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Original Article

Maternal Sociodemographic Characteristics, Pregnancy History, and Current Pregnancy of Infants With Low Birth Weight: A Case-Control Study

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Abstract

Background and aims: Low birth weight (LBW) remains a serious cause of infant mortality in Indonesia, contributing to 34.5% of deaths in 2021. Nationally, 3.1% of newborns were classified as LBW in 2020, while Banten Province reported a lower prevalence of 1.7%. LBW is associated with higher risks of childhood illness, developmental delays, malnutrition, and infection. Moreover, maternal sociodemographic factors, reproductive history, and pregnancy conditions, including coronavirus disease 2019 (COVID-19), may influence LBW outcomes. Thus, this study examined the association of these factors with LBW at Banten Provincial General Hospital.

Methods: An analytic observational study with a case-control design was conducted among mothers who delivered at Banten Provincial General Hospital, Indonesia, between January 2021 and December 2022. The cases included 51 mothers of LBW infants (<2500 g) who were recruited through total sampling, while controls comprised 51 mothers of normal birth weight infants randomly selected and matched by delivery month. Independent variables investigated in this study were maternal sociodemographic characteristics, pregnancy history, and current pregnancy conditions. The data were extracted from medical records and finally analyzed using chi-square tests and multivariate logistic regression ($P<0.05$).

Results: Overall, COVID-19 infection during pregnancy was significantly associated with LBW (odds ratio 3.67, $P=0.018$). However, other maternal characteristics and pregnancy-related factors demonstrated no significant associations ($P>0.05$).

Conclusion: Maternal COVID-19 infection is a serious risk factor for LBW, underscoring the need for enhanced monitoring and preventive strategies for pregnant women during infectious disease outbreaks.

Keywords: Low birth weight, Pregnancy, Sociodemographic factors, Reproductive History, COVID-19

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Introduction

Low birth weight (LBW), defined by the World Health Organization as a birth weight below 2,500 g, remains a major global health problem.[1] According to evidence, most LBW and preterm cases occur in South Asia and Sub-Saharan Africa, with a worldwide prevalence of 15–20% and the highest rates found in Asia and Africa. In particular, India accounts for a substantial proportion of cases, while the prevalence is 11.7% in Indonesia. Within the country, North Maluku reports the highest rate (20.1%), and West Java records the most significant number of LBW infants (104,585 cases).[2-4] It is noteworthy that LBW and prematurity are the leading causes of neonatal mortality and are linked to long-term complications, such as malnutrition, stunting, developmental delays, and increased susceptibility to infections.[5-8] Premature infant mortality remains a serious cause of childhood deaths.[9] A study on healthcare readiness in low-income and middle-income countries, including Indonesia, demonstrated that while overall hospital bed capacity may be adequate, the availability of neonatal intensive care beds is limited, particularly in district and remote hospitals. These shortages, along with insufficient specialized personnel, constrain the ability to provide optimal intensive care for LBW infants.[10]

Various maternal factors contribute to the occurrence of LBW, including sociodemographic characteristics (maternal age at delivery, residence, and education), reproductive history (birth spacing, parity, and history of abortion or preterm birth), nutritional status, anaemia, pregnancy-induced hypertension, periodontal disease, infertility, depression, smoking, substance use, and intrauterine growth restriction (IUGR).[4, 11-14] In Indonesia, rural residence is associated with a higher incidence of LBW (12.9% vs. 10.8% in urban areas; adjusted odds ratio [AOR]: 1.249, 95% confidence interval [CI]: 1.241–1.256).[4] Maternal education plays a critical role, as higher education levels are linked to healthier behaviours, greater use of antenatal care, and reduced smoking rates. In contrast, lower education is associated with anaemia, poor weight gain, and limited access to health services, thereby increasing LBW risk.[15]

Anaemia, in particular, reduces haemoglobin levels and impairs placental angiogenesis, thereby restricting oxygen delivery to the foetus and leading to IUGR and LBW.[8,16] Other determinants (e.g., inadequate antenatal care, maternal occupation, and adverse pregnancy outcomes) also play a role in this regard.[17-19] In addition, maternal infections (e.g., bacterial, parasitic, and viral infections) have been shown to increase LBW risk, with coronavirus disease 2019 (COVID-19) emerging as a suspected contributor.[20-22]

There are contradictory data regarding COVID-19 and LBW. Liu et al reported that pregnant women may be more vulnerable to COVID-19 infection.[21] Likewise, Dileep et al found that the neonates of mothers with moderate to severe COVID-19 had a 9.3-fold higher risk of being born with LBW compared to those whose mothers had mild or asymptomatic infection ($P<0.001$).[22] Similarly, Wei et al demonstrated that symptomatic or severe maternal COVID-19 was significantly associated with increased LBW risk. However, other studies have reported no clear association between COVID-19 and LBW.[23-25]

Given these inconsistent findings and the lack of regional data, particularly in Indonesia, where infant mortality remains high, further research is necessary. This study, therefore, aims to investigate the association between maternal sociodemographic characteristics, reproductive history, and current pregnancy conditions, including COVID-19 infection and LBW outcomes, at Banten Provincial General Hospital. It is expected that the findings provide evidence to strengthen maternal health interventions and guide public health policy in Banten Province.

Materials and Methods

This study applied an observational analytic case-control design to evaluate the association between maternal characteristics and LBW. Variables assessed in this study included sociodemographic factors (age, education, and employment), pregnancy history (previous LBW, abortion, and preterm birth), and current pregnancy conditions (hypertension, anaemia, parity, COVID-19 infection, and other infections). It should be noted that protective factors (e.g., maternal nutrition or vaccination) were not examined in the present study.

Selection and Description of Participants

The study population comprised all mothers who delivered at Banten Provincial General Hospital between January 2021 and December 2022, including both referral and routine cases. As the study setting was a referral hospital, the findings may merely reflect more complicated pregnancies and may not be generalizable to community births. The timeframe coincided with the COVID-19 pandemic, providing an opportunity to evaluate this specific exposure.

A case-control design was selected due to the relatively low prevalence of LBW. Cases included all incident LBW deliveries (<2,500 g) during the study period, while controls were mothers delivering normal birth weight infants (>2,500 g), frequency-matched by month. The groups were sampled at a 1:1 ratio. After excluding incomplete records, both groups comprised 51 participants, yielding a total of 102 subjects. Cases were incident cases (new LBW deliveries recorded during the study period) selected via total sampling, and controls were chosen by simple random sampling (Figure 1).

The required sample size was determined using the difference between 2 proportions using the following formula:

$$n_1 = n_2 = \left(\frac{Z_\alpha \sqrt{2PQ} + Z_\beta \sqrt{P1Q1 + P2Q2}}{P_1 - P_2} \right)^2$$

$n_1 = n_2 = 40$

$n = n_1 + n_2 = 80$

Description:

n_1 = Number of subjects in group 1

n_2 = Number of subjects in group 2

$Z\alpha = 1.96$ (95% CI)

$Z\beta = 0.84$ (80% power)

P_1 = Proportion of LBW infants in mothers afflicted with COVID-19 = 0.43 → $Q_1 = 1 - P_1 = 0.57$

P_2 = Proportion of non-LBW infants in mothers suffering from COVID-19 = 0.14 → $Q_2 = 1 - P_2 = 0.86$

The minimum required sample size was 80, which was increased to 88 to anticipate missing data. The final sample size was 102, exceeding this requirement. Power analysis based on assumed proportions ($P_1 = 0.43$, $P_2 = 0.14$, $\alpha = 0.05$) indicated a test statistic of 3.426, with ~93% power, surpassing the original 80% target.

Technical Information

COVID-19 infection was determined from medical records using *nucleic acid amplification test/reverse transcription–polymerase chain reaction* results, positive rapid diagnostic antigen tests, or classification as suspected/contact cases with positive rapid diagnostic antigen tests, following the guidelines of the Ministry of

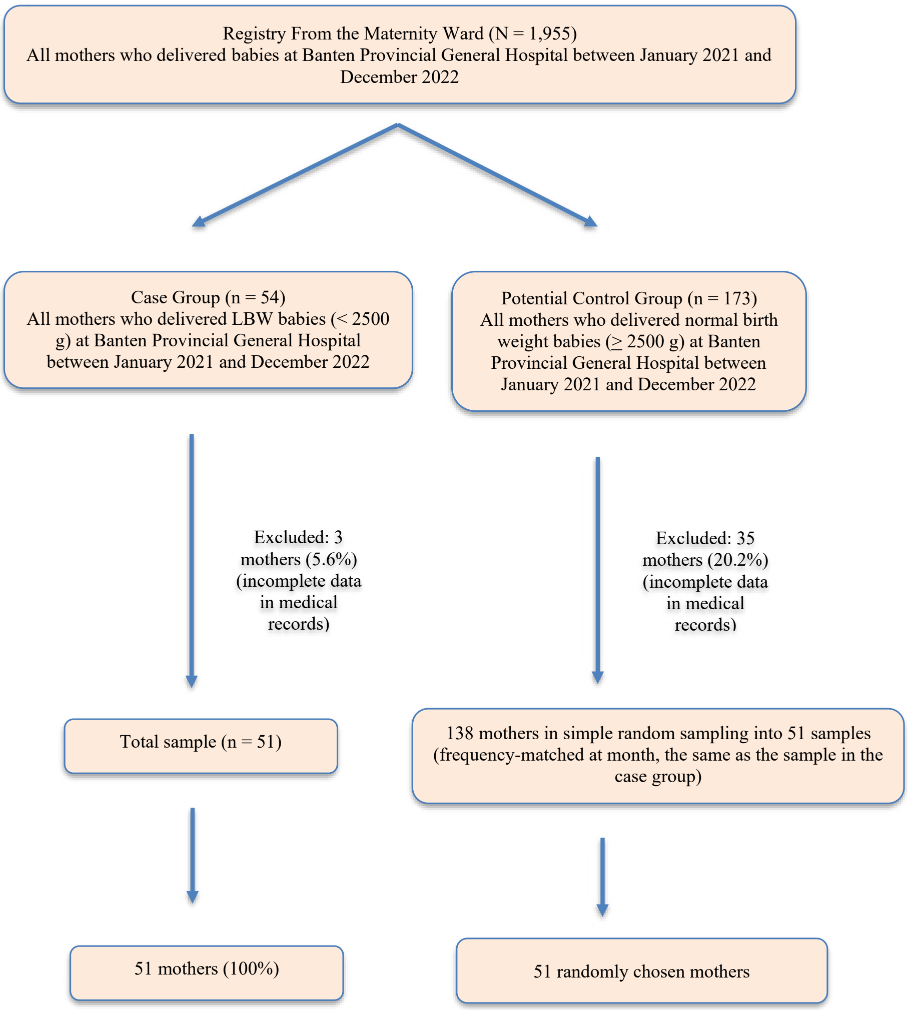

Figure 1. Sampling Process
Note. LBW: Low birth weight

Health. Structured forms were used for data collection, which were completed by trained enumerators based on medical records. Although enumerators were not blinded to outcomes, the use of objective data minimized bias. Required materials included a research permit, data forms, and patient medical records.

Statistical Analysis

The obtained data were analyzed using IBM SPSS software, version 23. Potential biases, such as selection bias, recall bias, and confounding, were reduced by selecting cases and controls from the same population using uniform criteria, relying on medical records, and applying matching and multivariate analysis. In addition, univariate analysis described demographic characteristics and group comparability. Furthermore, bivariate associations were tested using the chi-square test, and ORs with CIs were calculated. Moreover, multivariate logistic regression was used to assess the independent effects of variables on LBW, adjusting for confounders. The modelling process included crude, full, confounding, and final models. Variables with $P<0.25$ in the bivariate analysis or deemed clinically relevant were entered into the whole model. Variables with $P<0.05$ were retained in the final parsimonious model. It should be noted that no subgroup and sensitivity analyses were performed in this study.

Results

Figure 1 illustrates the sampling process. Overall, 54 potential LBW cases and 173 potential controls were identified from 1,955 deliveries recorded between January 2021 and December 2022. After excluding incomplete records, the final sample included 51 LBW cases and 51 controls, matched by delivery month. Cases and controls were selected through total and random sampling methods, respectively.

Most mothers were unemployed or housewives (62.7% of LBW vs. 80.4% of controls). High school was the most common educational level (33.3% LBW; 37.3% controls), followed by junior high and elementary school. Additionally, the mean maternal age was nearly identical (27.9 ± 4.9 years in LBW vs. 28.0 ± 4.8 years in controls). Based on the results (Table 1), there was a considerable difference in the average infant birth weight (1957.5 ± 334.6 g vs. 3244.4 ± 377.3 g).

Univariate analysis showed no significant differences between the groups in terms of prior LBW (5.9% vs. 7.8%), abortion (23.5% vs. 11.8%), or preterm birth (2.0% vs.

Table 1. Distribution of Sociodemographic Characteristics, Pregnancy History, and Covid 19 Infection (n=102)

Variables	Case	Control
Sociodemographic factors		
Age of Mothers (years)	27.9 ± 4.9*	28.0 ± 4.8*
Birth Weight of Baby (g)	1,957.5 ± 334.6*	3,244.4 ± 377.3*
Level of Education		
No education	1 (2)	1 (2)
Elementary School/equal	13 (25.5)	13 (25.5)
Junior High School/equal	16 (31.4)	9 (17.6)
High School/equal	17 (33.3)	19 (37.3)
University/equal	4 (7.8)	9 (17.6)
Work Status		
Working	19 (37.3)	10 (19.6)
Not Working	32 (62.7)	41 (80.4)
Previous Pregnancy History		
Low Birth Weight (LBW)		
Yes	3 (5.9)	4 (7.8)
No	48 (94.1)	47 (92.2)
Abortion		
Yes	12 (23.5)	6 (11.8)
No	39 (76.5)	45 (88.2)
Preterm Birth		
Yes	1 (2)	2 (3.9)
No	50 (98)	49 (96.1)
Current Pregnancy		
Parity		
Primiparity	37 (72.5)	33 (64.7)
Multiparity	14 (27.5)	18 (35.3)
Antenatal Care (ANC)		
Yes	15 (29.4)	20 (39.2)
No	36 (70.6)	31 (60.8)
Maternal Anemia		
Yes	15 (29.4)	20 (39.2)
No	36 (70.6)	31 (60.8)
Hypertension in Pregnancy		
Yes	15 (39.4)	15 (25.5)
No	36 (70.6)	38 (74.5)
Covid 19 Infection		
Yes	16 (31.4)	6 (11.8)
No	35 (68.6)	45 (88.2)
Other infections		
Yes	5 (9.8)	4 (7.8)
No	46 (90.2)	47 (92.2)

Values are presented as number (%).
* Values are presented as Mean ± standard deviation (SD).

3.9%). Regarding the current pregnancy, primiparity was more common in controls (72.5% vs. 64.7%). A greater proportion of LBW mothers (29.4% vs. 15.7%) did not attend antenatal care (ANC). Anaemia was more common in controls (39.2% vs. 29.4%), while hypertension was slightly higher in LBW mothers (29.4% vs. 25.5%). COVID-19 infection was more prevalent among LBW mothers (31.4% vs. 11.8%), similar to other infections (9.8% vs. 7.8%). Table 1 provides the distribution of sociodemographic characteristics, pregnancy history, and COVID-19 infection.

Bivariate analysis (Table 2) revealed no significant associations between LBW and maternal education ($P=0.234$), occupation ($P=0.079$), prior LBW ($P=1.000$), abortion history ($P=0.194$), parity ($P=0.522$), ANC ($P=0.155$), anaemia ($P=0.404$), hypertension ($P=0.824$), or other infections ($P=1.000$). However, COVID-19 infection showed a significant association with LBW ($P=0.030$; OR = 3.429).

Variables with $P<0.25$ in the crude analysis (education, occupation, abortion, ANC, and COVID-19) were entered into a multivariate logistic regression model. COVID-19 infection remained significantly associated with LBW ($P=0.018$; AOR = 3.672, 95% CI: 0.881–6.784). Nonetheless, occupation ($P=0.052$) and ANC ($P=0.086$) were not significant after adjustment (Table 2).

Discussion

In this study, mean birth weights in the LBW and non-LBW groups differed from those reported earlier. For instance, a study in Java recorded an average LBW of 2,096.4 ± 360.4 g,[26] while in another study reported a national mean birth weight of 3,144 ± 520.6 g. LBW remains a major contributor to infant morbidity and mortality, often leading to malnutrition, stunting, delayed cognitive development, and other long-term health risks,[7, 27] The average maternal age in Indonesia is 21.57 years. Nonetheless, this study excluded mothers under 20 and over 35 years old in order to minimize confounding, as extreme maternal ages are associated with greater risks of complications and LBW.[28, 29]

Maternal employment status has been linked to birth outcomes, with strenuous physical work raising stress and energy demands that, without sufficient nutrition, may impair foetal growth. Activities requiring heavy lifting or exertion can also elevate blood pressure and reduce placental blood flow, contributing to growth restriction or preterm birth.[30] However, our results demonstrated no significant association between employment and LBW ($P=0.079$), which contradicts the findings of earlier research.[31] The difference may relate to occupation classification or socioeconomic factors, as most participants of this study were housewives. Maternal education is generally protective, with higher education linked to healthier behaviours, better healthcare use, and lower smoking rates, while lower education is related to malnutrition and anaemia.[15] Nevertheless, our findings showed no significant relationship between education and LBW ($P=0.234$), which is consistent with the results of another study.[31]

A history of delivering an LBW infant is usually

Table 2. The Relationship Between Independent Variables and LBW (n = 102)

Variables	Crude*	*P* value	Full-model*¹	*P* value
Sociodemographic factors				
Level of Education				
< High School/equal	1.74 (0.79-3.81)	0.234	1.83 (0.78-4.33)	0.168
≥ High School/equal	1.00 (reference)		1.00 (reference)	
Work Status				
Working	2.43 (0.99-5.96)	0.079	2.69 (0.99-7.26)	0.051
Not Working	1.00 (reference)		1.0 (reference)	
Previous Pregnancy History				
Low Birth Weight (LBW)				
Yes	0.73 (0.16-3.46)	1.000	-	-
No	1.00 (reference)			
Abortion				
Yes	2.31 (0.79-6.73)	0.194	2.25 (0.38-4.12)	0.717
No	1.00 (reference)		1.00 (reference)	
Preterm Birth				
Yes	0.49 (0.43-5.58)	1	-	-
No	1.00 (reference)			
Current Pregnancy				
Parity				
Primiparity	1.44 (0.62-3.34)	0.522	-	-
Multiparity	1.00 (reference)			
Antenatal Care (ANC)				
Yes	2.24 (0.85-5.88)	0.155	2.36 (0.88-6.70)	0.106
No	1.00 (reference)		1.00 (reference)	
Maternal Anemia				
Yes	0.65 (0.28-1.47)	0.404	-	-
No	1.00 (reference)			
Hypertension in Pregnancy				
Yes	1.22 (0.50-2.91)	0.824	-	-
No	1.00 (reference)			
Covid 19 Infection				
Yes	3.43 (1.22-9.67)	0.030	3.37 (1.12-10.08)	0.030
No	1.00 (reference)		1.00 (reference)	
Other infections				
Yes	1.28 (0.32-5.06)	1	-	-
No	1,00 (reference)			

Note. COVID-19: Coronavirus disease 2019. *Values are presented as odds ratio (95% confidence interval)
¹Significant at $P<0.25$ (or $P>0.25$ for a variable considered sufficiently important) and analyzed in the full model.

considered a risk factor for recurrence, mediated by maternal age, parity, infection, and antenatal care.[32] Nevertheless, this study found no such association ($P = 1.000$), which does not match previous reports.[33] The discrepancy may stem from differences in respondent characteristics and the absence of IUGR data. Similarly, no significant association was observed between abortion history and LBW ($P = 0.194$), aligning with the results of Jayanti et al.[34] A prior preterm birth, often linked to LBW through shared complications (e.g., preeclampsia) also showed no association in this study ($P = 1.000$), contrasting with the findings of earlier research.[32] Likewise, there was no significant relationship between parity and LBW ($P = 0.522$), which conforms to the results of Jayanti et al, despite theories that primiparous women face higher risks due to physiological adaptation.[34]

During pregnancy, there are physiological changes, including increased vomiting and decreased appetite in early pregnancy. Primiparous women are believed to be at higher risk for LBW due to physiological adaptation and higher nausea and vomiting in their first pregnancies, which can affect maternal intake. Nevertheless, this study found no significant association between parity and LBW ($P = 0.522$), which corroborates the findings of Jayanti et al.[34]

ANC is known to reduce LBW risk, with fewer visits associated with worse outcomes.[35] Nonetheless, our findings revealed no significant association ($P = 0.155$). The difference may reflect limitations in medical records, which did not record visit frequency and only confirmed whether mothers attended at least one visit. Similarly, anaemia, commonly associated with LBW due to impaired placental oxygen delivery, was not significantly associated ($P = 0.404$). The observed lack of association contradicts previous reports, possibly because women with severe anaemia (Hb < 7) were excluded, leaving only mild-to-moderate cases. Hypertension, which can restrict placental blood flow and impair foetal nutrition, also represented no significant association ($P = 0.824$). This inconsistency may relate to the study's inability to distinguish between pre-existing and gestational hypertension or assess whether blood pressure was controlled.[16, 19, 36]

In contrast, COVID-19 infection during pregnancy was noticeably associated with LBW ($P = 0.030$), with infected mothers having a 3.429-fold higher risk. This association supports the findings of the meta-analysis by Wei et al and a cohort study from West Bengal, indicating an LBW incidence of 30.3% (AOR: 2.18, 95% CI: 1.3–3.63).[20,37] Other studies, however, reported contradictory results. In Turkey, LBW rates declined during the pandemic, except during the second lockdown. Simultaneously, U.S. multicentre data showed no significant differences before the pandemic versus during the pandemic or between infected and uninfected mothers.[38, 39] Research in Uruguay suggested an indirect association between the pandemic and LBW (OR: 1.21, 95% CI: 1.05–1.40).[40]

Mechanistically, COVID-19 may contribute to LBW through placental dysfunction. The viral invasion of trophoblasts and maternal immune activation can cause vascular damage, thrombosis, inflammation, and necrosis, thereby impairing oxygen and nutrient exchange. Maternal hypoxemia can further exacerbate placental insufficiency, thus restricting foetal growth.[41] Evidence from other viral infections also supports adverse outcomes for foetal development.[42] Moreover, COVID-19 has been associated with haematological changes, systemic inflammation, cytokine storms, and hypoxia, all of which are linked to increased maternal and foetal risk. Additionally, immune activation may affect foetal immune and nervous system development, potentially causing long-term neurodevelopmental consequences.[41] In this study, the variable "other infections" combined all non-COVID infections (i.e., bacterial, parasitic, and viral) without subcategorization. This broad classification limits interpretability and prevents comparison with more specific literature.

This study had several limitations. Key confounding factors, such as smoking history, pregnancy interval, nutritional intake, body mass index, stress, infertility, and socioeconomic status, were unavailable in medical records. In addition, data on COVID-19 severity, timing of infection, and gestational age were incomplete, thereby limiting the ability to distinguish LBW due to prematurity from LBW due to IUGR. Conducting the study in a single referral hospital, where more complicated cases are common, could also lead to selection bias and reduce generalizability to broader populations. Furthermore, wide CIs around the COVID-19–LBW association indicate imprecision, and reliance on secondary data may have caused misclassification. Although the achieved sample size provided adequate statistical power, it was based on assumed proportions and was smaller. Thus, more accurate effect sizes could reduce actual power. Sparse data on some confounders also reduced the stability of adjusted estimates, leading to wide CIs and precluding subgroup or sensitivity analyses.

Conclusion

The findings of this study demonstrated that pregnant women with COVID-19 infection at Banten Provincial General Hospital had a 3.67 times greater likelihood of delivering an LBW infant compared to those without infection, which is a statistically significant finding. These results emphasize the need for hospitals to implement enhanced surveillance and closer clinical monitoring of pregnant women diagnosed with COVID-19, particularly during antenatal visits, in order to enable early detection of growth restriction and timely intervention. Accordingly, preventive measures should be incorporated into routine antenatal care, including nutritional consultation, maternal education, and infection prevention strategies, to minimize the risk of LBW. Furthermore, the findings highlight the importance of strengthening maternal health programs at both hospital and community levels, ensuring integrated approaches that address infection control, maternal nutrition, and comprehensive perinatal care, thereby reducing LBW incidence among pregnant women affected by COVID-19.

Authors' Contribution

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Visualization: Ita Marlita Sari.
Writing-original draft: Ita Marlita Sari, Salsabila Hanifa Rusyda.
Writing-review & editing: Ita Marlita Sari.

Competing Interests

The authors declare they have no conflict of interests related to the

content, authorship, or publication of this manuscript.

Ethical Approval

The study protocol was approved by the Institutional Review Board of Health Research of the Faculty of Medicine, Sultan Ageng Tirtayasa University (IRB No. 206/UN.43.20/KEPK/2023). The research data were obtained from secondary sources, including the medical records of patients at Banten Provincial General Hospital. All data used in this study will maintain the confidentiality of the subject's identity, and the data will be utilized only for research purposes.

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