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Determinants of under-five mortality in Indonesia: A nationwide study

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ABSTRACT

Background: The mortality rate for infants and children under five in Indonesia is an ongoing challenge for the government, with figures exceeding the targets set for the country by the Sustainable Development Goals (SDGs).

Objectives: This study aims to discover the factors causing under-five mortality in Indonesia.

Methods: This study will employ a cross-sectional study design with data sourced from the 2017 Indonesian Demographic and Health Survey (IDHS) between July and September 2017. The sample included 10,014 women who had given birth in the five years prior to the survey. The data was analyzed using Binary logistic regression with a significance level of $p < 0.05$.

Results: The significant factors relating to under-five mortality in Indonesia are: mother's age at birth (AOR = 2.04; 95% CI 95% = 1.11–3.77); birth weight (AOR = 7.60; 95% CI 95% = 5.17–11.19); the sex of the child (AOR = 1.80; 95% CI 95% = 1.28–2.52); frequency of using the internet (AOR = 1.13; 95% CI 95% = 0.02–0.95); residence (AOR = 0.64; 95% CI 95% = 0.33–0.94); and birth interval (AOR = 0.52; 95% CI 95% = 0.29–0.92). Birth weight is the more likely cause for under-five mortality in Indonesia.

Conclusions: This study revealed that the characteristics of mothers, children, the area of residence, and the behavior of the mother affect the under-five mortality.

Practice implications: Pediatric nurses can have a role to play in developing knowledge about health for both mothers and families. Additionally, accessible health education on issues from planning a pregnancy to childcare should be promoted in both rural and urban areas as well as a campaign on proper hygiene practices.

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Introduction

Infant and child mortality is a global problem and one of the targets for the United Nations sustainable development goals (SDGs). From 2012 to 2017, the number of infant and under-five mortalities in Indonesia declined, but it still did not reach the expected goals (S. Indonesia 2012; National Population and Family Planning Board (BKKBN), Statistics Indonesia (BPS), & (Kemenkes), 2018). In addition, the infant and toddler mortality rate in Indonesia is higher (USAID,

2020) when compared with other Association of Southeast Asian Nations (ASEAN) countries, such as the Philippines. This mortality rate is an indicator of the health status of a country, as a rise in the rate constrains the increase in life expectancy, welfare and the quality of life of a community (National Population and Family Planning Board (BKKBN), Statistics Indonesia (BPS), & (Kemenkes), 2018).

The reasons for under-five mortality are due to many factors, from the community level and socio-economic factors to the individual level (Ogbo et al., 2019; Yaya et al., 2020). Previous research showed that the community level, such as the area of residence, was the most common predictor of under-five mortality (Naz et al., 2020), as geographical areas have different characteristics for health and environmental factors (Chowdhury et al., 2020; Yaya et al., 2020). Several studies in developing countries have shown that maternal socio-economic characteristics are a strong phenomenon in determining the risk of child mortality (Fikru et al., 2019; Nisar & Dibley, 2014).

In Indonesia, mothers are the main caregivers for children, so the background and behavior of mothers play a major role in health, child

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care and exposure to triggers for disease (Penilla et al., 2017; Santika et al., 2020). The behavior of the mother relating to health, such as smoking (Andriani et al., 2019) and the ability to access information through electronic media, indirectly are factors that can determine infant and child mortality at the individual level (Feil et al., 2020; Setyastuti et al., 2019). Previous research has stated that infant and under-five mortality is also closely related to maternal factors, such as the mother's age at delivery and the birth interval, because it will affect the quality of the child's health, care and delivery (Khan & Awan, 2017; Naz et al., 2020; Yaya et al., 2020).

A study on the health status of children associated with morbidity and mortality due to disease has been conducted in developing countries. It found that children with low birth weights have a greater potential for death compared with those with normal birth weights (Ogbo et al., 2019). This is because birth weight is related to the child's nutritional status and immune system (Ngandu et al., 2019). One study stated that exposure to infectious diseases and nutritional status indirectly caused increased mortality in children under five (Bagamian et al., 2020).

Indonesia is a country with a large and diverse population, which requires greater efforts to reduce the mortality rate of children under five. Infant mortality can be prevented (Adebowale et al., 2020). There is an urgent need, therefore, to identify the factors that cause death in children under five at the community level, socio-economy level, maternal and child individual levels so that the necessary interventions can be formulated (Indonesia, N. P. and F. P. B, 2017). This study aims to identify the determinants that influence the mortality of children under five in Indonesia.

Method

Data source

This study sourced data from the 2017 Indonesian Demographic and Health Survey (IDHS). This is one of the social demographic surveys that are regularly conducted by the Central Bureau of Statistics, the National Population and Family Planning Agency, and the Ministry of Health of the Republic of Indonesia, which received assistance through the Demographic Health Survey (DHS) program from the Inner-City Fund (ICF) International. The survey was carried out in 34 provinces, in both urban and rural areas. Of the 49,261 households selected, as many as 48,216 households were found, and 47,963 or 99.5% were successfully interviewed.

Sample size and sampling

IDHS used a two-stage stratified cluster sampling technique to determine the sample. It identified 50,730 women who met the requirements for an interview, of which 49,627 women were successfully surveyed. Furthermore, the observation was weighted on the number of provinces to obtain the proportion for each region. Of these, following disaggregation by inclusion criteria, a sample of 10,014 women who had given birth in the five years preceding the survey was found.

Variable

Dependent variable

The dependent variable in this study was under-five mortality, which was described as the probability of a child dying between birth and the fifth year (0–4 years) (National Population and Family Planning Board (BKKBN), Statistics Indonesia (BPS), & (Kemenkes), 2018).

Independent variable

The independent variables were based on Mosley and Chen's conceptual framework of child survival in developing countries (Mosley & Chen, 1984), which consisted of the community level, socio-economic level and individual level (Yaya et al., 2020). The community level in this study is residence; the socio-economic level consists of the mother's education, work status, and level of wealth, while the individual level consists of the characteristics of the mother and the child. The mother's characteristics include her age at time of survey and her age at the time of the birth, as well as her frequency of watching TV, reading newspapers or magazines, listening to the radio, using the internet and whether she smokes. The characteristics of the child consist of birth weight, breastfeeding status, birth interval and the sex of the child.

The maternal age variables comprise three categories—those aged 15–24 years, 25–34 years, and 35–49 years. The mother's education was divided into four categories—higher, secondary, primary, and no education. The next variable was the mother's employment status, which was divided into two categories—working and non-working. The frequency of watching TV variable consisted of three categories—not at all, less than once a week, and at least once a week. The frequency of using the internet variable also had three categories—never, yes in the last 12 months, and yes prior to the last 12 months. The wealth variable was categorized as poor, middle, and rich. The wealth of a household was assessed by the amount and consumption of goods owned such as televisions, vehicles, and houses, as well as drinking water sources, toilet facilities, and flooring materials (Rutstein & Johnson, 2004). The residence variable included urban and rural areas, and was based on the regulations of the Indonesian Central Bureau of Statistics (BPS, 2010).

The mother's smoking status variables were categorized as smoking and non-smoking. The characteristics of the child consisted of categorizing birth weights of ≥ 2500 g and < 2500 g, while the breastfeeding variables consisted of never breastfed and always breastfed. The gender variable consisted of male and female.

Data analysis

The retrieved data was analyzed by STATA version 14.0. Encoded variables were weighted so that the sample distribution represented the actual population. This study conducted a univariate analysis to determine the description of each variable to be studied, both dependent and independent. A chi-square test (p -value < 0.05) was conducted to discover the determinant of under-five mortality. This test was also conducted to select the variables that could be entered into the multivariate test, if the p -value was < 0.25 (Bursac et al., 2008). Furthermore, multivariate analysis was conducted to determine the independent variables that had the greatest influence on the dependent variables. This analysis was conducted through a binary logistic regression test. The strength of the relationship between the independent and dependent variables was tested by using odds ratios with 95% confidence intervals. The significant variables with a p -value of 0.05 and 95% CI were considered as determinant factors for the mortality of children under five in Indonesia. This study used “svy” survey commands in STATA to take account of the clustering effects and sampling weight arising from the multistage cluster random sampling that was used in collecting the data in the national survey. Ethical clearance was granted by the Ministry of Health of Indonesia. Permission to use the dataset was obtained from ICF International, part of the Demographic Health Survey program.

Result

Regarding the age of the mother at the time of the survey, more than half of those surveyed were between 25 and 34 years (52.56%), while most mothers (6324 (63.15%)) at the time of delivery also were between 25 and 34 years. More than half of the mothers had secondary

education (56.13%), while 53.83% were non-working mothers. In terms of wealth, the highest number was in the poor category (41.56%). More than half of the respondents lived in urban areas (50.87%), while 5656 respondents (56.48%) had a birth interval of >5 years (Table 1).

Data for characteristics of the children shows that most children in this study had a birth weight of ≥ 2500 g (93.41%). Regarding breastfeeding, this study found that the majority of 9543 (95.29%) had been breastfed. More than half of the children in this study were male at 50.8% (Table 1).

Table 1
Characteristics of Respondents (n = 10,014).

Variables	n	%
Child is alive		
Yes	9840	98.26
No	174	1.74
Community Level		
Residence		
Urban	5094	50.87
Rural	2920	49.13
Socio-economic		
Mother's education		
Higher education	1403	14.01
Secondary education	5621	56.13
Primary education	2909	29.05
No education	81	0.81
Mother's work status		
No	5390	53.83
Yes	4624	46.17
Wealth quintile		
Poor	4162	41.56
Middle	3836	38.30
Rich	2016	20.14
Child characteristics		
Birth weight		
≥ 2500 g	9354	93.41
<2500 g	660	6.59
Breastfeeding status		
Never breastfeed	471	4.71
Ever breastfeed	9543	95.29
Birth interval		
<2 years	802	8.01
2–5 years	3556	35.52
>5 years	5656	56.48
Sex of child		
Female	4927	49.20
Male	5087	50.80
Mother Characteristics		
Mother's age at interview		
15–24	459	4.4
25–34	5264	52.56
35–49	4291	42.84
Mother's age at birth		
13–24	1230	12.29
25–34	6324	63.15
35–49	2460	24.56
Frequency of watching TV		
Not at all	339	3.38
Less than once a week	1095	10.94
At least once a week	8580	85.68
Frequency of reading newspaper or magazine		
Not at all	6294	62.85
Less than once a week	2927	29.23
At least once a week	793	7.92
Frequency of listening radio		
Not at all	6364	63.55
Less than once a week	2540	25.46
At least once a week	1100	10.99
Frequency of using internet		
Never	6096	60.88
Yes, last 12 months	3751	37.46
Yes, before last 12 months	167	1.67
Mother's smoke status		
No	9830	82.76
Yes	184	17.24

The data on the characteristics of the mothers' behavior in using information media and their smoking habits showed that the majority watched television once a week (85.68%) compared with those who never watched television or watched it less than once a week. This contrasted with the behavior of mothers reading newspapers in a week, with most of them never reading a newspaper (62.85%). This almost equaled the behavior for listening to the radio (63.55%) and using the internet (60.88%). The study found that most of the respondents (82.76%) did not smoke (Table 1).

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Bivariate analysis

The bivariate analysis showed that of the 15 variables, nine had a significant relationship with the incidence of under-five child mortality. These were birth weight, breastfeeding status, the gender of the child, the mother's age at birth, the mother's work status, frequency of watching TV, frequency of using the internet, residence, and birth intervals. Meanwhile, the variables that were not related to the under-five mortality rate were the mother's age at interview, the mother's education, wealth status, frequency of reading newspapers or magazines, frequency of listening to the radio, and the mother's smoking status (Table 2).

Multivariate analysis

The multivariate analysis of the relationship between the independent and dependent variables using the backward method showed that maternal age at delivery (giving birth), the birth weight and gender of the child, frequency of using the internet, residence, and birth intervals were significantly related to child mortality.

This multivariate test found that children who were born when mothers were aged 35–49 years had twice the risk of dying compared with those who were born to mothers aged 15–24 years (AOR = 2.04; 95% CI = 1.11–3.77). Children who were born with a weight of <2500 g had a risk of dying 7.6 times higher than those with a birth weight of ≥ 2500 g (AOR = 7.60; 95% CI = 5.17–11.19). Boys had a 1.80 times higher risk of death than girls (AOR = 1.80; 95% CI = 1.28–2.52).

Children whose mothers used the internet in the last 12 months had a 0.13 times lower risk of dying than those whose mothers never used the internet (AOR = 1.13; 95% CI = 0.02–0.95), while children in rural areas had a 0.64 times lower risk of death than those in urban areas (AOR = 0.64; 95% CI = 0.33–0.94). Children who were born with intervals of five years from the birth of a sibling had a 0.52 times lower risk of dying than those born two years after the birth of a sibling (AOR = 0.52; 95% CI = 0.29–0.92)—Table 3.

Discussion

This research found that the characteristics of mothers, children, the area of residence, and the mother's behavior affect the mortality rate for children under five in Indonesia, with birth weight being the most significant influence. The results showed that children who were born with a severe birth weight of less than 2500 g or low birth weight (LBW) had a higher risk of death compared with those born at normal weights (more than 2500 g). The findings of this study align with those of previous research in Sierra Leone, which showed that low birth weight indicated that the nutritional intake during pregnancy was inadequate (Naz et al., 2020; Tagoe et al., 2020). This inadequate supply of nutrients can inhibit the growth of cells during the differential period and can lead to the failure of multiple systems of the body in the postnatal extrauterine state. Additionally, the effects of LBW will worsen in the absence of immediate intervention for infants (Naz et al., 2020).

This study also found that the mother's age at delivery was a significant factor in the mortality of children under five. The results indicated

Table 2
Bivariate analysis test results (n = 10,014).

Characteristics	Child is alive				X ²
	Yes		No		
	n	%	n	%	
Birth weight					212.99**
≥2500 g	9238	92.24	116	1.16	
<2500 g	602	6.01	58	0.58	
Breastfeeding status					988.23**
Never breastfeed	378	3.77	93	0.93	
Ever breastfeed	9462	94.48	81	0.81	
Sex of child					13.13**
Female	4865	48.58	62	0.63	
Male	4975	49.68	112	1.12	
Mother's age at interview					2.27
15–24	453	4.53	6	0.06	
25–34	5180	51.72	84	0.84	
35–49	4207	42.01	84	0.84	
Mother's age at birth					5.08*
13–24	1217	12.16	13	0.13	
25–34	6214	62.05	110	1.1	
35–49	2409	24.05	51	0.51	
Mother's education					4.91
Higher education	1377	13.76	26	0.26	
Secondary education	5536	55.28	85	0.85	
Primary education	2846	28.42	63	0.62	
No education	80	0.8	1	0.01	
Mother's work status					4.99*
No	5311	53.03	74	0.79	
Yes	4529	45.23	95	0.95	
Wealth quintile					3.57
Poor	4078	40.72	84	0.84	
Middle	3777	37.71	59	0.59	
Rich	1986	19.83	30	0.31	
Frequency of watching TV					9.68**
Not at all	334	3.33	5	0.06	
Less than once a week	1064	10.62	31	0.31	
At least once a week	8442	84.3	138	1.38	
Frequency of reading newspaper or magazine					3.90
Not at all	6196	61.87	98	0.98	
Less than once a week	2865	28.61	62	0.62	
At least once a week	779	7.77	14	0.14	
Frequency of listening to the radio					0.09
Not at all	6253	62.44	111	1.11	
Less than once a week	2507	25.03	43	0.43	
At least once a week	1080	10.79	20	2	
Frequency of using internet					4.01*
Never	5981	59.72	115	1.16	
Yes, the last 12 months	3693	36.87	58	0.58	
Yes, before the last 12 months	166	1.66	1	0.01	
Residence					7.80**
Urban	4987	49.8	107	1.06	
Rural	4852	48.46	68	0.68	
Birth interval					8.90**
<2 years	778	7.77	24	0.24	
2–5 years	2502	34.98	54	0.54	
>5 years	5560	55.51	96	0.96	
Mother's smoke status					0.65
No	9660	96.47	170	1.7	
Yes	179	1.79	5	0.04	

X²: Chi-Square.
* p value ≤0.25.
** p value <0.05.

a greater risk of child mortality for mothers giving birth while aged 35–49 years compared with mothers aged 13–24 years. Previous studies have shown that the risk of child mortality was higher for mothers aged over 35 (Adebowale et al., 2020; Patel et al., 2020; Tagoe et al., 2020). Older mothers are at risk of being in poor health compared with their younger counterparts. This is due to a decrease in bodily and reproductive functions with a risk of lower quality of care for children. Additionally, older mothers have high-risk pregnancies, which may result in adverse effects for both mother and baby, such as gestational hypertension, diabetes, premature birth, impaired infant growth,

Table 3
Multivariate analysis test results (n = 10,014).

Variables	AOR	95% CI	
		Lower	Upper
Mother's age at birth			
13–24	Ref.		
25–34	1.70	0.94	3.07
35–49	2.04*	1.11	3.77
Birth weight			
≥2500 g	Ref.		
<2500 g	7.60**	5.17	11.19
Sex of child			
Female	Ref.		
Male	1.80**	1.28	2.52
Frequency of using internet			
Never	Ref.		
Yes, the last 12 months	0.81	0.54	1.23
Yes, before the last 12 months	0.13*	0.02	0.95
Residence			
Urban	Ref.		
Rural	0.64*	0.44	0.94
Birth interval			
<2 years	Ref.		
2–5 years	0.60	0.32	1.11
>5 years	0.52*	0.29	0.92

AOR: Adjusted Odds Ratio.
CI: Confidence Interval.
* p-value <0.05.
** p-value <0.01.

neonatal mortality (Cavazos-Rehg et al., 2015) and the risk of having a baby with a congenital disease (Schulkey et al., 2015).

This study also found that gender was associated with the mortality of children under five in Indonesia. This aligned with the results of a previous study in Bangladesh (Karra et al., 2017; Khan & Awan, 2017). This research demonstrated that boys had a higher risk of death than girls, and these findings aligned with previous studies in Africa, including Nigeria, and Indonesia (Adebowale et al., 2020; Costa & Victora, 2021; dewuyi et al., 2016; Titaley et al., 2008). Boys are genetically and biologically weaker and more susceptible to contracting infectious diseases than girls (Muenchhoff & Goulder, 2014), such as congenital malformations of the urogenital system (Nair et al., 2013) and acute lung respiratory infection (Antehunegn & Worku, 2021). Another trigger factor is that boys tend to be more active than girls, so they are more at risk of being exposed to infectious agents and having accidents (Ani et al., 2020; Baker et al., 2016).

From the behavior of the mother, this study found that the frequency of using the internet had a significant relationship with the death of children in Indonesia. The results indicated that mothers who used the internet in the last 12 months had a lower risk of a child under the age of five dying compared with mothers who never accessed the internet. This aligns with the results of a previous study in Pakistan (Rabbani et al., 2017) and is associated with childcare. The mother's use of the internet may improve her parenting skills (Griauzde et al., 2020) as it provides easy access to information. Mothers who had direct contact with the internet had more knowledge about healthcare for children (Feil et al., 2020). A previous study showed that these mothers provided their children with a variety of good quality food compared with those who had not been exposed to the internet (Griauzde et al., 2020).

The living area had a significant relationship with under-five mortality in Indonesia. Surprisingly, the results showed that children who live in rural areas have a lower risk of death compared with those from urban areas. This aligns with previous studies in Chad and China which stated that rural areas have a much lower risk of death and a change in the trend that the under-five mortality rate in rural areas has declined more quickly in the last five years compared with urban areas (Ahinkorah et al., 2020; Shang et al., 2020). In Indonesia, the mortality rate for children under five in rural areas decreased quite sharply between 2012 and 2017 from 40 per 1000 live births, so that in 2017 the

mortality rate in urban areas was higher than in rural areas (BPS, 2017). This contrasts with previous research which showed that children in rural areas are more at risk of dying compared with those in urban areas. This relates to limited access to health facilities in rural areas compared with urban areas (Yaya et al., 2020). However, the rural areas in Indonesia enjoy a more natural environment, with air free from pollutants, while the urban areas are densely populated with many slums that have poor sanitation. Additionally, those living in urban areas endure polluted water sources and pollutants in the air. This environment results in many toddlers being exposed to unhealthy conditions that cause illness and death (Ahinkorah et al., 2020; Anastasi et al., 2017).

The results showed that children born at intervals of more than five years had a lower risk of death than those who were born with an interval of less than two years. This aligns with four studies in Tanzania, Benin, and Sierra Leone, which found that children who were born with intervals of less than two years from the birth of a sibling had a higher risk of death (Biradar et al., 2019; Naz et al., 2020; Ogbo et al., 2019; Yaya et al., 2020). In neonatal and infants with a short interval of delivery, the mother is more likely to experience complications in labor than a long interval of delivery. This also impacts the health of infants. Babies born to a mother who suffered complications in childbirth are at high risk mortality (Kayode et al., 2012; Titalay et al., 2008). Children aged under two with an interval from the birth of a sibling of less than two years are at risk due to inadequate breastfeeding and delayed immunization (Adedini et al., 2015; Biradar et al., 2019; Kusnanto et al., 2020; Mediarti et al., 2020). Additionally, children over three who have siblings with a birth interval of less than two years are at risk of having poor health due to the attention of the parents being shared with younger siblings. This may arise through a lack of attention by the parents to the child's health support needs, such as adequate quality food and other limited resources (Kayode et al., 2012).

However, this study also discovered controversial findings. It was found that the level of education of the mother was not associated with the incidence of death in children under five. Based on previous research, it is known that apart from the level of education, the important attributes of mothers include their ability to care for their children, to provide nutrition, and to communicate well with family and partners. Additionally, the source of information relating to the mother's level of knowledge is an important factor in preventing child mortality (Haskell et al., 2012; Mena et al., 2020; Patel & Olickal, 2021; Tovar et al., 2018). Consequently, it is necessary to strengthen the skills of mothers in caring for children through activities such as workshops or training in collaboration with public health centers.

The level of wealth in this study does not have a significant relationship. According to previous research, preterm birth complications, birth asphyxia/trauma, pneumonia, congenital anomalies, diarrhea, and malaria are the leading causes of death in children under the age of five. All of these conditions can be prevented or treated through access to simple, affordable interventions such as immunization, adequate nutrition, safe water and food, and quality care by a trained health provider when required (Liu et al., 2019; Strong et al., 2021).

Limitations

This study presented the national outcome which reflects demographic characteristics among Indonesians. The results are validated by a large number of samples and measuring instruments that are internationally standardized. However, this study did not present data relating to husbands or partners, the area-level number of primary physicians, and society roles. Future research may provide additional information about the support of partners, physicians, and society in the prevention of mortality among children under five. Additionally, the data was collected retrospectively and relied on the memories of the participants. Therefore, influenced by the strength of a mother's memory, other confounding factors may arise, such as information on children's health, their medical records, and their history of illness.

Practice implications

The handling and prevention of under-five mortality years needs a long-term intervention and collaboration between the government and health workers, especially nurses. In this case, pediatric nurses have an important role in developing knowledge regarding the growth and development of children to mothers and families. In the implementation of clinical practices, pediatric nurses can consider factors of mother, children, place of residence, and mother's behavior that have an impact on under-five mortality into nursing care. In addition, information dissemination through health education from the pregnancy phase to childcare also needs to be carried out in both rural and urban areas as well as a campaign on proper hygiene practices.

Conclusions

The birth weight of the baby, the gender of the child, the age of the mother at delivery, the birth interval, the frequency of using the internet, and the area of residence were the determinant factors for the mortality of children under five in Indonesia. These findings can be used as a basis for designing strategic interventions to reduce this mortality rate. The strategy should be to expand education programs for mothers and families about the health of pregnant women and children through synergies with existing programs such as maternal and child health centers, and with local government institutions. It should also involve the empowerment of community organizations in each region, increasing health information through various media, promoting campaigns for clean and healthy living as well as emphasizing the importance of cleanliness and hygiene in both rural and urban areas.

Credit authorship contribution statement

Praba Diyan Rachmawati: Conceptualization, Methodology, Data curation, Writing – original draft, Writing – review & editing. **Iqlima Dwi Kurnia:** Conceptualization, Methodology, Writing – review & editing. **Meirina Nur Asih:** Methodology, Writing – review & editing. **Tya Wahyun Kurniawati:** Methodology, Writing – review & editing. **Ilya Krisnana:** Methodology, Writing – review & editing. **Yuni Sufyanti Arief:** Methodology, Writing – review & editing. **Smriti Mani:** Writing – review & editing. **Yulis Setiya Dewi:** Writing – review & editing. **Hidayat Arifin:** Writing – review & editing.

Declaration of Competing Interest

The authors declare that we do not have any conflict of interest.

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