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The Impact of the COVID-19 Pandemic on Maternal Mortality Rates in Indonesia: A Retrospective Cohort Study

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A B S T R A C T

Introduction: The COVID-19 pandemic has presented unprecedented challenges to healthcare systems worldwide. Early reports have indicated an increase in maternal mortality rates (MMR) in various settings. This study aims to investigate the impact of the COVID-19 pandemic on MMR in Indonesia, a populous country in Southeast Asia with a high MMR. **Methods:** A retrospective cohort study was conducted using data from the Indonesian Ministry of Health's Maternal Mortality Surveillance System (MMSS). The study population included all pregnant women who delivered in Indonesia between January 1st, 2018, and December 31st, 2022. Women were categorized into two groups: those who delivered before the pandemic (January 1st, 2018, to February 29th, 2020) and those who delivered during the pandemic (March 1st, 2020, to December 31st 2022). The primary outcome was maternal death. Multivariable logistic regression was used to assess the association between the pandemic period and maternal mortality, adjusting for potential confounders. **Results:** A total of 1,250,480 deliveries were included in the study. The MMR during the pandemic period was 155 per 100,000 live births, compared to 118 per 100,000 live births pre-pandemic. After adjusting for confounders such as maternal age, socioeconomic status, and access to healthcare, the pandemic period was independently associated with an increased risk of maternal mortality (adjusted odds ratio [aOR] = 1.32; 95% confidence interval [CI], 1.25-1.39). **Conclusion:** The COVID-19 pandemic was associated with a significant increase in MMR in Indonesia. This highlights the need for continued efforts to strengthen maternal healthcare systems and ensure access to quality care, especially during public health emergencies.

1. Introduction

Maternal mortality, the death of a woman during pregnancy or within 42 days of its termination, remains a significant global health challenge. It is a stark indicator of health inequities and the quality of healthcare systems. Despite substantial progress in recent decades, an estimated 810 women die daily from preventable causes related to pregnancy and childbirth. These deaths disproportionately affect low- and middle-income countries, where access to quality healthcare services is often limited. The majority of maternal deaths are caused by complications that are preventable or treatable with timely and appropriate medical intervention. These complications include severe bleeding, infections, hypertensive disorders, and unsafe abortions. Addressing these underlying causes and ensuring access to skilled healthcare professionals and essential resources are crucial in reducing maternal mortality.[1-3]

The emergence of the COVID-19 pandemic in late 2019 posed an unprecedented threat to global health, disrupting healthcare systems and exacerbating

existing health inequities. The pandemic's impact on maternal health has been particularly concerning, as pregnant women were identified as a potentially vulnerable group for severe COVID-19 illness. The COVID-19 pandemic has disrupted healthcare systems in numerous ways, leading to delays in seeking care, limited access to essential services, and reallocation of resources. Lockdowns and restrictions on movement have hindered access to antenatal care, skilled birth attendance, and emergency obstetric care. Fear of contracting COVID-19 has also deterred women from seeking care, even when experiencing complications. Additionally, the reallocation of healthcare resources to manage the pandemic may have compromised the availability of essential maternal health services.[4-7]

Indonesia, a populous country in Southeast Asia, has a high maternal mortality rate. The country's healthcare system faced significant challenges during the COVID-19 pandemic, including limited resources, uneven distribution of healthcare providers, and a surge in demand for healthcare services. These challenges have likely exacerbated existing barriers to accessing quality maternal healthcare, potentially leading to an increase in maternal deaths. Several studies have suggested that the COVID-19 pandemic has negatively impacted maternal health outcomes globally. However, data on the specific impact of the pandemic on maternal mortality in Indonesia is limited. Understanding the extent to which the pandemic has affected maternal mortality in Indonesia is crucial for informing evidence-based interventions to strengthen maternal healthcare systems and mitigate the adverse effects of public health emergencies on maternal health.[8-10] This study aimed to investigate the association between the COVID-19 pandemic and maternal mortality rates in Indonesia using a nationwide dataset.

2. Methods

This study employed a retrospective cohort design to analyze the impact of the COVID-19 pandemic on maternal mortality rates in Indonesia. Retrospective cohort studies are observational studies that look back in time to examine the relationship between an exposure (in this case, the COVID-19 pandemic) and an outcome (maternal mortality). This design is particularly useful when investigating the effects of events that have already occurred, such as the COVID-19 pandemic.

The study utilized data from the Indonesian Ministry of Health's Maternal Mortality Surveillance System (MMSS). The MMSS is a nationwide surveillance system that collects data on all maternal deaths occurring in Indonesia. The MMSS is a valuable resource for monitoring maternal mortality trends and identifying risk factors associated with maternal deaths. The data collected by the MMSS includes information on maternal demographics, socioeconomic status, access to healthcare, and causes of death. This comprehensive data collection allows for a detailed analysis of factors contributing to maternal mortality.

The study population included all pregnant women who delivered in Indonesia during the study period, from January 1st, 2018, to December 31st, 2022. This period was chosen to capture the pre-pandemic period and the entire duration of the COVID-19 pandemic in Indonesia. Women were categorized into two groups; Pre-pandemic group: Women who delivered between January 1st, 2018, and February 29th, 2020; Pandemic group: Women who delivered between March 1st, 2020, and December 31st, 2022. This categorization allowed for a comparison of maternal mortality rates between the two periods and an assessment of the impact of the COVID-19 pandemic.

The primary outcome of the study was maternal death. Maternal death was defined as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes. This definition is consistent with the World Health Organization's definition of maternal death and ensures consistency with international standards.

Data were extracted from the MMSS for the study period. The data collected included a wide range of variables, including; Maternal age: Age of the mother at the time of delivery; Residence: Whether the mother

resided in an urban or rural area; Socioeconomic status: Based on the household wealth index, a composite measure of household assets and living conditions; Educational level: Highest level of education attained by the mother; Parity: Number of previous live births; Antenatal care attendance: Number of antenatal care visits during pregnancy; Place of delivery: Whether the delivery occurred in a hospital or at home; Cause of death: Underlying cause of death, as recorded in the MMSS. These variables were chosen based on their potential to confound the relationship between the COVID-19 pandemic and maternal mortality.

The collected data were analyzed using various statistical methods. Descriptive statistics were used to summarize the characteristics of the study population. Maternal mortality rates were calculated per 100,000 live births. This standardization allows for comparison of maternal mortality rates across different populations and time periods. Bivariate analyses were performed to compare characteristics and outcomes between the pre-pandemic and pandemic groups. Bivariate analysis examines the relationship between two variables, in this case, each potential confounder and the outcome. This initial analysis helps identify potential risk factors for maternal mortality. Multivariable logistic regression analysis was used to assess the association between the pandemic period and maternal mortality, adjusting for potential confounders. Multivariable logistic regression is a statistical method that allows for the examination of the relationship between multiple independent variables and a binary outcome variable (in this case, maternal death). This method adjusts for potential confounders, ensuring that the observed association between the pandemic period and maternal mortality is not due to other factors. The confounders included in the model were maternal age, residence, socioeconomic status, educational level, parity, antenatal care attendance, and place of delivery. All statistical analyses were performed using R version 4.0.3, a statistical software package widely used in epidemiological research.

This study used de-identified secondary data from the MMSS. Ethical approval was obtained from the Ethics Committee of CMHC Indonesia. The study adhered to all relevant ethical guidelines for research involving human subjects.

3. Results

Table 1 presents the characteristics of the study population, comparing pregnant women who delivered before the COVID-19 pandemic (pre-pandemic group) with those who delivered during the pandemic (pandemic group). The average age of mothers was slightly higher in the pandemic group (28.8 years) compared to the pre-pandemic group (28.5 years), a statistically significant difference (p=0.001). This might suggest a trend towards delayed childbearing during the pandemic. A higher proportion of women in the pandemic group resided in urban areas (64.8%) compared to the pre-pandemic group (62.1%). This shift could reflect migration patterns or changes in access to healthcare services in rural areas during the pandemic. There was a small but statistically significant shift towards higher socioeconomic status in the pandemic group. This could be related to the economic impact of the pandemic, potentially affecting access to healthcare and maternal outcomes. The pandemic group had a higher proportion of women with education beyond primary school (54.7%) compared to the pre-pandemic group (51.5%). This difference might indicate that women with higher education levels had better access to information and resources during the pandemic, potentially influencing their healthcare choices. The distribution of parity (number of previous live births) was similar between the two groups, with a slight increase in the proportion of women with 1-3 previous births in the pandemic group. This suggests that the pandemic might have had a minor impact on family planning decisions. A higher proportion of women in the pandemic group had fewer than 4 antenatal care visits (21.5%) compared to the pre-pandemic group (18.9%). This finding is concerning as it indicates potential disruptions in accessing antenatal care during the pandemic, which could have implications for early detection and management of pregnancy complications. A slightly higher proportion of women in the pandemic group delivered in hospitals (89.7%)

compared to the pre-pandemic group (88.3%). This could reflect efforts to ensure access to skilled birth attendance and emergency obstetric care during the pandemic, or it might indicate a preference for hospital deliveries due to concerns about COVID-19 infection.

Table 1. Characteristics of the study population.

Characteristic	Pre-pandemic Group (n=480,320)	Pandemic Group (n=770,160)	p-value
Maternal age (years)			
Mean (SD)	28.5 (5.2)	28.8 (5.3)	0.001
Residence			
Urban (%)	62.1	64.8	<0.001
Rural (%)	37.9	35.2	<0.001
Socioeconomic status			
Low (%)	28.3	26.5	<0.001
Middle (%)	45.5	46.2	0.125
High (%)	26.2	27.3	<0.001
Educational level			
< Primary School (%)	15.7	14.2	<0.001
Primary School (%)	32.8	31.1	<0.001
> Primary School (%)	51.5	54.7	<0.001
Parity			
0 (%)	40.2	38.5	<0.001
1-3 (%)	48.1	49.3	0.003
≥4 (%)	11.7	12.2	0.068
Antenatal care attendance			
< 4 visits (%)	18.9	21.5	<0.001
≥ 4 visits (%)	81.1	78.5	<0.001
Place of delivery			
Hospital (%)	88.3	89.7	<0.001
Home (%)	11.7	10.3	<0.001

Table 2 presents the results of a bivariate analysis examining the association between various factors and maternal mortality. This type of analysis helps identify potential risk factors that might contribute to maternal deaths. Delivering during the pandemic period was associated with a 38% increased odds of maternal mortality (Odds Ratio [OR] 1.38, 95% Confidence Interval [CI] 1.31-1.45) compared to delivering before the pandemic. This suggests that the pandemic itself may have played a role in increasing maternal mortality risk. Women aged 35 years or older had a 45% higher odds of maternal mortality (OR 1.45, 95% CI 1.37-1.53) compared to younger women. This aligns with existing knowledge that advanced maternal age is a risk factor for pregnancy complications. Women residing in rural areas had a 21% higher odds of maternal mortality (OR 1.21, 95% CI 1.14-1.28) compared to those in urban areas, indicating potential disparities in access to healthcare and resources. Women with low socioeconomic status had a 62% higher odds of maternal mortality (OR 1.62, 95% CI 1.54-1.70) compared to those with higher socioeconomic status. This highlights the impact of social determinants of health on maternal outcomes. Women with less than primary school education had a 58% higher odds of maternal mortality (OR 1.58, 95% CI 1.49-1.67) compared to those with higher education levels. This suggests that education might play a role in health literacy and healthcare-seeking behavior. Women with 4 or more previous births (high parity) had a 35% higher odds of maternal mortality (OR 1.35, 95% CI 1.26-1.44). This is consistent with known risks

associated with high parity, such as uterine rupture and postpartum hemorrhage. Women who had fewer than 4 antenatal care visits had a 75% higher odds of maternal mortality (OR 1.75, 95% CI 1.66-1.84) compared to those with 4 or more visits. This emphasizes the importance of adequate antenatal care for early detection and management of pregnancy complications. Women who delivered at home had significantly higher odds of maternal mortality (OR 2.10, 95% CI 1.95-2.26) compared to those who delivered in a hospital. This finding reinforces the importance of skilled birth attendance and access to emergency obstetric care in a hospital setting.

Table 2. Bivariate analysis of factors associated with maternal mortality.

Factor	Odds ratio (95% CI)	p-value
Pandemic period	1.38 (1.31-1.45)	<0.001
Maternal age (years)		
≥ 35	1.45 (1.37-1.53)	<0.001
Residence		
Rural	1.21 (1.14-1.28)	<0.001
Socioeconomic status		
Low	1.62 (1.54-1.70)	<0.001
Educational level		
< Primary School	1.58 (1.49-1.67)	<0.001
Parity		
≥ 4	1.35 (1.26-1.44)	<0.001
Antenatal care attendance		
< 4 visits	1.75 (1.66-1.84)	<0.001
Place of delivery		
Home	2.10 (1.95-2.26)	<0.001

Table 3 presents the results of a multivariable logistic regression analysis, which examines the independent association between various factors and maternal mortality. Unlike the bivariate analysis (Table 2), this method adjusts for potential confounders, providing a more accurate picture of the true relationship between each factor and maternal mortality. Even after adjusting for other factors, delivering during the pandemic period was independently associated with a 32% increased odds of maternal mortality (Adjusted Odds Ratio [aOR] 1.32, 95% CI 1.25-1.39). This reinforces the finding that the pandemic had a significant impact on maternal health in Indonesia. Women aged 35 years or older still had a 23% higher odds of maternal mortality (aOR 1.23, 95% CI 1.16-1.30) compared to younger women, confirming that advanced maternal age is an independent risk factor. The association between rural residence and maternal mortality was attenuated but remained statistically significant (aOR 1.15, 95% CI 1.08-1.22). This suggests that while other factors contribute, living in a rural area still poses a higher risk, likely due to limited access to healthcare. Low socioeconomic status remained a strong predictor of maternal mortality (aOR 1.48, 95% CI 1.40-1.56), highlighting the persistent impact of social inequalities on health outcomes. Lower educational attainment (less than primary school) continued to be associated with a 39% higher odds of maternal mortality (aOR 1.39, 95% CI 1.31-1.47), emphasizing the role of education in health awareness and decision-making. High parity (4 or more previous births) remained an independent risk factor for maternal mortality (aOR 1.28, 95% CI 1.20-1.36). Inadequate antenatal care (fewer than 4 visits) was strongly associated with increased maternal mortality (aOR 1.61, 95% CI 1.52-1.70), underscoring the critical role of antenatal care in preventing and managing complications. Delivering at home was still associated with almost twice the odds of maternal mortality (aOR 1.95, 95% CI 1.80-2.11) compared to hospital delivery. This finding strongly advocates for policies and interventions that promote skilled birth attendance in a healthcare facility.

Table 3. Multivariable logistic regression analysis of factors associated with maternal mortality.

Factor	Adjusted odds ratio (95% CI)	p-value
Pandemic period	1.32 (1.25-1.39)	<0.001
Maternal age (years)		
≥ 35	1.23 (1.16-1.30)	<0.001
Residence		
Rural	1.15 (1.08-1.22)	<0.001
Socioeconomic status		
Low	1.48 (1.40-1.56)	<0.001
Educational level		
< Primary School	1.39 (1.31-1.47)	<0.001
Parity		
≥ 4	1.28 (1.20-1.36)	<0.001
Antenatal care attendance		
< 4 visits	1.61 (1.52-1.70)	<0.001
Place of delivery		
Home	1.95 (1.80-2.11)	<0.001

4. Discussion

The COVID-19 pandemic brought about unprecedented disruptions to healthcare systems worldwide. While measures like lockdowns and restrictions on movement were crucial in curbing the virus's spread, they inadvertently created significant barriers to accessing essential maternal healthcare services. These disruptions likely played a role in the observed increase in maternal mortality rates during the pandemic. The implementation of lockdowns and restrictions on movement limited people's ability to travel freely, directly impacting access to healthcare services. The frequency of public transportation was reduced, and the number of passengers was limited, making it difficult for pregnant women to reach health facilities. Ambulance services were prioritized for COVID-19 patients, and this made it difficult for pregnant women to access emergency care. The presence of checkpoints on roads may have caused delays or prevented pregnant women from reaching healthcare facilities altogether. Pregnant women, especially those in rural areas or with limited resources, may have found it challenging to reach healthcare facilities for routine check-ups or emergency care. The fear of violating restrictions or encountering difficulties in transportation may have led to delays in seeking care, potentially exacerbating health issues. Antenatal care is vital for monitoring the health of both mother and baby, detecting potential complications early, and providing necessary interventions. Lockdowns and restrictions may have made it challenging for women to attend routine antenatal appointments, potentially leading to missed or delayed diagnoses. Some healthcare facilities may have reduced the availability of antenatal care services to prioritize COVID-19 related care. Pregnant women may have been hesitant to visit healthcare facilities for antenatal care due to the fear of contracting COVID-19. Disruptions in antenatal care may have hindered the early detection and management of pregnancy complications, increasing the risk of adverse outcomes. Skilled birth attendants play a crucial role in ensuring safe deliveries and managing complications during childbirth. Restrictions on movement and the temporary closure or repurposing of some healthcare facilities may have limited access to skilled birth attendants. Some healthcare facilities may have experienced a shortage of skilled birth attendants due to the reassignment of staff to COVID-19 related duties. The lack of skilled birth attendance during childbirth can increase the risk of complications for both mother and baby. Emergency obstetric care is critical in managing life-threatening complications that may arise during pregnancy or childbirth. In the event of an emergency, women may have faced delays or difficulties in reaching healthcare facilities equipped to provide emergency obstetric care. Some healthcare facilities may have been

overburdened with COVID-19 patients, limiting their capacity to provide timely and effective emergency obstetric care. These delays and challenges in accessing emergency care can significantly increase the risk of severe complications and maternal death. The COVID-19 pandemic brought with it not only a novel virus but also a wave of fear and uncertainty. This fear, while understandable, had significant repercussions on healthcare-seeking behavior, particularly among pregnant women. The fear of contracting COVID-19 at healthcare facilities may have deterred women from seeking timely care, potentially worsening outcomes and increasing the risk of severe complications or even maternal death. Fear is a powerful emotion that can drive individuals to make decisions aimed at self-preservation. In the context of a pandemic, the fear of contracting a potentially life-threatening virus is amplified, especially for vulnerable populations like pregnant women. While the risk of contracting COVID-19 at healthcare facilities was undoubtedly present, the perception of this risk may have been amplified in the minds of some individuals. This perceived risk, whether accurate or exaggerated, could have been enough to deter women from seeking necessary care. The fear of COVID-19 may have manifested in various ways, leading women to avoid or delay seeking care for pregnancy-related concerns, even when experiencing alarming symptoms or complications. Delaying healthcare for pregnancy-related issues can have serious consequences. Many pregnancy complications require timely intervention to prevent them from escalating into life-threatening situations. Delays in seeking care can allow existing conditions to worsen, potentially leading to more severe complications and poorer outcomes for both mother and baby. Early detection and intervention are crucial in managing many pregnancy complications. Fear-driven delays can lead to missed opportunities for early intervention, increasing the risk of adverse outcomes. Delayed care can increase the risk of severe complications such as preeclampsia, eclampsia, postpartum hemorrhage, and sepsis, all of which can be life-threatening. In the most severe cases, delayed healthcare seeking due to fear of COVID-19 can contribute to maternal death. Providing clear and accurate information about the risks of COVID-19 and the safety measures in place at healthcare facilities is crucial in alleviating fear and encouraging women to seek timely care. Healthcare providers need to build trust and confidence with their patients, addressing their concerns and reassuring them about the safety of seeking care. Making healthcare services more accessible and convenient, such as through telehealth options, can help reduce barriers to seeking care and address fear-driven delays. The COVID-19 pandemic presented an unprecedented challenge to healthcare systems globally. The rapid surge of COVID-19 patients placed immense strain on healthcare resources, forcing many facilities to make difficult decisions about resource allocation. This reallocation, while necessary to manage the influx of critically ill patients, may have inadvertently compromised the availability of essential maternal health services. The pandemic overwhelmed healthcare systems, with hospitals and healthcare facilities struggling to cope with the sheer number of COVID-19 patients requiring urgent care. Healthcare systems faced severe constraints in terms of hospital beds, medical equipment, and healthcare personnel. Healthcare administrators had to make difficult decisions about how to allocate scarce resources, often prioritizing the most critically ill patients, which frequently were those with severe COVID-19. To manage the surge of COVID-19 patients, many healthcare workers, including doctors, nurses, and midwives, were reassigned to COVID-19-related duties. This reassignment led to a shortage of skilled healthcare providers dedicated to providing maternal health services, potentially affecting the quality and availability of care for pregnant women. Healthcare workers faced immense pressure and long working hours, leading to burnout and fatigue, which may have further impacted the quality of care provided. The surge of COVID-19 patients requiring hospitalization led to a high demand for hospital beds, often exceeding capacity. This limited the availability of hospital beds for pregnant women, including those experiencing complications or requiring emergency obstetric care. Essential medical equipment, such as ventilators and oxygen supplies, were often in short supply,

potentially affecting the care of pregnant women with respiratory complications or those requiring intensive care. The reallocation of resources may have reduced access to essential maternal health services, including antenatal care, skilled birth attendance, and emergency obstetric care. Pregnant women may have experienced delays in receiving necessary treatment or interventions due to limited resources and staff availability. The shortage of healthcare personnel and essential equipment may have increased the risk of complications during pregnancy and childbirth. While the COVID-19 pandemic undoubtedly exacerbated maternal health risks, it is crucial to acknowledge the persistent underlying factors that contribute to maternal mortality, independent of the pandemic's influence. This study identified several such factors that demand focused attention and targeted interventions to safeguard the health and well-being of mothers. Advanced maternal age (35 years or older) is well-established as a risk factor for various pregnancy complications. Women of advanced maternal age have a higher risk of developing gestational diabetes, preeclampsia (a dangerous condition involving high blood pressure), and preterm birth. Older mothers may also have pre-existing health conditions that can complicate pregnancy and increase risks. Socioeconomic factors play a significant role in health outcomes. Women from lower socioeconomic backgrounds often face multiple barriers to accessing quality healthcare. Financial limitations can hinder access to essential healthcare services, including antenatal care, skilled birth attendance, and emergency obstetric care. Lower health literacy can impede a woman's understanding of health information and her ability to make informed decisions about her healthcare. Lack of reliable transportation can limit access to healthcare facilities, particularly for women in rural areas or those who lack personal vehicles. Education empowers individuals with knowledge and critical thinking skills, enabling them to make informed decisions about their health. Lower educational attainment can limit a woman's ability to understand and interpret health information, potentially hindering her ability to recognize warning signs or seek timely care. Education can also equip women with the skills to navigate the healthcare system effectively, advocating for their needs and accessing appropriate services. High parity, or a history of multiple pregnancies and births, can increase the risk of certain complications. The risk of uterine rupture, a life-threatening complication where the uterus tears open, is higher in women with multiple previous births. High parity can also increase the risk of postpartum hemorrhage, or excessive bleeding after childbirth. Regular antenatal check-ups are essential for monitoring the health of both mother and baby throughout pregnancy. Antenatal care allows for the early detection of potential complications, enabling timely intervention and management. Antenatal visits also provide opportunities for health education and counseling, empowering women with knowledge and support to make informed decisions about their care. Delivering at home without the presence of a skilled birth attendant significantly increases the risk of complications and maternal death. In the event of an emergency during childbirth, home deliveries lack the immediate access to emergency care and interventions available in a healthcare facility. Women who deliver at home are more vulnerable to complications such as postpartum hemorrhage, sepsis (severe infection), and obstructed labor, all of which can be life-threatening.[11-14]

This study's findings resonate with a growing body of research that has documented an alarming increase in maternal mortality rates (MMR) during the COVID-19 pandemic. Studies from various countries have reported similar trends, painting a grim picture of the pandemic's global impact on maternal health. These studies provide compelling evidence that the pandemic has exacerbated existing vulnerabilities in maternal health systems, particularly in settings already grappling with health inequities. One of the most alarming trends observed during the COVID-19 pandemic has been the global increase in maternal mortality rates (MMR). This disturbing phenomenon has been documented in numerous studies from diverse regions worldwide, highlighting the pandemic's far-reaching and detrimental impact on maternal health. Studies from various countries, including both

high-income and low-income settings, have consistently reported an increase in MMR during the COVID-19 pandemic. This convergence of evidence strongly suggests that the pandemic has had a widespread and detrimental effect on maternal health globally. The observed increase in MMR is not limited to a specific geographic region or type of healthcare system. It has been documented in countries with vastly different socioeconomic conditions, healthcare infrastructure, and pandemic response strategies. This consistency further strengthens the evidence that the pandemic has played a significant role in exacerbating maternal health risks worldwide. While the general trend of increasing MMR is consistent across studies, the magnitude of the increase varies. Some studies have reported modest increases, while others have documented more substantial rises in MMR during the pandemic period. The severity of the pandemic's impact on healthcare systems and populations varies across countries and regions. Areas with higher infection rates, overwhelmed healthcare facilities, and limited resources may experience more significant increases in MMR. The resilience of healthcare systems in different settings also plays a role. Healthcare systems with robust infrastructure, adequate staffing, and effective emergency response mechanisms may be better equipped to mitigate the pandemic's impact on maternal health. The pre-existing vulnerabilities of populations, such as high rates of poverty, limited access to healthcare, and existing health inequities, can further exacerbate the pandemic's effects on maternal health. The increase in maternal mortality rates (MMR) observed in this study is not an isolated phenomenon. Studies from various countries across the globe have reported similar trends, providing compelling evidence of the COVID-19 pandemic's widespread and detrimental impact on maternal health. These studies, conducted in diverse settings with varying socioeconomic conditions and healthcare systems, offer valuable insights into the complex interplay of factors contributing to increased maternal mortality during the pandemic. A study conducted in Brazil found that the MMR increased by 20% during the pandemic period. This alarming rise in maternal deaths highlights the pandemic's profound impact on maternal health in the country. The study attributed the increase in MMR to several factors, including disruptions in healthcare services, fear of contracting COVID-19 among pregnant women, and the reallocation of healthcare resources to pandemic management. These factors likely created barriers to accessing essential maternal healthcare services, potentially leading to delays in seeking care, missed or inadequate antenatal care, and difficulties in accessing skilled birth attendance and emergency obstetric care. A study in Colombia revealed a more significant increase in MMR, with a 30% rise during the pandemic. This study further highlighted the disproportionate impact of the pandemic on regions with high social vulnerability, underscoring the interplay between the pandemic's effects and existing health inequities. The findings from Colombia emphasize that the pandemic did not affect all populations equally. In regions already facing socioeconomic challenges and limited access to healthcare, the pandemic's impact on maternal health was particularly severe. This underscores the urgent need to address social determinants of health and ensure equitable access to quality healthcare services, especially during public health emergencies. Studies in the United States have also documented an increase in MMR, pregnancy-related complications, and maternal deaths during the COVID-19 pandemic. These studies have highlighted the pandemic's impact on access to care, mental health, and the quality of maternal healthcare services. Research from Mexico has shown an increase in maternal deaths and stillbirths during the pandemic, particularly among women with COVID-19 infection. These findings emphasize the direct and indirect effects of the pandemic on maternal and child health. Studies conducted in India have reported an increase in MMR and a decline in the utilization of antenatal and postnatal care services during the pandemic. These findings reflect the pandemic's impact on healthcare-seeking behavior and access to essential services. Research from South Africa has documented an increase in maternal deaths and stillbirths, as well as a decline in antenatal care attendance and facility-based deliveries during the pandemic. These findings

highlight the pandemic's multifaceted effects on maternal health in a resource-constrained setting. The COVID-19 pandemic has not only posed immediate threats to maternal health but has also laid bare the underlying vulnerabilities of maternal health systems worldwide. The pandemic has acted as a stress test, revealing critical weaknesses and exacerbating existing challenges in the provision of essential maternal healthcare services. The pandemic has brought to light pre-existing systemic weaknesses in maternal health systems, such as inadequate infrastructure, insufficient staffing, and limited resources. The pandemic has also exacerbated existing inequalities in access to maternal healthcare services. Vulnerable populations, such as women living in poverty, those in rural areas, and those facing discrimination, have been disproportionately affected by disruptions in care and limited access to essential services. The surge of COVID-19 patients has placed an immense burden on healthcare workers, leading to burnout, fatigue, and psychological distress. This has further strained maternal health services, as healthcare workers struggle to cope with the increased workload and the challenges posed by the pandemic. The pandemic has caused widespread disruptions in essential maternal healthcare services, including antenatal care, skilled birth attendance, and emergency obstetric care. Lockdowns, restrictions on movement, and fear of contracting COVID-19 have led to delays in seeking care for many pregnant women. These delays can have serious consequences, as timely intervention is crucial for managing pregnancy complications and preventing adverse outcomes. Disruptions in antenatal care services have resulted in missed or inadequate antenatal check-ups for many women. This can hinder the early detection and management of pregnancy complications, potentially increasing the risk of adverse outcomes for both mother and baby. Restrictions on movement and the closure or repurposing of some healthcare facilities have limited access to skilled birth attendants for many women. This can increase the risk of complications during childbirth, particularly for those without access to emergency obstetric care. The pandemic's impact on maternal health has been particularly severe in settings with existing health inequities. Women already facing multiple barriers to accessing quality healthcare, such as those living in poverty, those in rural areas, and those facing discrimination, have been disproportionately affected by the pandemic's disruptions. The pandemic has exacerbated existing barriers to accessing care, including financial constraints, limited health literacy, inadequate transportation, and cultural beliefs. These barriers can further delay or prevent women from seeking essential maternal healthcare services, increasing their risk of complications and adverse outcomes.[15-17]

Amidst the turmoil of the COVID-19 pandemic, the importance of ensuring access to quality maternal healthcare services has become even more apparent. The pandemic has disrupted healthcare systems, creating barriers to essential services and exacerbating existing inequalities. To safeguard the health and well-being of mothers, it is crucial to prioritize access to quality care, even during public health emergencies. Access to quality antenatal care, skilled birth attendance, and emergency obstetric care should be prioritized as essential maternal healthcare services. Antenatal care provides essential monitoring of both mother and baby throughout pregnancy, allowing for early detection and management of potential complications. Skilled birth attendance ensures safe deliveries and the ability to manage complications during childbirth, protecting the health of both mother and baby. Emergency obstetric care provides life-saving interventions in the event of complications during pregnancy or childbirth, reducing the risk of maternal death. Strategies should be implemented to ensure continuity of care for pregnant women, even during lockdowns or other disruptions caused by public health emergencies. Utilizing telehealth technologies can enable remote consultations, monitoring, and support for pregnant women, reducing the need for in-person visits and maintaining access to care during periods of restricted movement. Providing home-based care for certain pregnancy-related services can reduce the burden on healthcare facilities and minimize the risk of exposure to infectious diseases. Establishing alternative care

sites, such as temporary clinics or community health centers, can help to ensure continued access to essential services when primary healthcare facilities are overwhelmed or inaccessible. Barriers to accessing care, such as financial constraints, transportation challenges, and cultural beliefs, should be addressed to ensure equitable access to quality maternal healthcare services for all women. Financial constraints can be addressed through initiatives such as health insurance coverage, subsidies for healthcare services, and financial assistance programs. Transportation barriers can be overcome through strategies such as providing transportation vouchers, organizing community transport services, and improving public transportation infrastructure. Cultural barriers can be addressed through community engagement, culturally sensitive healthcare services, and education to dispel myths and misconceptions about maternal healthcare. Social determinants of health, such as poverty, education, and living conditions, play a significant role in shaping health outcomes, including maternal health. To achieve lasting improvements in maternal health, it is essential to address these underlying social determinants and tackle the root causes of health inequities. Targeted interventions are needed to address the specific vulnerabilities faced by women with low socioeconomic status, low educational levels, and those residing in rural areas. Interventions should be tailored to the unique needs and challenges of each vulnerable group. This may involve providing financial assistance, improving access to education and information, and strengthening community-based support systems. It is important to recognize that many women face multiple vulnerabilities. Interventions should address these intersecting challenges in a holistic and integrated manner. Efforts to improve socioeconomic conditions, such as poverty reduction programs, can have a significant impact on maternal health. Poverty can limit access to essential resources, such as food, housing, and healthcare, increasing the risk of adverse maternal health outcomes. Educational initiatives can empower women with knowledge, skills, and opportunities, improving their health literacy and enabling them to make informed decisions about their health. Social support services, such as childcare, elder care, and mental health counseling, can help to alleviate the burdens on women and families, reducing stress and improving overall well-being. Empowering women through education and information can enable them to make informed decisions about their health, seek timely care, and advocate for their needs. Providing women with access to resources, such as healthcare services, financial assistance, and social support, can help to overcome barriers and improve their ability to manage their health. Promoting women's self-efficacy, or their belief in their ability to manage their health, can encourage them to take an active role in their healthcare and seek support when needed. Strong and resilient health systems are the bedrock of effective maternal healthcare. Investing in health infrastructure, human resources, and information systems is essential to ensure that healthcare systems can withstand shocks, such as pandemics or natural disasters, and provide quality, accessible care to all women. Investments in health infrastructure, including hospitals, clinics, and medical equipment, are crucial to ensure the availability of essential maternal healthcare services. Expanding access to healthcare facilities, particularly in underserved and rural areas, can reduce geographical barriers to care and ensure that women have access to essential services regardless of their location. Upgrading existing healthcare facilities to meet modern standards and equipping them with essential medical technologies can improve the quality and safety of maternal healthcare services. Investing in the training and development of healthcare personnel, including doctors, nurses, and midwives, is essential to ensure an adequate workforce to provide quality maternal healthcare services. Providing specialized training in maternal healthcare can enhance the skills and knowledge of healthcare providers, enabling them to provide competent and compassionate care to pregnant women. Implementing strategies to attract and retain healthcare workers in underserved areas can help to address workforce shortages and ensure equitable access to care. Strengthening health information systems can improve the monitoring of

maternal health outcomes, enabling the identification of trends, risk factors, and areas for improvement. Robust health information systems can facilitate data-driven decision-making, informing policies and interventions to improve maternal health outcomes. Strengthening information systems can enhance the coordination of care between different healthcare providers and facilities, ensuring seamless transitions and continuity of care for pregnant women. Building resilience into healthcare systems is crucial to ensure that they can withstand future shocks, such as pandemics or natural disasters. Diversifying supply chains for essential medical equipment and supplies can reduce dependence on single sources and minimize disruptions in the event of a crisis. Developing surge capacity plans can ensure that healthcare systems can rapidly expand their capacity to manage increased demand for services during emergencies. Investing in emergency preparedness, including training healthcare workers, stockpiling essential supplies, and establishing communication protocols, can enhance the ability of healthcare systems to respond effectively to crises.[18-20]

5. Conclusion

In conclusion, this study underscores the detrimental impact of the COVID-19 pandemic on maternal mortality rates in Indonesia. The pandemic exacerbated existing challenges in maternal healthcare access and delivery, contributing to a significant increase in maternal deaths. These findings highlight the urgent need for interventions to strengthen maternal health systems and ensure access to quality care, especially during public health emergencies. Several key takeaways emerge from this study. First, the pandemic period was independently associated with an increased risk of maternal mortality, even after adjusting for potential confounders. Second, several well-established risk factors for maternal mortality, such as older maternal age, low socioeconomic status, and inadequate antenatal care attendance, were independently associated with higher maternal mortality risk. Finally, the study underscores the vulnerability of maternal health systems to disruptions caused by public health emergencies, particularly in settings with existing health inequities. These findings have important policy and practice implications. Continued efforts are needed to ensure access to quality maternal healthcare services, particularly for vulnerable populations. Future research should investigate the specific causes of maternal death during the pandemic and evaluate the effectiveness of interventions to improve maternal health outcomes in similar settings.

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