang terms when referring to genitals. In Javanese, the male genitalia (penis) are called the *manuk* (bird) or *titit*. Using a word substitution strategy sometimes does not enable children to understand the fundamental concept of the reproduct-

ive organ, and they only grasp a similar understanding of the content.[30] This attempts to translate taboo terms with other words or phrases.[31] Therefore, children likely avoid the topic when discussing reproductive health with their parents.

Reproductive health education should be addressed early to reduce adolescent pregnancies. Some studies indicate that early reproductive health education helps parents talk to children.[30] Educational supplies carried out as early as possible can prevent adolescents from falling into the massive health risk behaviors encountered as teenagers. A conversation about reproductive health has a positive impact on avoiding adolescent pregnancies.[32] Poor parental communication and a lack of skills and confidence are linked to poor reproductive health among adolescents. The more educated parents are, the more quickly they discuss reproductive health issues with their children. Parents should be able to follow the development of their children by assessing their children's needs. As the closest person to children, parents should always try to improve their communication skills and learn information on adolescent reproductive health, so that they can provide valid information to their children. Therefore, parents will be children's close friends, whom children can trust to provide correct reproductive health information.

Strengths and Limitations

To participate in this online survey, the respondents relied heavily on the availability of the internet access. Some limitations in this study must also be acknowledged concerning online data collection. This condition caused the authors be unable to know the actual situation of respondents when answering the survey. To overcome it, the authors eliminated not only respondents answering the form more than once, but also the completeness of the answers and the suitability of respondents' responses based on favorable and unfavorable questions when cleaning data. The authors suggested further studies to investigate parents' communication skills and explore the obstacles to discussing reproductive health matters with children through in-depth and face-to-face qualitative study.

Many studies report on parents' communication skills in discussing reproductive health information with adolescents. However, this study revealed parents' perspectives in delivering reproductive health information to their children aged 9–11 years, which has not been explored in previous studies. This study also involved many samples to gather more accurate information.

Conclusion

Most parents believe that reproductive health information is important for their children, but they find it difficult to facilitate this topic with their children due to taboos and awkward feelings. Parents tend to avoid direct talk about reproductive health by replacing original terms with slang to reduce taboo words. Parents who allow their children to date should equip them with adequate health information to avoid risky health behaviors. The Indonesian Ministry of Health should empower parents to discuss reproductive health issues with their children openly. Hence, children will have trustworthy sources of information in the family circle.

Abbreviations

WHO: World Health Organization; GSHS: Global School-based Health Survey; IPPA: the Indonesian Planned Parenthood Association; PKBI: *Perkumpulan Keluarga Berencana Indonesia*; IDHS: Indonesia Demographic and Health Survey; SDKI: *Survei Demografi dan Kesehatan Indonesia*; LSSR: Large-Scale Social Distancing; PSBB: *Pembatasan Sosial Berskala Besar*; COVID-19: Coronavirus Disease 2019; IDR: Indonesian Rupiah; PACHIQ: The Parent-Child Interaction Questionnaire.

Ethics Approval and Consent to Participate

The study was approved by the Ethics Committee of the Faculty of Public Health, Universitas Diponegoro (Approval ID: 158/EA/KEPK-FKM/2021).

Competing Interest

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

Availability of Data and Materials

The data supporting this study's findings are available upon reasonable request from the corresponding author. The data are not publicly available as they contain information that could compromise the privacy of the research participants.

Authors' Contribution

BW and RI conceived the study concept. RI conducted the methodology and data analysis and wrote and edited the manuscript. NH and AK collected data and wrote the original draft. All authors discussed the final results and contributed to the final manuscript.

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References

1. Ajayi AI, Odunga SA, Oduor C, Ouedraogo R, Ushie BA, Wado YD. "I was tricked": understanding reasons for unintended pregnancy among sexually active adolescent girls. Reprod Health. 2021; 18 (1): 19.

2. Bearak J, Popinchalk A, Alkema L, Sedgh G. Global, Regional, and subregional trends in unintended pregnancy and its outcomes from 1990 to 2014: estimates from a Bayesian Hierarchical model. Lancet Glob Heal. 2018; 6 (4): e380–9.
3. Ganatra B, Gerdts C, Rossier C, Johnson BR Jr, Tunçalp Ö, et al. Global, regional, and subregional classification of abortions by safety, 2010–14: estimates from a Bayesian hierarchical model. Lancet. 2017; 390 (10110): 2372–81.
4. Singh S, Shekhar C, Acharya R, Moore AM, Stillman M, Pradhan MR, et al. The incidence of abortion and unintended pregnancy in India, 2015. Lancet Glob Heal. 2018; 6 (1): 111–20.
5. Ocviyanti D, Dorothea M. Aborsi di Indonesia. J Indones Med Assoc. 2018; 68 (6): 213–5.
6. Pusat Penelitian dan Pengembangan Upaya Kesehatan Masyarakat. Perilaku berisiko kesehatan pada pelajar SMP dan SMA di Indonesia. Pusat Penelitian dan Pengembangan Upaya Kesehatan Masyarakat; 2016.
7. Kementerian Kesehatan Republik Indonesia. Situasi kesehatan reproduksi remaja. Jakarta; Pusat Data dan Informasi Kementerian Kesehatan Republik Indonesia; 2015.
8. Badan Kependudukan dan Keluarga Berencana Nasional. Survei Demografi dan kesehatan Indonesia 2017: Buku Remaja. Jakarta; Badan Kependudukan dan Keluarga Berencana Nasional; 2018.
9. Sasongko AJ. Tingginya kehamilan remaja tuntut PKBI Jateng susun program kerja 2015-2018. PKBI Daerah Jawa Tengah; 2019.
10. Wahab A, Wilopo SA, Hakimi M, Ismail D. Declining age at menarche in Indonesia: a systematic review and meta-analysis. Int J Adolesc Med Health. 2018; 32 (6).
11. Gayatri S, Shaluhiyah Z, Indraswari R. Faktor-faktor yang berhubungan dengan frekuensi akses pornografi dan dampaknya terhadap perilaku seksual pada remaja di Kota Bogor. J Kesehat Masy. 2020; 8 (3): 410–9.
12. Wulandari S. Perilaku seksual pranikah berisiko terhadap kehamilan tidak diinginkan pada remaja SMKN Tandun Kabupaten Rokan Hulu. J Matern Neonatal. 2016; 4 (1): 74–84.
13. Wanufika I, Sumarni S, Ismail D. Komunikasi orang tua tentang seksualitas terhadap perilaku seksual pranikah remaja. Ber Kedokt Masy. 2017; 33 (10): 495–500.
14. Badan Kependudukan dan Keluarga Berencana Nasional. Survei demografi dan kesehatan Indonesia 2017: kesehatan reproduksi remaja (indikator utama). Jakarta: Badan Kependudukan Keluarga Berencana Nasional; 2018.
15. Rusady IK, Shaluhiyah Z, Husodo BT. Analisis kebutuhan pendidikan kesehatan reproduksi pada diswa SMP di wilayah Kecamatan Pedurungan Semarang. J Kesehat Masy. 2017; 5 (5): 1010–20.
16. Mohammad-Esmaeil M, Rejaei L, Jonidi AJ, Ardalan G, Dorouzi J, Rezaei N, et al. Priorities in health education needs of youth based on needs assessment and stakeholder involvement, in areas covered by the Health Departments of Iran University of Medical Sciences. J Educ Community Heal. 2016; 3: 51–7.
17. Indraswari R, Shaluhiyah Z, Widjanarko B, Suryoputro A. Factors of mothers' hesitation in discussing reproductive health. Int J Public Heal Sci. 2021; 10 (4): 801–6.
18. Lange A, Blonk R, Wiers RW. Assessment: the parent-child interaction questionnaire, PACHIQ. Clin Psychol Psychother. 1998; 5(3): 187–98.
19. Fischer AL, O'Rourke N, Thornton WL. Age differences in cognitive and affective theory of mind: concurrent contributions of neurocognitive performance, sex, and pulse pressure. J Gerontol B Psychol Sci Soc Sci. 2017; 72 (1): 71–81.
20. Correia R, Barroso J, Nieto A. Age-related cognitive changes: the importance of modulating factors. J Geriatr Med Gerontol. 2018; 4 (2): 1–10.
21. Sigiro AN. Care Economy and the burden of housewives' work in Indonesia. J Peremp. 2018; 23 (4): 249.
22. Navickienė V, Sederevičiūtė-Pačiauskienė Ž, Valantinaitė I, Žilinskaitė-Vytienė V. The relationship between communication and education through the creative personality of the teacher. Creat Stud. 2019; 12 (1): 49–60.
23. Obaki SO. Impact of classroom environment on children's social behavior. Int J Educ Pract. 2017; 5 (1): 1–7.
24. Dávila SPE, Champion JD, Monsiváis MGM, Tovar M, Arias MLF. Mexican adolescents' self-reports of parental monitoring and sexual communication for prevention of sexual risk behavior. J Pediatr Nurs. 2017; 35: 83–9.
25. Handayani S. Faktor-faktor yang mempengaruhi kejadian kehamilan tidak diinginkan pada remaja di Kelurahan Balecatur Gampingan Sleman Yogyakarta. J Kesehat Samudra Ilmu. 2016; 7 (1).
26. Green LW, Kreuter MW. Health promotion: planning an educational and environmental approach. 2nd ed. CA: Mayfield; 1991.
27. Shin H, Lee JM, Min JY. Sexual knowledge, sexual attitudes, and perceptions and actualities of sex education among elementary school parents. Child Heal Nurs Res. 2019; 25 (3): 312–23.
28. Robinson KH, Smith E, Davies C. Responsibilities, tensions and ways forward: parents' perspectives on children's sexuality education. Sex Educ. 2017; 17 (3): 333–47.
29. Runcan R, Bahnaru A. Sex education revisited: school-based sex education. Analele Univ din Craiova. 2019; 18 (1): 1–7.
30. Khoshsaligheh M, Ameeri S, Mehdizadkhani M. A Socio-cultural study of taboo rendition in Persian fansubbing: an issue of resistance. Lang Intercult Commun. 2018; 18 (6): 663–80.
31. Robati FZNN, Zand F. Translation of taboos: the absolutely true diary of a part-time Indian. Int J Appl Linguist English Lit. 2018; 7 (3): 35–40.
32. Azira N, Abdullah FB, Muda SM, Zain NM. The role of parents in providing sexuality education to their children. Makara J Heal Res. 2020; 24 (3): 157–63.

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Knowledge, Attitudes, and Behaviors of Students at Islamic Boarding School X toward COVID-19 Incidence in 2022

Aisyah Raisa Haninda, Dewi Susanna*, Aria Kusuma, Laila Fitria

Department of Environmental Health, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia

Abstract

The spread of COVID-19 can occur in various settings but most notably in gathering places. Health protocols to avoid the spread of COVID-19 may be influenced by the knowledge and attitude of individuals. This study examined the relationship between knowledge, attitudes, and behaviors of students at the Islamic Boarding School X in Serang City, Banten Province, Indonesia, with the COVID-19 incidence. A quantitative approach with a cross-sectional study design was used. The study population consisted of 994 students, from which (via the Slovin's formula) a minimum sample size of 285 students was obtained. Data collection was carried out using an online validated questionnaire. The data collected related to age, sex, education level, knowledge level, attitude, behavior, and the COVID-19 incidence as experienced by the respondents. The results showed that most students had low-level knowledge (71.9%), negative attitudes (51.3%), and poor behaviors (53.2%) regarding the COVID-19. Most of the students were infected by the COVID-19 (88%). Statistically, knowledge, attitude, and behavior had no significant relationship with the COVID-19 incidence (p-value>0.05). This study concludes that knowledge, attitude, and behavior are not related to the COVID-19 incidence.

Keywords: attitude, behavior, COVID-19, Islamic students, knowledge

Introduction

Coronavirus disease 2019 (COVID-19) is a respiratory disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus, which spreads from person to person through droplets released, e.g., coughs, sneezes, or talks.[1] Patients infected with COVID-19 have various symptoms; still, most patients experience mild to moderate symptoms and recover without hospitalization. Common symptoms experienced are fever, cough, fatigue, and anosmia (e.g., loss of the sense of taste and smell). On average, patient experiences symptoms five to six days after infection, but symptoms can present as late as 14 days after infection.[2]

The confirmed cases have significantly impacted community activities, including teaching and learning activities. On March 24, 2020, the Ministry of Education and Culture of the Republic of Indonesia issued the Circular Letter No. 4 of 2020 on Implementation of Education Policy amidst COVID-19 Outbreak, which mainly discussed implementing school from home (SFH) to avoid the spread of COVID-19 in school environments.[3] Then, on December 23, 2021, the Minister of Education, Culture, Research, and Technology; the Minister of Religious Affairs; the Minister of Health; and the Minister of Home Affairs of the Republic of Indonesia issued Joint Ministerial Decree No. 05/KB/2021, 1347 of 2021 HK.01.08/MENKES/6678/2021, and 443-5847 of 2021, respectively, concerning Learning Activities Guidelines amidst COVID-19 Pandemic, providing policy updates for areas affected by the Enforcement of Community Activity Restrictions (ECAR)/*Pemberlakuan Pembatasan Kegiatan Masyarakat* (PPKM). The areas under the ECAR levels 1-3 had to conduct limited face-to-face learning activities in school.[4] For areas under the ECAR levels 1 and 2, 50% of students could attend face-to-face learning and SFH for the rest. While, areas under the ECAR levels 3 and 4, the learning process runs 100% online.[5] Face-to-face learning was limited across various educational units, such as kindergarten, elementary school, junior and senior high school, higher education, individual course and training institutions (*pesantren*/ Islamic boarding schools, religious education institutions, and boarding education units).[6]

To support face-to-face learning activities during the

Correspondence:* *Dewi Susanna, Department of Environmental Health, Building D 2nd Floor, Faculty of Public Health, Universitas Indonesia, Kampus Baru UI Depok 16424, Indonesia. E-mail: dsusanna@ui.ac.id, Phone: +62 812 1870 252*

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COVID-19 pandemic, teachers, educators, and students (both at boarding and non-boarding schools) were required to comply with the health protocols enforced by the Indonesian Government to prevent new clusters of COVID-19. At non-boarding schools, students could only gather when attending class, and at boarding schools, students gathered both at school and in their dormitories. Those conditions at boarding schools affected the rate of COVID-19 transmission because the students gathered for long periods of activities.[7] Also, many boarding schools had limited facilities, which meant several students had to use the toilet and bathroom at once. This caused concerns on the emergence of new clusters of COVID-19 at boarding schools.[8]

Islamic and non-religious boarding schools are academic units potentially exacerbating the transmission of COVID-19. The students of these schools have been observed to apply the required health protocols poorly.[9] Further, only 32% of all the Islamic boarding schools, members of the *Rabithah Ma'ahid Islamiyah Nahdlatul Ulama* (RMI NU), implemented the required health protocols.[9] Also, students are in close contact when they use the same sanitation facilities or borrow each other's clothes, worship equipment, toiletries, and towels. Further, there tends to be a lack of distance between students at these schools.[8]

Community knowledge and attitudes influence the application of health protocols. Respondents who are more mature and did attain higher education have a good level of knowledge, a positive attitude, and better motivation.[10] Similarly, those with higher levels of education tend to adhere more to health protocols. A previous study showed that a person's level of knowledge relates to their compliance with the health protocol to use masks within the community to prevent the spread of COVID-19.[11] Another study indicated that behaviors supporting the COVID-19 prevention occur more among *santri* (a student at Islamic Boarding School) with higher education levels, good knowledge and perceptions of COVID-19 and support from *Ustaz/Ustazah* (teacher/leader in Islamic boarding school), caregivers, and friends.[12] A good level of knowledge, support from colleagues, and the existence of binding regulations related to COVID-19 prevention influence the behavior of officers of the National Population and Family Planning Agency/*Badan Kependudukan dan Keluarga Berencana Nasional* (BKKBN).[13]

Since returning to face-to-face learning (February 2022), 28, 21, 46, and 40 students at the Islamic Boarding School in Blora and Magelang Districts and Depok and Yogyakarta Cities, Indonesia, respectively, were confirmed positive for COVID-19.[14-17] As for the regular boarding schools, confirmed cases a university in Banda Aceh City and a school in Muaro Jambi District, Indonesia amounted to 60 and 2016 students, respectively.[18,19] Another boarding school that maintains face-to-face learning activities is Islamic Boarding School X in Serang City, Banten Province, Indonesia. The school continued its in-person learning activities according to the Instruction of the Minister of Home Affairs Number 5 of 2022 regarding the Implementation of Level 3, Level 2, and Level 1 COVID-19 Restrictions on Public Activities in Java and Bali Areas.[20]

The Islamic Boarding School X is located in Cinangka Subdistrict, Serang District, Banten Province, Indonesia. It has a total area of 30 hectares with school buildings, dormitories, and other infrastructure. In 2017, the student consisted of 994 males and females. The Islamic Boarding School X has 17 dormitories, with nine male and eight female dormitories; each room consists of five to six students. During face-to-face learning activities in 2022, 695 students were confirmed positive for COVID-19 from January to March 2022.[21] The high risk of COVID-19 transmission at boarding schools, the study on the low application of health protocols in Islamic boarding schools, and the confirmation of COVID-19 cases in Islamic boarding schools all emphasize the need for a study that explains the relationships between knowledge, attitude, and behavior and COVID-19 incidence. This study aimed to address this need by analyzing student's knowledge of COVID-19 and examining this against the COVID-19 incidence among students at Islamic Boarding School X.

Method

This study was conducted using a quantitative approach and a cross-sectional design in Islamic Boarding School X Serang District, Banten Province, Indonesia, from April to May 2022. From the total population of 994 junior and senior high school students at Islamic Boarding School X, a minimum sample of 285 students remained after applying the Slovin's Formula. However, at the time of data collection, the number of students filling out the questionnaire was more than the minimum sample size, which was 334. Then when the data was cleaned, 24 students' answers were incomplete, so that they were removed. Therefore, the samples consisted of 310 students. The following inclusion criteria were used to confirm the sample: (1) a student of Islamic Boarding School X, (2) participating in face-to-face learning activities, (3) not tested positive for COVID-19, and (4) willing to complete the questionnaire. The exclusion criteria were: (1) non-students of Islamic Boarding School X, (2) tested positive for COVID-19, and (3) not willing to complete the questionnaire.

Data was collected using a Google Forms questionnaire distributed by the Islamic Boarding School X of Serang Public Relations and student council via social

media (Instagram) to the junior and senior high school homeroom teachers, then to the students. The questionnaire contained questions regarding the independent variables of age, sex, education level, knowledge level, attitude, and behavior related to the COVID-19. The questions also pertained to the dependent variable, the COVID-19 incidence experienced by the students.

Validity and reliability tests were carried out to confirm that the questions listed in the questionnaire provided to the respondents were valid and reliable. The questionnaire had a reliability score of 0.927, meaning it was reliable enough to use for data collection. While, for the results of the validity test on the questionnaire, the questions tested were valid questions because they had a Corrected Item-Total Correlation of greater than 0.3610, or the results of R count were greater than R table.

The data collected was processed using a data processing application and analyzed univariately to determine the frequency distribution of each independent variable, dependent variable, and bivariate. The Chi-square test was used to determine the relationship between each independent variable and the dependent variable. Each independent variable was categorized as high or low for the level of knowledge, positive or negative for attitude, and good or bad for behavior. The independent and dependent variables were determined to have a relationship if the Chi-square test results obtained a p-value of <0.05, resulting in the rejection of the study hypothesis. The data from the analysis (descriptions of the respondents; the COVID-19 incidence; the knowledge level, attitudes, and behaviors of the respondents; and the relationship between knowledge, attitude, and behavior with the COVID-19 incidence among the students) were presented in tabular form.

Results

The results of this study describe the respondents; COVID-19 incidence among the respondents; their knowledge, attitudes, and behaviors; and the relationship between knowledge, attitude, and behavior with the COVID-19 incidence among the students. The respondents in this study were all students attending the Islamic Junior High School and Senior High School at Islamic Boarding School X. Most respondents (69.4%) were 14 years old or younger, female (56.8%), and junior high school students (72.3%). Of the 310 respondents who filled out the questionnaire, 273 had a history of COVID-19, with 230 confirmed positives (Table 1).

Knowledge Level

The respondents' knowledge was measured using eight questions related to the COVID-19. Most respondents answered the eight questions correctly; moreover, the first question on the COVID-19 causing respiratory disease got the most correct answer (98.4%). However, the last question on booster vaccination got the least correct answer (56.1%) of all eight questions (Table 2).

Attitude

Respondents' attitudes were measured using 12 questions. More than half the respondents strongly agreed with the statements on using masks properly, washing hands with soap and clean water, and washing hands with hand sanitizer. The statement receiving the most "strongly agree" responses were those related to isolation if confirmed positive for the COVID-19 (81.9%). The statement receiving the most "strongly disagree" responses were those about washing hands and using hand sanitizer to prevent infection with the COVID-19 (4.2%) (Table 3).

Behavior

As shown in Table 4, the statements with the most positive answers were those related to notifying *Ustaz* and *Ustazah* if the student felt symptoms of COVID-19. A total of 224 students responded favorably to these

Table 1. Respondent's Characteristics (n = 310)

Variable	Category	n	%
Age	14 years old	215	69.4
	>14 years old	95	30.6
Sex	Male	134	43.2
	Female	176	56.8
Education level	Junior high school	224	72.3
	Senior high school	86	27.7
Confirmed records of COVID-19	Once	273	88.1
	Never	37	11.9
COVID-19 confirmed locations*	Outside	230	74.2
	Inside	9	2.9
	Inside and outside	34	11
	Never	37	11.9

Note: *Inside/outside the boarding school

Table 2. Respondent's Knowledge Levels (n = 310)

Question	Correct Answer	
	n	%
COVID-19 causes respiratory disease*	305	98.4
What are the symptoms of COVID-19?		
Fatigue	251	81.0
Headache	259	83.5
Pain in the body	223	71.9
What can be done to prevent infection with COVID-19?		
Wash hands with soap and hygienic running water for 40–60 seconds	285	91.9
Do students know the difference between primary vaccination and booster vaccination?	217	70.0
If you know, then what is meant by primary vaccination?	214	69.0
If you know, then what is a booster vaccination?**	174	56.1

Notes: *Question with the most correct answers, **Question with the least correct answers

Table 3. Respondent's Attitudes

Statement	SD	D	N	A	SA
	n (%)	n (%)	n (%)	n (%)	n (%)
Using a mask correctly, you will not be infected with COVID-19	9 (2.9)	27 (8.7)	86 (27.7)	77 (24.8)	111 (35.8)
Wash your hands with soap and clean running water; you will not be infected with COVID-19	8 (2.6)	34 (11.0)	78 (25.2)	79 (25.5)	111 (35.8)
Wash your hands with an alcohol-based hand sanitizer, and you will not be infected with COVID-19**	13 (4.2)	29 (9.4)	95 (30.6)	80 (25.8)	93 (30.0)
Maintaining a distance of 1 meter can reduce the risk of being infected with COVID-19	3 (1.0)	10 (3.2)	46 (14.8)	83 (26.8)	168 (54.2)
Using personal cutlery and not borrowing from friends can reduce the risk of being infected with COVID-19	5 (1.6)	4 (1.3)	24 (7.7)	71 (22.9)	206 (66.5)
Adhere to health protocols, and you will not be infected with COVID-19	5 (1.6)	10 (3.2)	53 (17.1)	73 (23.5)	169 (54.5)
I believe that the COVID-19 vaccination reduces my risk of contracting COVID-19	5 (1.6)	9 (2.9)	59 (19.0)	70 (22.6)	167 (53.9)
I believe that if I become infected with COVID-19 after receiving two doses of the vaccine, then my symptoms will be lighter than before receiving two doses of the vaccine	4 (1.3)	10 (3.2)	61 (19.7)	79 (25.5)	156 (50.3)
I agree that everyone who can get vaccinated should get a COVID-19 vaccination	3 (1.0)	7 (2.3)	38 (12.3)	63 (20.3)	199 (64.2)
The COVID-19 vaccination will create herd immunity	3 (1.0)	5 (1.6)	54 (17.4)	71 (22.9)	177 (57.1)
I agree to isolate if confirmed positive for COVID-19*	1 (0.3)	2 (0.6)	19 (6.1)	34 (11.0)	254 (81.9)
I agree that isolation will reduce the risk of spreading COVID-19	2 (0.6)	1 (0.3)	25 (8.1)	36 (11.6)	246 (79.4)

Notes: SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree
*Statements with the most strongly agreed answers, **Statements with the most strongly disagreed answers

Table 4. Respondent's Behavior

Statement	N	R	S	O	A
	n (%)	n (%)	n (%)	n (%)	n (%)
I tell *Ustaz*/*Ustazah* if I get symptoms similar to COVID-19*	5 (1.6)	3 (1.0)	24 (7.7)	54 (17.4)	224 (72.3)
I tell *Ustaz*/*Ustazah* if my friends get symptoms similar to COVID-19	6 (1.9)	3 (10)	25 (8.1)	55 (17.7)	221 (71.3)
I wear the mask properly	2 (0.6)	6 (1.9)	37 (11.9)	70 (22.6)	195 (62.9)
I disinfect the mask before throwing it away**	52 (16.8)	39 (12.6)	77 (24.8)	42 (13.5)	100 (32.3)
I cut the mask before throwing it away	17 (5.5)	13 (4.2)	33 (10.6)	51 (16.5)	196 (63.2)
I wash my hands with soap and hygienic running water	3 (1.0)	5 (1.6)	22 (7.1)	67 (21.6)	213 (68.7)
I wash my hands with soap and hygienic running water for 40–60 seconds	10 (3.2)	21 (6.8)	60 (19.4)	83 (26.8)	136 (43.9)
I wash my hands using hand sanitizer	6 (1.9)	19 (6.1)	61 (19.7)	76 (24.5)	148 (47.7)
I wash my hands with hand sanitizer for 20–30 seconds	15 (4.8)	40 (12.9)	65 (21.0)	73 (23.5)	117 (37.7)
I apply cough and sneeze etiquette even though it is not confirmed COVID-19	4 (1.3)	4 (1.3)	35 (11.3)	67 (21.6)	200 (64.5)
I use personal cutlery and do not borrow my friend's cutlery	2 (0.6)	6 (1.9)	45 (14.5)	65 (21.0)	192 (61.9)
I keep a safe distance of 1 meter from other people when outside the boarding school	8 (2.6)	21 (6.8)	56 (18.1)	78 (25.2)	147 (47.4)
I change clothes after coming home from activities outside the dorm	10 (3.2)	12 (3.9)	59 (19.0)	72 (23.2)	157 (50.6)
I take a shower after coming home from activities outside the dorm	8 (2.6)	12 (3.9)	68 (21.9)	82 (26.5)	140 (45.2)
I still apply the health protocols even though I have received the COVID-19 vaccination	4 (1.3)	5 (1.6)	44 (14.2)	90 (29.0)	167 (53.9)
I still apply the health protocols while in the boarding school	5 (1.6)	12 (3.9)	60 (19.4)	76 (24.5)	157 (50.6)
I continue to apply health protocols while outside the boarding school	3 (1.0)	7 (2.3)	41 (13.2)	64 (20.6)	195 (62.9)
I disinfect the room when a roommate is confirmed COVID-19	11 (3.5)	8 (2.6)	39 (12.6)	58 (18.7)	194 (62.6)
I notify *Ustaz*/*Ustazah* if I come in close contact with a friend who is tested positive for COVID-19	3 (1.0)	6 (1.9)	36 (11.6)	48 (15.5)	217 (70.0)

Notes: N = Never, R = Rarely, S = Sometimes, O = Often, A = Always
*The statement with the most "always" answers, **Statements with the most "never" answers

questions. The statements with the most negative answers were those related to disinfecting masks after use (16.8%).

Relationship of Knowledge, Attitude, and Behavior and COVID-19 Incidence

The relationships between the respondents' knowledge, attitudes, and behaviors with the COVID-19 incidence among the students are described in Table 5. After grouping the knowledge variables, it was determined that respondents had a low-level knowledge related to the COVID-19, with 223 respondents answering seven or fewer questions correctly. The analysis of the frequency distribution for the attitude of the respondents reveals

Table 5. Relationship of Level of Knowledge, Attitude, and Behavior with COVID-19 Incidence

Variable	Category	COVID-19 Incidence			p-value	OR	95% CI
		Once (n = 273)	Never (n = 37)	Total (n = 310)			
		n (%)	n (%)	n (%)			
Knowledge level	Low	196 (87.9)	27 (12.1)	223 (100.0)	1.000	0.943	0.436–2.040
	High	77 (88.5)	10 (11.5)	87 (100.0)			
Attitude	Negative	139 (87.4)	20 (12.6)	159 (100.0)	0.855	0.882	0.443–1.756
	Positive	134 (88.7)	17 (11.3)	151 (100.0)			
Behavior	Bad	145 (187.9)	20 (12.1)	165 (100.0)	1.000	0.963	0.484–1.918
	Good	128 (88.3)	17 (11.7)	145 (100.0)			

Notes: OR = Odds Ratio, CI = Confidence Interval

that most respondents had a negative attitude to the COVID-19; 159 respondents exhibited a negative attitude. Most respondents (165 respondents) exhibited bad behavior toward the COVID-19.

Discussion

Most students in this study got infected with the COVID-19 (88.1%) while attending Islamic boarding schools (74.2%). These cases are not surprising as the COVID-19 transmission is influenced by the time at which students spend together in groups.[7] Students attending Islamic boarding schools gather in classes, dormitories, mosques, and other shared areas. Based on Table 2, the questions with the most correct answers are those related to the COVID-19 causing respiratory tract disease. The COVID-19 is a respiratory disease caused by SARS-CoV-2.[22] Many students did not answer questions on COVID-19 booster vaccination correctly; only 174 students (56.1%) answered correctly. The COVID-19 booster vaccine is injected to people older than 18 years.[23] Many respondents in this study were students aged under 18 years, which may have contributed to their inadequate knowledge of the COVID-19 booster vaccinations.

A study on Islamic Boarding School in Lebak District, Banten Province, Indonesia, assessing students' knowledge levels reported that most students maintained a good level of relevant knowledge. However, some areas required improvement, most notably the statement that "not all infected people will show symptoms but can transmit the COVID-19 virus."[24] This study was conducted in the same province but with a different type of *pesantren*. The focus of the measured knowledge variables was also different; this study was related to transmission and vaccines, including boosters, while the previous study,[24] did not focus on the COVID-19 vaccines since it was conducted at early pandemic.

The data analysis in this study indicated that the knowledge was not related to the COVID-19 incidence because the p-value was 1.000 or >0.05. The knowledge variable might be unrelated to the COVID-19 incidence due to the homogeneous level of student's knowledge. While attending boarding school, students only receive information from *Ustaz* and *Ustazah*; the knowledge level might vary if they can access information from another source. Another study showed that sources of information such as social media, telecommunication tools, television, and radio have a significant relationship with health workers' knowledge level.[25] The variables in this study are further unrelated because the questions designed to assess student's knowledge did not sufficiently describe their actual knowledge.

Table 3 demonstrates that the statements with the most "strongly agree" answers are those related to self-isolation if tested positive for COVID-19, with 254 (81.9%) respondents strongly agreeing. This attitude was in line with Circular Letter No. HK.02.01/MENKES/202/2020 concerning the Self-Isolation Protocol in Handling COVID-19 mandates that people tested positive must be isolated.[26] The self-isolation reduces the risk of transmission.[27] The previous study of Islamic boarding school did not investigate self-isolation for those tested positive for COVID-19 cases, even though the students tended to have a positive attitude to COVID-19.[24]

A total of 13 students (4.2%) stated "strongly disagree" to the statement on washing hands with hand sanitizer to avoid the COVID-19 infection; thus, it became the statement with the most "strongly disagree" responses in the questionnaire. The students did not seem to be aware that washing hands with hand sanitizer can reduce the number of germs and bacteria on the hands.[28] The data analysis showed that attitudes were not related to the COVID-19 incidence because a p-value of 0.855 or >0.05 was obtained. These variables may not relate to the COVID-19 incidence because the students' attitudes were homogeneous. They learn to deal with things at boarding schools; hence, the attitudes that arise tend to be the same. The students may also have experienced dif-

ficulty in understanding the statements given, meaning that the statements did not sufficiently describe the actual attitudes of the students.

Table 4 illustrates the statements with the most positive answers related to telling the *Ustaz*/*Ustazah* if the student get the COVID-19 symptoms. A total of 224 (72.3%) students stated that they will always tell *Ustaz*/*Ustazah* if they get COVID-19 symptoms. *Ustaz*/*Ustazah* is a substitute for parents while the students are at boarding school. If students reported symptoms similar to the COVID-19, they would undergo an antigen rapid or Reverse Transcription Polymerase Chain Reaction (RT-PCR) test to confirm the COVID-19 infection.[1] If the test result turned out to be positive, the student would receive treatment according to the symptoms experienced and be asked to conduct contact tracing to reduce the virus transmission.[29]

A previous study stated that 30% of Islamic boarding school students did not wear masks.[24] While, in this study, the most "never" answers were related to mask disinfection. A total of 52 (16.8%) students reported never disinfecting their masks after use. This may be because the students had never received information about mask disinfection. As such, student adherence to health protocols would likely increase if the students were given routine education. Mask disinfection is advised so that used masks do not become a medium for virus transmission.[30] The disinfection of masks can be done at home or in a dormitory by soaking used masks in a disinfectant, chlorine, or bleach before disposal.[31]

This study's data analysis showed that behavior was not related to the COVID-19 incidence with a p-value of 1.000 or >0.05. These results align with previous studies stating that behavior is irrelevant to COVID-19 incidence.[32,33] The absence of a relationship between behavioral variables and the COVID-19 incidence in this study may have been influenced by the homogeneous behavior of students. This can happen because students see and imitate behaviors from the same environment or the same *Ustaz* and *Ustazah*. In addition, the answers given to the existing statements may not have sufficiently described the actual student's behavior, resulting in the analysis showing no relationship between the variables.

Most studies on Islamic boarding schools are conducted in Indonesia because few countries have established this specific school. For this reason, the references used are primarily from Indonesia. Controlling COVID-19 transmission by implementing health protocols at an Islamic boarding school is difficult, yet it must be done.[24] Similarly, implementing health protocols must also be applied at Islamic boarding and regular schools.

This study was conducted using primary data collected via online questionnaires (Google Forms). The respondents may not have filled in the answers according to their opinions or actual conditions. While collecting data via online questionnaires, there is a risk of the questions or directions not being well understood by the respondents. This study was limited to describing the population within the study setting; junior and senior high schools at Islamic Boarding School X. The study could not describe the knowledge, attitudes, and behaviors of students attending other boarding schools and other educational institutions.

Conclusion

Most surveyed students in Islamic Boarding School X get infected with the COVID-19 while attending face-to-face learning activities. Of these, most students possessed a low level of knowledge, a negative attitude, and poor behavior towards the COVID-19. However, after analyzing the data, their knowledge, attitudes, and behaviors do not have relationship to the COVID-19 incidence.

Recommendation

Institutions must educate students to increase their knowledge related to the COVID-19. Education can be in the forms of giving seminars, placing posters in classroom and on dormitory wall boards, or installing billboards and banners along the streets of the boarding school. Providing education and posting information can be coordinated with local clinics, health centers, and health offices. It is also necessary to supervise and provide examples to students regarding attitudes and behaviors towards the COVID-19. This could include providing examples of and supervising the application of health protocols at school and dormitories, mosques, and other shared spaces.

The Indonesian Ministry of Religious Affairs and Ministry of Health need to revisit the existing face-to-face learning policies in boarding schools. Supervision and periodic training must be put in place at all boarding schools regarding the number of students participating in face-to-face learning. Health protocols to reduce the spread of the COVID-19 in boarding schools must be implemented more strictly. Future study should consult a broader population so that the resulting data is not homogeneous. It would also be beneficial to include sociodemographic, economic, and geographical factors to determine the COVID-19 incidence more accurately.

Abbreviations

COVID-19: Coronavirus Disease 2019; SARS-CoV-2: Severe Acute Respiratory Syndrome Coronavirus 2; SFH: School From Home; ECAR: Enforcement of Community Activity Restrictions; PPKM: *Pemberlakuan Pembatasan Kegiatan Masyarakat*; RMI NU: *Rabithah Ma'ahid Islamiyah Nahdlatul Ulama*; BKKBN: *Badan Kependudukan dan Keluarga Berencana Nasional*; RT-PCR: Reverse Transcription Polymerase Chain Reaction.

Ethics Approval and Consent to Participate

This research obtained an ethical license with the letter Ket-156/UN2.F10.D11/PPM.00.02.2022 from the Research and Community Engagement Ethical Committee, Faculty of Public Health, Universitas Indonesia.

The title, objectives, respondent criteria, the guarantee of data confidentiality, respondent's right to resign from filling out the questionnaire, possible risks, time to fill out the questionnaire, rules around giving gifts or souvenirs, and a list of authors of this study were provided to each respondent before filling out the questionnaire. Afterward, the authors asked questions about the respondent's willingness to complete the questionnaire. The respondent could choose "Willing" and continue to fill out the questionnaire or "Not willing" and not fill out the questionnaire.

Competing Interest

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

Availability of Data and Materials

The data available is only data that has been written in the manuscript, because other data are limited by research ethics.

Authors' Contribution

ARH and DS compiled the questionnaires. ARH collected, processed, and analyzed the data, and wrote the manuscript. DS supervised and gave recommendations on data processing and analysis.

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References

1. Centers for Disease Control and Prevention. COVID-19 testing: what you need to know. Centers for Disease Control and Prevention; 2022.
2. World Health Organization. Coronavirus disease (COVID-19). World Health Organization; 2022.
3. Menteri Pendidikan dan Kebudayaan Republik Indonesia. Surat Edaran Menteri Pendidikan dan Kebudayaan Nomor 4 Tahun 2020 tentang Pelaksanaan Kebijakan Pendidikan dalam Masa Darurat Penyebaran Coronavirus Disease (COVID-19). Jakarta; Kementerian Pendidikan dan Kebudayaan Republik Indonesia; 2020.
4. Menteri Kesehatan Republik Indonesia. Peraturan Menteri Kesehatan Republik Indonesia No. 14 Tahun 2021 tentang Standar Kegiatan Usaha dan Produk Pada Penyelenggaraan Perizinan Berusaha Berbasis Risiko Sektor Kesehatan. Jakarta: Kementerian Kesehatan Republik Indonesia; 2021.
5. Mulyadi M. Penerapan pemberlakuan pembatasan kegiatan masyarakat (PPKM) untuk mengendalikan laju pandemi Covid 19. Info Singkat. 2021; 13 (16): 13–8.
6. Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi, Menteri Agama, Menteri Kesehatan, dan Menteri Dalam Negeri Republik Indonesia. Keputusan Bersama Tentang Panduan Penyelenggaraan Pembelajaran di Masa Pandemi COVID-19. Jakarta: Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi; 2021.
7. Pusparisa Y. Sekolah asrama terpapar virus Corona. Katadata; 2020.
8. Fahham AM. Learning at Islamic boarding schools during Covid-19 pandemic period. Info Singk. 2020; 12 (14): 13–8.
9. Izzati A. Pesantren miliki risiko tinggi tertular COVID-19. Universitas Islam Nusantara; 2020.
10. Afrianti N, Rahmiati C. Faktor-faktor yang mempengaruhi kepatuhan masyarakat terhadap protokol kesehatan COVID-19. J Ilm Perm STIKES Kendal. 2021; 11 (1): 113–24.
11. Sari DP, 'Atiqoh NS. Hubungan antara pengetahuan masyarakat dengan kepatuhan penggunaan masker sebagai upaya pencegahan penyakit COVID-19 di Ngronggah. Infokes J Ilm Rekam Medis dan Inform Kesehat. 2020; 10 (1): 52–5.
12. Agustina A, Budiono I. Perilaku pencegahan Covid-19 pada santri di Pondok Pesantren Al-Asy'ariyyah Kalibeber Kabupaten Wonosobo. Indones J Public Heal Nutr. 2021; 1 (3): 282–90.
13. Sari A, Budiono I. Faktor yang berhubungan dengan perilaku pencegahan Covid-19. Indones J Public Heal Nutr. 2021; 1 (1): 101–13.
14. Pradana ARY. 28 penghuni ponpes di Blora terpapar Covid-19. Kompas; 2022.
15. Susanto E. 21 Santri ponpes di Magelang terpapar COVID-19. Detikcom; 2022.
16. Mantaelan V. Temuan 46 kasus Covid-19, semua penghuni pesantren Babussalam Depok sudah di-swab. Kompas; 2021.
17. KompasTV Jateng. 60 orang positif Covid-19 dari klaster sekolah asrama. KompasTV; 2022.
18. CNN Indonesia. 60 mahasiswa di asrama positif Covid, USK Aceh kuliah daring [Internet]. cnnindonesia.com. 2022 [cited 2022 Jun 23].
19. CNN Indonesia. 206 Siswa SMA Titian Teras Jambi positif Covid-19 sekolah ditutup. CNN Indonesia; 2022.
20. Menteri Dalam Negeri Republik Indonesia. Instruksi Menteri Dalam Negeri Nomor 5 Tahun 2022 tentang Pemberlakuan Pembatasan Kegiatan Masyarakat Level 3, Level 2, Dan Level 1 Coronavirus Disease 2019 Di Wilayah Jawa dan Bali. Jakarta; Kementerian Dalam Negeri Republik Indonesia; 2022.
21. Klinik NFBS. Jumlah kasus positif COVID-19 di lingkungan Pesantren X Semester II [Laporan]. Serang; 2022.
22. Khoury M, Cuenca J, Cruz FF, Figueroa FE, Rocco PRM, Weiss DJ. Current status of cell-based therapies for respiratory virus infections: applicability to COVID-19. Eur Respir J. 2020; 55 (6): 2000858.
23. Direktur Jenderal Pencegahan dan Pengendalian Penyakit. Surat Edaran Nomor HK.02.02/II/252/2022 tentang Vaksinasi COVID-19 Dosis Lanjutan (Booster). Jakarta: Kementerian Kesehatan Republik Indonesia; 2022.
24. Herdayati M, Besral B, Karniastuti J. Knowledge, attitude, and practice regarding COVID-19 among residents of pesantren. Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal). 2021; 16 (Special Issue 1): 29-35.
25. Jemal B, Aweke Z, Mola S, Hailu S, Abiy S, Dendir G, et al. Knowledge, attitude, and practice of healthcare workers toward

COVID-19 and its prevention in Ethiopia: a multicenter study. SAGE Open Med. 2021; 9: 1–10.
26. Menteri Kesehatan Republik Indonesia. Surat Edaran Nomor HK.02.01/MENKES/202/2020 Tentang Protokol Isolasi Diri Sendiri Dalam Penanganan COVID-19. Jakarta: Kementerian Kesehatan Republik Indonesia; 2020.
27. Gugus Tugas Percepatan Penanganan COVID-19. Protokol penyiapan fasilitas shelter untuk karantina dan isolasi kolektif di fasilitas umum berbasis masyarakat di masa pandemi COVID-19. Satuan Tugas Penanganan COVID-19; 2020.
28. Centers for Disease Control and Prevention. Handwashing in communities: clean hand saves lives. Centers for Disease Control and Prevention; 2022.
29. Centers for Disease Control dan Prevention. Isolation and precautions for people with COVID-19. Centers for Disease Control and Prevention; 2022.
30. Nasir AM. Begini cara kelola limbah masker di masyarakat untuk cegah penularan COVID-19. INFEKSIEMERGING; 2021.
31. Direktur Kesehatan Lingkungan. Pedoman pengelolaan limbah masker dari masyarakat. Kementerian Kesehatan Republik Indonesia; 2021.
32. Sitorus EB. Hubungan pengetahuan masyarakat dengan perilaku social distancing dalam upaya pencegahan COVID-19 di DKI Jakarta [Undergraduate Thesis]. Depok: Universitas Indonesia; 2021.
33. Putri NRF. Analisis perilaku selama pandemi, faktor demografi dan sosioekonomi terhadap kejadian COVID-19 di Indonesia [Undergraduate Thesis]. Depok: Universitas Indonesia; 2021.

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Spatial Analysis of Seven Islands in Indonesia to Determine Stunting Hotspots

Tiopan Sipahutar*, Tris Eryando, Meiwita Paulina Budhiharsana

Department of Biostatistics and Population Studies, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia

Abstract

Indonesia is a vast country struggling to reduce its stunting prevalence. Hence, identifying priority areas is urgent. In determining areas to prioritize, one needs to consider geographical issues, particularly correlations among areas. This study aimed to discover whether stunting prevalence in Indonesia occurs randomly or in clusters; and, if it occurs in clusters, which areas are the hotspots. This ecological study used aggregate data from the 2018 National Basic Health Research and Poverty Data and Information Report from the Statistics Indonesia. This study analyzed 514 districts/cities across 34 provinces on seven main islands in Indonesia. The method used was the Euclidean distance to define the spatial weight. Moran's index test was used to identify autocorrelation, while a Moran scatter plot was applied to identify stunting hotspots. Autocorrelation was found among districts/cities in Sumatra, Java, Sulawesi, and Bali East Nusa Tenggara West Nusa Tenggara Islands, resulting in 133 districts/cities identified as stunting hotspots on four major islands. Autocorrelation proves that stunting in Indonesia does not occur randomly.

Keywords: Indonesia, spatial analysis, stunting, stunting hotspots

Introduction

Stunting continues to be a public health problem in Indonesia. Despite a decrease in the national prevalence by 6.4% since 2013, it was still more than 30% in 2018.[1] Furthermore, the distribution of stunting prevalence at the district/city level appears to have increased in some areas from 2015 to 2017. The Government of Indonesia's National Strategy for the Acceleration of Stunting Prevention 2018–2024 includes priority areas of intervention.[2] Although several studies were used as the basis for this strategy; the method used to determine priority areas did not consider correlations among geographical areas. Studies have shown that stunting does not occur randomly; instead, it is clustered or spatially structured.[3-6]

Reducing stunting in Indonesia is a major challenge, considering that Indonesia is a large country consisting of 17,504 islands, 34 provinces, and 514 districts/cities. It is the largest archipelagic country in the Southeast Asia, with an area of 1,904,569 km^2 and regional and sociocultural characteristics, behaviors, and poverty levels that differ from island to island and among the districts/cities in a province. Hence, significant resources will be needed if all regions carry out the same intervention, and each region's capacity is different. The spatial analysis could be utilized to generate information for decision-making about allocating limited resources to the most affected areas. Hotspot identification could allow policymakers to design and develop economically viable and effective region-based intervention strategies.[3,5,7-12]

Although Indonesia is a vast country, spatial analysis in the context of stunting is still not widely used to examine the pattern of stunting across the country, or as a decision support system for developing policies or programs at the national and regional levels. The high prevalence of stunting, large gaps in socioeconomic and facilities in many areas, and limited funds require the central and regional governments to prioritize intervention types and regions and act quickly to meet the national target (19% of children under five by 2024),[13] and the Global World Health Assembly target (40% of children under five by 2025).[14] Therefore, this study aimed to discover whether stunting occurs randomly or in clusters in Indonesia and, if it occurs in clusters, which areas are

Correspondence*: *Tiopan Sipahutar, Department of Biostatistics and Population Studies, Building A 2nd Floor, Faculty of Public Health, Universitas Indonesia, Lingkar Kampus Raya Street, Universitas Indonesia, Depok 16424, Indonesia, E-mail: tiopansipahutar@gmail.com, Phone: +62 21 786 4975*

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the hotspots. Identifying the cluster areas (or hotspots) will allow the government to determine and target the priority areas for stunting interventions instead of simultaneously distributing resources across all areas.

Method

This ecological study used aggregate data from the 2018 National Basic Health Research.[1] This nationally representative survey provides data on stunting from all districts/cities in Indonesia for children under five. The units of analysis in this study were 514 Indonesian districts/cities located on seven main islands in Indonesia: Sumatra (10 provinces, 154 districts/cities), Java (6 provinces, 119 districts/cities), Kalimantan (5 provinces, 56 districts/cities), Sulawesi (6 provinces, 81 districts/cities), Bali East Nusa Tenggara West Nusa Tenggara (Bali ENT WNT) (3 provinces, 41 districts/cities), Maluku (2 provinces, 21 districts/cities), and Papua (2 provinces, 42 districts/cities). All data were grouped according to these islands for analysis.

The missing data were calculated using the mean value of the neighboring area prevalence—four statistical assumptions of the stunting prevalence residual needed to be fulfilled before the spatial analysis process. The Anderson–Darling (AD) test was employed to check the normality of the stunting prevalence residual, the Durbin–Watson (DW) test to check the residual independence, the variance inflation factor (VIF) value to check the multicollinearity, and the Breusch–Pagan (BP) test to check the homoscedasticity.[15] The hypothesis of each test successively was that the stunting prevalence residual is normally distributed, independent, and has no multicollinearity if the VIF is less than 10 and the stunting prevalence residual is homogeneous. In each test, the p-value was compared with a = 0.05. H0 was rejected when the p-value was less than the a-value.

The Euclidean distance method was employed to define the spatial weight. The neighborhood area was defined when the distance between areas was within a radius of 1° or equivalent to 111 km, in accordance with the Euclidean definition.[15] The Moran's index (I) test was used to determine the autocorrelation among the districts/cities on each island, with a significance level of 0.05. Autocorrelation is useful for estimating the level of observed spatial similarity among attribute values of neighboring regions in the research area. Moran's I coefficient is the same as Pearson's correlation coefficient and quantifies the similarity of an outcome variable between regions defined as having a spatial relationship.[16] The null hypothesis for autocorrelation was that there is no autocorrelation among the areas (I = 0). H0 was rejected when the p-value was less than the a-value. The value of Moran's I lay between +1 and −1. A zero (0) value in the Moran's I indicated no spatial clustering or autocorrelation between areas; a positive Moran's I value indicated a positive spatial autocorrelation (a grouping of areas with the same attribute value). In contrast, a negative Moran's I value indicated a negative spatial autocorrelation (neighboring areas tend to have different attribute values). A positive and higher Moran's I value (close to 1) indicated that adjacent districts/cities tend to cluster based on similar stunting prevalence, either high or low.

The hotspot areas were determined using a Moran scatter plot, which was used to describe the spatial autocorrelation statistics. This scatter plot can provide an overview of how similar an attribute value in one area is to its neighboring area. The Moran scatter plot has four quadrants representing four spatial autocorrelation types. In this study, Quadrant 1 (Q1) was a quadrant that described an area with a high prevalence of stunting and surrounded by areas with a high prevalence of stunting. This area was called a high–high area, and the form of spatial autocorrelation was called positive. Quadrant 3 (Q3) described an area with a low stunting prevalence among an area with a low stunting prevalence (low–low); it is a form of positive spatial autocorrelation. Quadrant 4 (Q4) indicated an area with a low prevalence of stunting surrounded by neighboring areas with a high prevalence of stunting; the form of the autocorrelation was negative. Quadrant 2 (Q2) indicated an area with a high prevalence of stunting surrounded by neighboring areas with a low prevalence of stunting; the autocorrelation was negative. In this study, the areas in the high–high quadrant were defined as stunting hotspots, which means that an area with a high prevalence of stunting was surrounded by areas with a high prevalence of stunting.[17] R software version i386 3.6.1 (free version) was used to run the analysis, and Tableau Public 2020 was used to create the map. No patients or public members were involved in this study, so it did not need ethical permission. All the data used in this study are in the public domain.

Results

The results of the normality, independence, homoscedasticity, and multicollinearity assumption tests of stunting prevalence residuals are presented in Table 1, showing significant spatial autocorrelation among the districts/cities based on stunting prevalence in Sumatra, Java, Sulawesi, and Bali ENT WNT Islands. In contrast, no autocorrelation was found among the districts/cities and their neighboring areas in Kalimantan, Maluku, and Papua. The spatial autocorrelation results indicated that stunting was not random in Sumatra, Java, Sulawesi, and Bali ENT WNT.

The Moran scatter plots for Sumatra, Java, Sulawesi, and Bali ENT WNT are shown in Figure 1. The hotspots were the districts/cities located in each Moran scatter plot's high–high quadrant (Figure 1). The authors identi-

Table 1. Statistical Test Results and Moran's Index Values for Each Island

Island	Statistical Test Result (p-value)				Moran's Index Value
	AD	DW	BP	VIF	
Sumatra	0.538 (0.166)	2.052 (0.832)	3.562 (0.829)	VIF of all variables <10	0.299 (1.522e–10)
Java	0.714 (0.0609)	1.754 (0.154)	10.253 (0.419)	VIF of all variables <10	0.105 (1.246e–06)
Sulawesi	0.4696 (0.241)	1.868 (0.48)	6.604 (0.678)	VIF of all variables <10	0.303 (2.038e–09)
Bali ENT WNT	0.669 (0.075)	1.727 (0.34)	11.809 (0.298)	VIF of all variables <10	0.633 (4.127e–15)
Kalimantan	0.420 (0.315)	1.868 (0.56)	4.851 (0.773)	VIF of all variables <10	0.104 (0.073)
Maluku	0.149 (0.956)	2.393 (0.516)	7.608 (0.574)	VIF of all variables <10	–0.128 (0.4103)
Papua	0.243 (0.751)	2.655 (0.02)	5.851 (0.664)	VIF of all variables <10	0.126 (0.55)

Notes: AD = Anderson–Darling, DW = Durbin–Watson, BP = Breusch–Pagan, VIF = Variance Inflation Factor, ENT = East Nusa Tenggara, WNT = West Nusa Tenggara

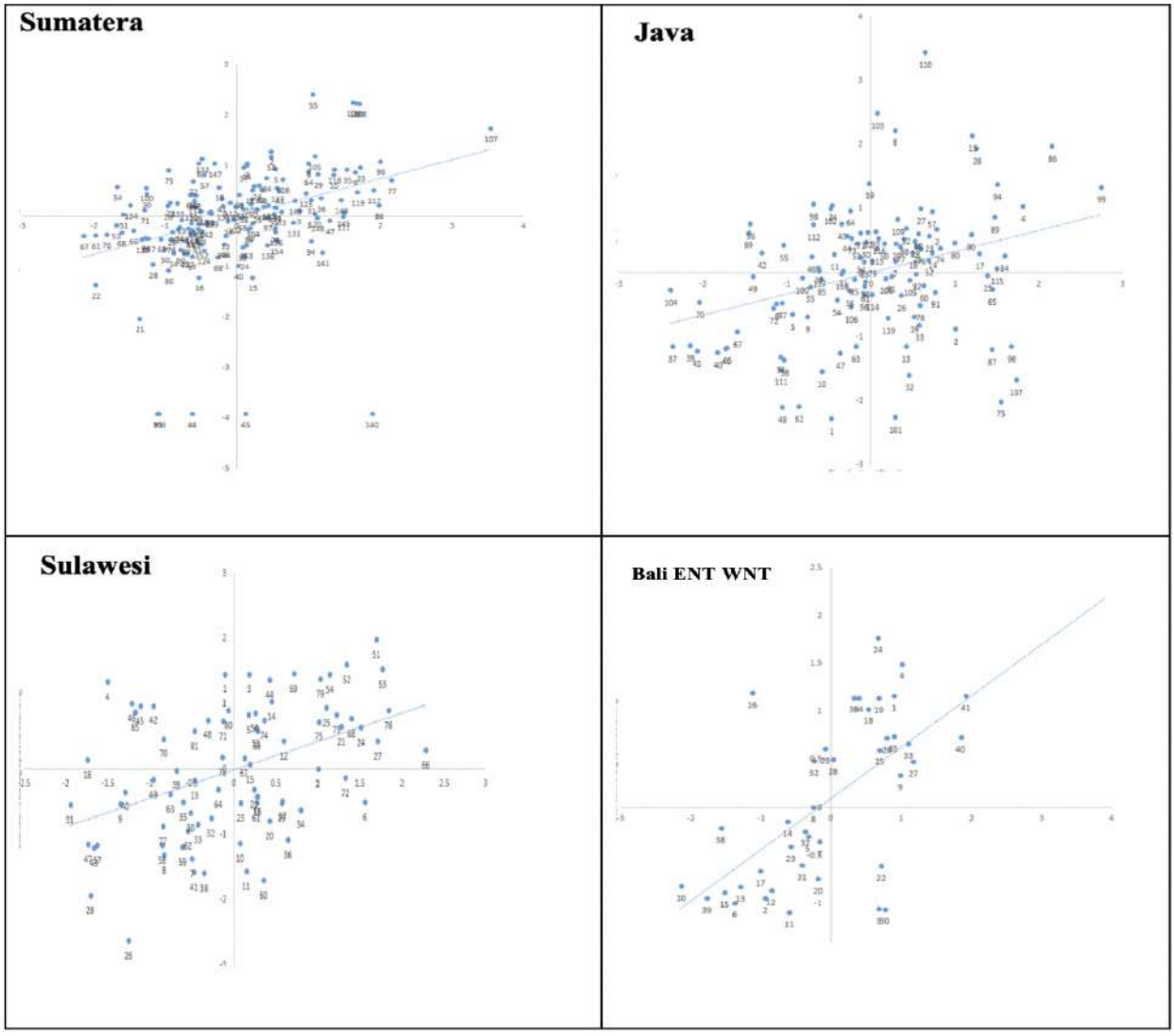

Figure 1. Moran Scatter Plots for Sumatra, Java, Sulawesi, and Bali East Nusa Tenggara West Nusa Tenggara

fied 133 hotspot districts/cities spread across 14 provinces on four islands. Figure 2 shows the geographic distribution of the hotspots in Indonesia, and Table 2 shows the detailed areas of the hotspots.

Figure 2. Stunting Hotspots in Indonesia (2018)

Table 2. Hotspot Areas by Island (Total = 133)

Island	Province	District/City	The Number of Hotspot Areas
Sumatra	Nanggroe Aceh Darussalam (NAD)	West Aceh, Southwest Aceh, Aceh Besar, Aceh Jaya, South Aceh, Aceh Tamiang, Central Aceh, Southeast Aceh, East Aceh, North Aceh, Bener Meriah, Gayo Lues, Lhokseumawe, Subulussalam, Pidie, Pidie Jaya, Naganraya	17
	North Sumatra	Dairi, Humbang Hasundutan, Gunungsitoli, Padangsidimpuan, Labuhanbatu, South Labuhanbatu, Langkat, Mandailing Natal, Nias, West Nias, South Nias, North Nias, Padang Lawas, North Padang Lawas, Pakpak Bharat, Central Tapanuli, North Tapanuli	17
	Bengkulu	South Bengkulu, Kaur, Kepahiang, Seluma, Muko-Muko	5
	South Sumatra	Empat Lawang, Pagar Alam, Muara Enim, Musi Rawas, Penukal Abab, Lematang Ilir, Ogan Komering Ulu, Lahat	7
	Jambi	Sungai Penuh, West Tanjung Jabung, Tebo	3
	West Sumatra	Pasaman, West Pasaman.	2
	Riau	Indragiri Hilir, Indragiri Hulu.	2
Java	West Java	Bandung, Ciamis, Cirebon, Garut, Indramayu, Cirebon City, Tasikmalaya, Majalengka, Pangandaran, Sumedang.	10
	East Java	Bangkalan, Banyuwangi, Bojonegoro, Bondowoso, Jember, Kediri, Pasuruan, Lamongan, Lumajang, Madiun, Magetan, Ngawi, Pamekasan, Pasuruan, Ponorogo, Probolinggo, Sampang, Situbondo, Sumenep, Trenggalek, Tuban.	21
	Central Java	Banyumas, Blora, Brebes, Cilacap, Jepara, Pati, Tegal.	7
Sulawesi	Central Sulawesi	Banggai Kepulauan, Buol Banggai Laut, Parigi Moutong.	3
	South Sulawesi	Barru, Bone, Bulukumba, Enrekang, Gowa, Jeneponto, Kepulauan Selayar, Kota Palopo, North Luwu, Maros, Pangkajene Kepulauan, Pinrang, Sinjai, Soppeng, Takalar, Tana Toraja, North Toraja.	17
	West Sulawesi	Majene, Mamasa, Mamuju, Central Mamuju, North Mamuju, Polewali Mandar.	6
Bali ENT WNT	ENT	Alor, Belu, East Flores, Kupang, Lembata, Malaka, Manggarai, West Manggarai, East Manggarai, Nagekeo, West Sumba, Southwest Sumba, Central Sumba, East Sumba, South Central Timor, North Central Timor.	16

Notes: ENT = East Nusa Tenggara; WNT = West Nusa Tenggara

Discussion

The purpose of conducting spatial autocorrelation was to determine whether the prevalence of stunting in a district/city was whether it occurred randomly.[16] The autocorrelation found in Sumatra, Java, Sulawesi, and Bali ENT WNT indicated that the stunting prevalence, whether high or low, in one district/city did not occur randomly; rather, it was related to the stunting prevalence in the surrounding districts/cities. The attribute value of a variable from an area tended to be the same or almost the same as the closer region compared to a farther region. This is based on the basic concept of geogra-

phy (Tobler's First Law), which states that "everything is related to everything else, but near things are more related than distant things."[15-19] The highest Moran index value of 0.633 (p-value = 4.127e-15) was found in Bali ENT WNT, followed by Sulawesi, Sumatra, and Java with a Moran index value of 0.303 (p-value = 2.038e-09), 0.299 (p-value = 1.522e-10), and 0.105 (p-value = 1.246e-06), respectively. A positive and higher Moran index value (close to a value of 1) indicated that adjacent districts/cities tend to cluster based on similar stunting prevalence, either high or low.[17] Previous studies in other countries, including India, Ethiopia, and Peru, showed similar results.[4,6,20] The autocorrelation findings of this study can be used to tailor the stunting interventions designed for these four islands.

Spatial autocorrelation among districts/cities could not be identified in Kalimantan, Maluku, and Papua because Kalimantan and Papua are vast islands with greater distances between districts, while Maluku's geographic situation is slightly different from Papua and Kalimantan, as the districts are separated by water. These unique features and the absence of autocorrelation emphasized that district size, the distance between districts, and the varied geographical conditions between districts significantly affected neighborhood status. In this case, these factors affected the spatial autocorrelation of stunting prevalence. Geographic theories state that the attribute of a variable in a region tends to be the same or almost the same as that of an area closer to it than a farther one.[17,21,22] In the context of spatial analysis, autocorrelation is the similarity that varies with the distance between locations, and this variation is affected by that distance.[23]

On the islands where spatial autocorrelation was identified, 16 hotspot areas in Bali ENT WNT were located in the ENT Province, 26 hotspot areas in Sulawesi were found in three provinces (Central Sulawesi, South Sulawesi, and West Sulawesi), 51 hotspot areas were located in seven provinces (NAD, North Sumatra, Bengkulu, South Sumatra, Jambi, West Sumatra, and Riau), and 38 hotspot areas in Java were located in three provinces (West Java, East Java, and Central Java). Determining the priority areas for stunting interventions in Indonesia is based only on the high prevalence of stunting and is weighted by the percentage of poverty in the region.[24] However, the spatial analysis method can determine priority areas by identifying hotspots within a certain period. The rationale is that the stunting prevalence in a district/city is related to nearby areas, interventions should target all districts/cities within a hotspot. The stipulation of priority areas for stunting intervention using spatial analysis has been described in studies conducted in Peru, Pakistan, and Africa.[4,5,8,9,22,25-30]

There were some limitations to this study. This ecological study was prone to an ecological fallacy, in which aggregate data representing areas were applied at the individual level.[18,31] An estimation was performed to fill the gap left by missing data, but the weakness of such a data estimation was it could not completely represent the actual situation. Missing data were often encountered during the data entry process, the missing data were manipulated. The weakness of this treatment was that the data did not precisely represent the actual situation. The issue of secondary data quality became very important during the study process.

The use of Euclidean distance to define neighboring areas as within a radius of 1° led to bias in the autocorrelation definition for a large island/area. The larger the area, the higher the probability of a larger island/area having no neighboring areas, as found in Kalimantan, Papua, and Maluku. It is advisable to use different methods (the most suitable according to the island characteristics) for defining neighboring; for instance, this study used Euclidean distance for Sumatra Island but not in Maluku (an island area), Papua, and Kalimantan (a large mainland area).

Conclusion and Recommendation

Indonesia is making progress toward stunting prevention: to reduce the stunting prevalence to 14% by 2024. Considering the vast size of Indonesia and its different regional characteristics, it is necessary to have priority areas for intervention. Spatial analysis can help determine priority areas by using a Moran scatter plot to identify hotspots (areas located in the high–high quadrant). This study reveals that of the 514 Indonesian districts/cities analyzed, 133 are stunting hotspots spread across four major islands: Sumatra, Java, Sulawesi, and Bali ENT WNT. All these hotspots have been recommended to the government as priority areas for stunting interventions. Given that there is autocorrelation among neighboring districts/cities and that stunting does not occur randomly in the four regions, intervention programs should target these hotspot clusters.

Abbreviations

WNT: West Nusa Tenggara; ENT: East Nusa Tenggara; AD: Anderson–Darling; DW: Durbin–Watson; VIF: Variance Inflation Factor; BP: Breusch–Pagan; NAD: Nanggore Aceh Darussalam.

Ethics Approval and Consent to Participate

This study was based on data available in the public domain; therefore, there are no ethical issues.

Competing Interest

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

Availability of Data and Materials

Data are available online from Statistics Indonesia at https://www.bps.go.id/pressrelease/2019/07/15/1629/persentase-penduduk-miskin-maret-2019-sebesar-9-41-persen.html and the Indonesian Ministry of Health at https://www.litbang.kemkes.go.id/laporan-riset-kesehatan-dasar-riskesdas. The data are included in the Statistics Indonesia report and 2018 National Basic Health Research.

Authors' Contribution

TS contributed to all the steps of this study, starting from the concept, design, writing, data interpretation, and review. TE and MPB contributed to the concept, interpretation, and review. All authors made substantial contributions to this study and approved the final manuscript.

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References

1. Kementerian Kesehatan Republik Indonesia. Laporan Nasional Riskesdas 2018. Jakarta: Badan Penelitian dan Pengembangan Kesehatan; 2019.
2. Tim Nasional Percepatan Penanggulangan Kemiskinan (TN2PK). Gerakan Nasional Pencegahan Stunting dan Kerjasama Kemitraan Multi Sektor. Jakarta: Sekretariat Wakil Presiden Republik Indonesia; 2018.
3. Hagos S, Hailemariam D, WoldeHanna T, Lindtjørn B. Spatial heterogeneity and risk factors for stunting among children under age five in Ethiopia: a Bayesian geo-statistical model. PLoS One. 2017; 12 (2): e0170785.
4. Alemu ZA, Ahmed AA, Yalew AW, Birhanu BS. Nonrandom distribution of child undernutrition in Ethiopia: spatial analysis from the 2011 Ethiopia demographic and health survey. Int J Equity Health. 2016; 15: 198.
5. Haile D, Azage M, Mola T, Rainey R. Exploring spatial variations and factors associated with childhood stunting in Ethiopia: spatial and multilevel analysis. BMC Pediatr. 2016; 16: 49.
6. Hernández-Vásquez A, Tapia-López E. Chronic malnutrition among children under five in Peru: a spatial analysis of nutritional data, 2010-2016. Rev Esp Salud Publica. 2017; 91: e201705035.
7. Development Initiatives Poverty Reasearch. Global nutrition report 2018. Bristol: Development Initiatives Poverty Reasearch Ltd; 2018.
8. Di Cesare M, Bhatti Z, Soofi SB, Fortunato L, Ezzati M, Bhutta ZA. Geographical and socioeconomic inequalities in women and children's nutritional status in Pakistan in 2011: an analysis of data from a nationally representative survey. Lancet Glob Health. 2015; 3 (4): e229-39.
9. Bharti R, Dhillon P, Narzary PK. A spatial analysis of childhood stunting and its contextual correlates in India. Clin Epidemiol Glob Health. 2019; 7 (3): 488-95.
10. Yadav A, Ladusingh L, Gayawan E. Does a geographical context explain regional variation in child malnutrition in India? J Public Health. 2015; 23: 277-87.
11. Pawloski LR, Curtin KM, Gewa C, Attaway D. Maternal-child overweight/obesity and undernutrition in Kenya: a geographic analysis. Public Health Nutr. 2012; 15 (11): 2140-7.
12. Menon P, Headey D, Avula R, Nguyen PH. Understanding the geographical burden of stunting in India: a regression-decomposition analysis of district-level data from 2015-16. Matern Child Nutr. 2018; 14 (4): e12620.
13. Badan Perencanaan Pembangunan Nasional. Rancangan Teknokratik Rencana Pembangunan Jangka Menengah Nasional 2020-2024. Jakarta: Kementerian PPN/Bappenas; 2019.
14. World Health Organization. Global nutrition targets 2025: stunting policy brief. Geneva: WHO; 2014.
15. Myers RH. Classical and modern regression with applications. 2nd ed. Boston: Duxbury Press; 2020.
16. Pfeiffer D, Robinson T, Stevenson M, Rogers D, Clements A. Spatial analysis in epidemiology. Oxford: Oxford University Press; 2008.
17. Grekousis G. Spatial analysis methods and practice: describe, explore, explain through GIS. New York: Cambridge University Press; 2020.
18. Souris M. Epidemiology and Geography. London: John Wiley & Sons; 2019.
19. Fischer MM, Wang J. Spatial data analysis models, methods and Ttechniques. London New York: Springer; 2011.
20. Khan J, Mohanty SK. Spatial heterogeneity and correlates of child malnutrition in districts of India. BMC Public Health. 2018; 18: 1027.
21. Bhunia GS, Shit PK. Geospatial analysis of public health. Cham: Springer Nature; 2019.
22. Waller LA, Gotway CA. Applied spatial statistics for public health data. London: John Wiley & Sons; 2004.
23. Fotheringham AS, Rogerson PA. The SAGE handbook of spatial analysis. London: Sage; 2009.
24. Tim Nasional Percepatan Penanggulangan Kemiskinan (TN2PK). 100 kabupaten/kota prioritas untuk intervensi anak kerdil (stunting). Jakarta: Sekretariat Wakil Presiden Republik Indonesia; 2017.
25. Barankanira E, Molinari N, Msellati P, Laurent C, Bork KA. Stunting among children under 3 years of age in Côte d'Ivoire: spatial and temporal variations between 1994 and 2011. Public Health Nutr. 2017; 20 (9): 1627–39.
26. Spray AL, Eddy B, Hipp JA, Iannotti L. Spatial analysis of undernutrition of children in Léogâne Commune, Haiti. Food and Nutrition Bulletin (FNB). 2013; 34 (4): 444–61.
27. Adekanmbi VT, Uthman OA, Mudasiru OM. Exploring variations in childhood stunting in Nigeria using league table, control chart and spatial analysis. BMC Public Health. 2013; 13: 361.
28. Otterbach S, Rogan M. Exploring spatial differences in the risk of child stunting: evidence from a South African national panel survey. J. Rural Stud. 2018; 65: –78.
29. Hagos S, Lunde T, Mariam DH, Woldehanna T, Lindtjørn B. Climate change, crop production and child under nutrition in Ethiopia; a longitudinal panel study. BMC Public Health 2014; 14: 884.
30. Akseer N, Bhatti Z, Mashal T, Soofi S, Moineddin R, Black RE, Bhutta ZA. Geospatial inequalities and determinants of nutritional status among women and children in Afghanistan: an observational study.

Lancet Glo. Health. 2018; 6 (4): e447–59.
31. Gerstman BB. Epidemiology kept simple. London: John Wiley & Sons; 2013.