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The impact of the COVID-19 pandemic on maternal healthcare utilization in Ngawi regency, Indonesia: an interrupted time-series analysis

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Abstract

Purpose: The burden of COVID-19 threatened the health system and reversed gains in healthcare services. It led to significant disruptions in access and delivery of maternal healthcare. In consequence, the Maternal Mortality Rate (MMR) in Ngawi Regency is 276.9 per 100,000 live births, surpassing the MMR for East Java, and the coverage of maternal health indicators has declined during the pandemic. This study aims to investigate the effect of the COVID-19 pandemic on maternal healthcare in Ngawi Regency, Indonesia. **Methods:** An Interrupted Time-Series (ITS) design was used to assess the impact of the COVID-19 outbreak on the outcome variable, the number of women who utilized maternal healthcare services. Data were collected from January 1st, 2019, to December 31st, 2021. An interrupted-time series analysis was conducted using an Autoregressive Integrated Moving Average (ARIMA) model. **Results:** A significant decline of 54 women (95% CI -80.45 to -27.06) in fourth maternal healthcare utilization at pandemic onset. The following reductions were also observed in health-facility delivery and postnatal care utilization: 66 women (95% CI: -112.04 to -20.51) and 106 women (95% CI: -184.60 to -26.49); however, no significant changes in first antenatal care or obstetric-complication treatment at pandemic onset. The statistically significant reductions in fourth antenatal care, health-facility delivery, and postnatal care utilization were 3 (95% CI: -5.14 to -1.67), 7 (95% CI: -11.66 to -1.85), and 11 (95% CI: -15.50 to -5.51) women, respectively. **Conclusion:** The COVID-19 pandemic has disrupted the fourth antenatal care, health facility delivery, and postpartum care in Ngawi Regency. The disruption due to mobility restrictions, a shift in focus and health resources towards combating COVID-19, and a decrease in the frequency of antenatal care visits.

Keywords: antenatal care; COVID-19; health services; maternal health; maternal mortality

INTRODUCTION

Reducing the maternal mortality ratio (MMR) is a global health priority, as maternal death is an outcome that strongly impacts health services, the economy, and society. In this regard, the Sustainable Development Goals (SDGs) aim to reduce the global MMR to less than 70 per 100,000 live births by 2030, despite the Global Maternal Mortality Rate (MMR) from the Global Burden of Disease (GBD) study in 2021 being 147.77 per 100,000 live births. In 2021, Indonesia's Maternal Mortality Rate (MMR) increased by 22.83% to 226 per 100,000 live births, compared with 2020. According to the Health

Office of East Java Province, the maternal mortality rate in Ngawi Regency was 276.9 per 100,000 live births, surpassing the rate for East Java (234.7 per 100,000 live births) in 2021. The rate was also higher than the maternal mortality rate of Ngawi Regency in 2019 (84.4 per 100.000 live-births) [12]. Before the pandemic, first antenatal care, fourth antenatal care, obstetric-complication treatment, health-facility delivery, and postnatal care coverage in Ngawi Regency reached 99.63%, 90.9%, 112.8%, 96.4%, and 95.0%, respectively. During the pandemic situation in 2021, the coverage rates declined (except for obstetric complication treatment) to 96.0%, 89.2%, 106.0%, 93.5%, and 89.4%4.

The World Health Organization (WHO) declared Coronavirus Disease 2019 (COVID-19) as a Public Health Emergency of International Concern (PHEIC) on January 30th 2020 [1]. The disease has infected over 291 million (of which over 4 million were from Indonesia) and resulted in over 5 million deaths as of December 31st, 2021 [2]. In Indonesia, COVID-19 has affected over 4 million cases and over 144.000 deaths3. As part of the regency of East Java, one of the provinces in Indonesia with the highest total COVID-19 cases in the early pandemic era, Ngawi Regency reported 7,614 cases and 829 deaths as of December 31st 2021 [3]. According to the Health Profile of Indonesia and the Health Profile of Ngawi Regency, Ngawi Regency had a higher case fatality rate (10.89%) than East Java (7.4%).

In comparison, its recovery rate (90.24%) was lower than that of East Java (92.5%) [3,4]. The pandemic situation has adverse effects on the health outcomes of prepartum, labor, and postpartum women because this group is one of the high-risk susceptible groups to have COVID-19. As of September 14th, 2020, the Task Force for the Acceleration of COVID-19 Handling reported that 4.9% of pregnant women in Indonesia had been infected with COVID-19 [5]. As a result, around 40% maternal mortality cases in Indonesia were caused by COVID-19 [6]. Another study showed that COVID-19 is associated with adverse outcomes in pregnancy that can affect both the mother and her newborn, such as pre-eclampsia, gestational diabetes, premature birth, and low birth weight [7]. Therefore, the trend of Maternal Mortality Rate (MMR) increased during the COVID-19 pandemic. COVID-19 has intensified these challenges, exposing weaknesses in the health system and impacting access to adequate care during pregnancy, childbirth, and the postpartum period. However, inequities in pregnant and postpartum women's healthcare coexist with the advances, and preventable maternal deaths prevail in the country.

The emergence of COVID-19 has disrupted the health, social, and economic sectors for one-third of the world's population due to mobility restrictions [8]. In Indonesia, this policy was known as the Large-Scale Social Restrictions (PSBB). To limit mobilization, this policy also affected individual and social quality of life and led to the disrepair of many economic and healthcare systems worldwide, notably maternal health services. Disruptions in maternal health services have been of major concern since the COVID-19 pandemic began in early 2020. The burden of COVID-19, which required a shift in resources (budgets, health workers, facilities, logistics, and supplies), threatened the health system and reversed gains in healthcare services [9]. It led to significant disruptions in access and delivery of maternal healthcare. In a survey conducted by WHO, over a third of countries reported disruptions to antenatal and postnatal care, while 25% countries reported disruptions in health-facility delivery [10].

The downward trend in healthcare supply was driven by changes in treatment policies and shortages of medical equipment, health products, and personal protective equipment (PPE) for healthcare workers. Furthermore, many facilities may have experienced a decline in demand due to mobility restrictions, financial barriers, and fear of COVID-19 infection [11]. Consequently, there was a decline in the percentage of maternal healthcare utilization, which also contributed to the rising trend in maternal mortality during the COVID-19 pandemic, notably in Ngawi Regency. Previous studies assessing the effect of the COVID-19 pandemic on maternal healthcare utilization in Rwanda and Ethiopia revealed reductions in antenatal care (ANC), facility-based delivery, and postnatal attendance during the early period of the pandemic (March to June 2020) [13,14]. In Indonesia, studies in Tangerang Regency and South Tangerang City also showed a declining trend in ANC-1, ANC-4, and health-facility delivery attendance in the early period of the COVID-19 pandemic (Maret-Mei, 2020) [15,16].

Previous studies on the effect of the COVID-19 pandemic on maternal healthcare utilization using interrupted time-series analysis are few. In addition, we find that most research studies focus only on antenatal care and health-facility delivery. Whereas maternal health indicators in Indonesia also include obstetric complication treatment and postnatal care. Our study aims to investigate the effect of the COVID-19 pandemic on maternal healthcare in Ngawi Regency. This study provides valuable insight into the impact of COVID-19 on healthcare utilization in Ngawi Regency. It can be helpful for other regions in Indonesia and for the Health Office of Ngawi Regency to develop policies to mitigate the pandemic's long- and short-term impacts.

METHODS

Study design and setting

An Interrupted Time-Series (ITS) design was used to assess the impact of the COVID-19 outbreak on outcome variables, the number of women who utilized maternal healthcare services. The ITS study design was selected because it is suitable for evaluating antenatal care before and after COVID-19 in Ngawi Regency and for determining whether COVID-19 affected trends in maternal health service visits. The determination of the periods before and after the intervention was based on data from the first cases reported in Ngawi Regency, as reported in news available at [https://jatim.antaranews.com].

This study was conducted in Ngawi Regency, one of the regencies in East Java Province, Indonesia. The regency covers an area of 1,298.58 km2. 864,643 people were living in this area in 2021. The administrative area is divided into 19 districts and 217 villages. There are 24 community health centers and 3 hospitals spread across the districts.

Variables

Data were abstracted from the Local Area Monitoring-Maternal Child Health Report (PWS-KIA) for Maternal Health Indicators in Ngawi Regency, prepared by the Ngawi Regency Health Office. This monthly routine report contains the number of women who received each type of maternal healthcare service in healthcare facilities. These types of maternal healthcare services are the outcome variables for this study, i.e., first antenatal care (ANC-1), fourth antenatal care (ANC-4), health-facility delivery, treatment of obstetric complications, and postnatal care.

Data were collected from January 1st, 2019, to December 31st, 2021. Therefore, 36 data sets were obtained for each outcome variable, i.e., 15 months before the pandemic and 21 months after. Data collection was conducted using the Local Area Monitoring-Maternal Child Health Report (PWS-KIA) for Maternal Health Indicators in Ngawi Regency, provided by the Ngawi Regency Health Office. Health officers then performed data cleaning to ensure there was no missing data. To ensure the data's validity, we previously verified it with the Person in Charge of the Maternal and Child Health Program at the Ngawi Regency Health Office.

Data analysis

This study design involves a statistical comparison of time trends before and during the COVID-19 pandemic. The segmented regression model was used to estimate the impact of the COVID-19 pandemic on maternal healthcare utilization. The interrupted time-series models require at least three independent variables [17] in which :

$\beta 0$ estimates the baseline level (intercept) of the outcome variable

$\beta 1$ estimates the slope of the outcome variable before the pandemic (the pre-existing trend; 15 months before the COVID-19 first case was announced in Ngawi Regency)

$\beta 2$ estimates the change in the outcome variable's value in the first month after the COVID-19 pandemic was announced.

$\beta 3$ estimates the change in trend or slope in the post-interruption time (21 months after the COVID-19 pandemic was announced), compared to the pre-pandemic trend

$\beta 1 + \beta 3$ estimates the trend or slope of the outcome variable in the post-interruption time

T is the time trend variable, which ranges in value from 1 (first observation) to 36 (last observation)

Xt is a binary variable that represents before and after the first case was announced (Xt = 0 for before and Xt = 1 for after)

Xt Tt is coded as 0 for the period before the COVID-19 first case and assigned a value between 1 (first observation after the COVID-19 first case was announced) and 20 (last observation after the COVID-19 first case was announced)

Yt is the dependent variable (the number of women who utilized maternal healthcare services in a given month).

The first COVID-19 case occurred on April 30th, 2020 (at the end of the month). This indicates that from April 1st to 29, 2020, no cases were found, so the pre-intervention period (code 0) was set at 15 months, including the first COVID-19 case in Ngawi Regency (April 30th, 2020). This was done to minimize bias from the intervention effect, as the first case occurred on only one day in April 2020, specifically April 30th, 2020.

The dependent variables used in the study include the number of K1 antenatal care (ANC-1) visits, the number of K4 antenatal care (ANC-4) visits, the number of obstetric complications handled, the number of deliveries assisted by health workers, and the number of postnatal care visits. Independent variables include Time, which measures the baseline trend before COVID-19. Phase/intervention: measures the immediate change in level after COVID-19. Interaction: measures changes in trends after COVID-19. The data used are secondary, in the form of monthly (PWS-KIA) reports from 2019-2021, originating from the Ngawi District Health Office. Data analysis steps are: 1) Initial exploration of data trends to determine trend patterns,

seasonal fluctuations, and outliers visually; 2) Examination of data stationarity using autocorrelation function (ACF) plots and the Ljung-Box Q test. A model without differencing (d=0) is used if the Ljung-Box test results show a p-value > 0.05. If the p-value is ≤ 0.05, then a differencing model (d = 1) can be used. This test is performed to ensure that the model used is white noise and there is no autocorrelation; 3) ARIMA Model Selection. Candidate ARIMA models were identified based on ACF & PACF patterns. Several candidate models (ARIMA (0,0,0), ARIMA (1,1,0), ARIMA (0,1,1), etc.) were estimated.

Interrupted Time-Series Analysis consists of: 1) Data coding—code 1: months after the first case appeared (May 2020 to Dec 2021). Code 0: months before & when the first case appeared (Jan 2019 – April 2020). ITS analysis was performed by trying several selected ARIMA candidate models; 2) Compare models using BIC, RMSE, and check residual diagnostics using the Ljung-Box Test. Model selection was based on the lowest Bayesian Information Criterion (BIC), smallest Root Mean Square Error (RMSE), and a non-significant Ljung–Box test for residual independence (p-value > 0.05); 3) Estimate intervention effect. If the results of the analysis on each independent variable (β0, β1, β2, and β3) are significant (p-value < 0.05), then the parameter estimates can indicate a statistically significant increase or decrease in visits.

Statistically significant steps occur when the intervention has an immediate (positive or negative) impact on the series. Statistically significant ramps occur when the intervention has a progressive (positive or negative) impact on the series, whether independently or in conjunction. When neither measure is significant, the intervention (or the factor under test) is interpreted as not associated with the time series.

An interrupted-time series analysis was conducted using an Auto-regressive Integrated Moving Average (ARIMA) model to estimate the intervention effects. The interruption point was considered on April 30th, 2020, when the first case was confirmed in Ngawi Regency. To examine the autocorrelation, we visually inspected the ACF and PACF plots. In addition, to check the residuals from the chosen model, we plot the ACF of the residuals. To choose the best model, we considered the BIC and RMSE values (lower is better) in data analysis using SPSS Software version 18.

RESULTS

Figure 1 shows that the trends in antenatal care visits (K1, ANC-1) and K4 (ANC-4), obstetric complications managed, deliveries assisted by healthcare workers, and postnatal care visits in Ngawi Regency decreased during COVID-19 compared with pre-COVID-19 (Jan 2019 to February 2020). Table 1 reports the average number of women who utilized maternal healthcare before and during the COVID-19 pandemic. It suggested that while the average number of women who utilized antenatal care-1 (ANC-1) before the COVID-19 pandemic was 956.73, the corresponding figure during the pandemic was 891.86. A 6.78% decrease in the average number of women who utilized the first antenatal care per month. A decreasing trend was also observed in the average number of women who utilized the fourth antenatal care visit, obstetric-complication treatment, health-facility delivery, and postnatal care. However, the most significant gap between before and during the COVID-19 pandemic was in the treatment of obstetric complications (8.73%).

Table 2 presents the results of the time-series analysis for the first antenatal care visit. The results indicated that approximately 1011 women utilized first antenatal care during the study period. For this indicator, this study observed a decreasing trend before the COVID-19 pandemic, although it was not statistically significant (95% CI -14.82 to 1.04, p=0.086). A month after the first case was announced, this indicator showed a statistically non-significant increase of 14 women (95% CI -82.99 to 111.95, p=0.764). Compared with the pre-COVID-19 period, the monthly trend in the number of first ANC utilization after the COVID-19 pandemic increased by 5 women, although this was not statistically significant (95% CI: -4.99 to 14.51, p=0.327). After the pandemic, 2 fewer women used the first ANC each month. For the variable antenatal care visits K-1 (ANC-1), we used an ARIMA q(0,0,0) model with predictors time, phase, and their interaction. This model was chosen based on the lowest BIC and RMSE values (BIC: 8,944 and RMSE: 71,746) as well as residuals that are white noise (Ljung-Box p-value = 0.329).

Table 2 presents the results of the time-series analysis for the fourth antenatal care visit. The results indicated an estimated initial number of women who utilized the fourth antenatal care during the study period was 871. Our study observed a decreasing trend before the COVID-19 pandemic, although it was not statistically significant (95% CI: -0.57 to 3.45, p=0.159). A month after the first case was announced, this indicator showed a statistically significant decrease of 54 women (95% CI: -80.45 to -27.06, p=0.000). Compared with the pre-COVID-19 period, the number of fourth antenatal care visits after the COVID-19 pandemic declined by 3 women per month (95% CI: -5.14 to -1.67, p=0.000). After the pandemic, 2 fewer women used the fourth antenatal care each month. For the variable on

antenatal care visits K-4 (ANC-4), we used an ARIMA (2,0,1) model. This model was chosen based on the lowest BIC and RMSE values (BIC: 7,918; RMSE: 36,991) and white-noise residuals (Ljung-Box p-value = 0.957).

Table 2 presents the results of time-series analysis for obstetric-complication treatment. The initial number of women treated for an obstetric complication was estimated at 222. For this indicator, this study observed a decreasing trend before the COVID-19 pandemic, although it was not statistically significant (95% CI -3.11 to 2.15, p=0.722). A statistically insignificant increase of one more woman receiving treatment for obstetric complications was observed in the first month after the first case of COVID-19 was announced (95% CI: -31.38 to 33.23, p=0.956). Compared with the pre-COVID-19 period, the monthly trend in the number of women receiving treatment for obstetric complications after the COVID-19 pandemic decreased by 1 woman. However, this was not statistically significant (95% CI: -4.50 to 1.97, p=0.449). After the pandemic, one fewer woman received treatment for obstetric complications each month. For the variable on maternal complication handling service visits, we used an ARIMA(0,0,0) model. This model was selected based on the lowest BIC and RMSE values (BIC: 6,815; RMSE: 24,744) and white-noise residuals (Ljung-Box p-value = 0.091).

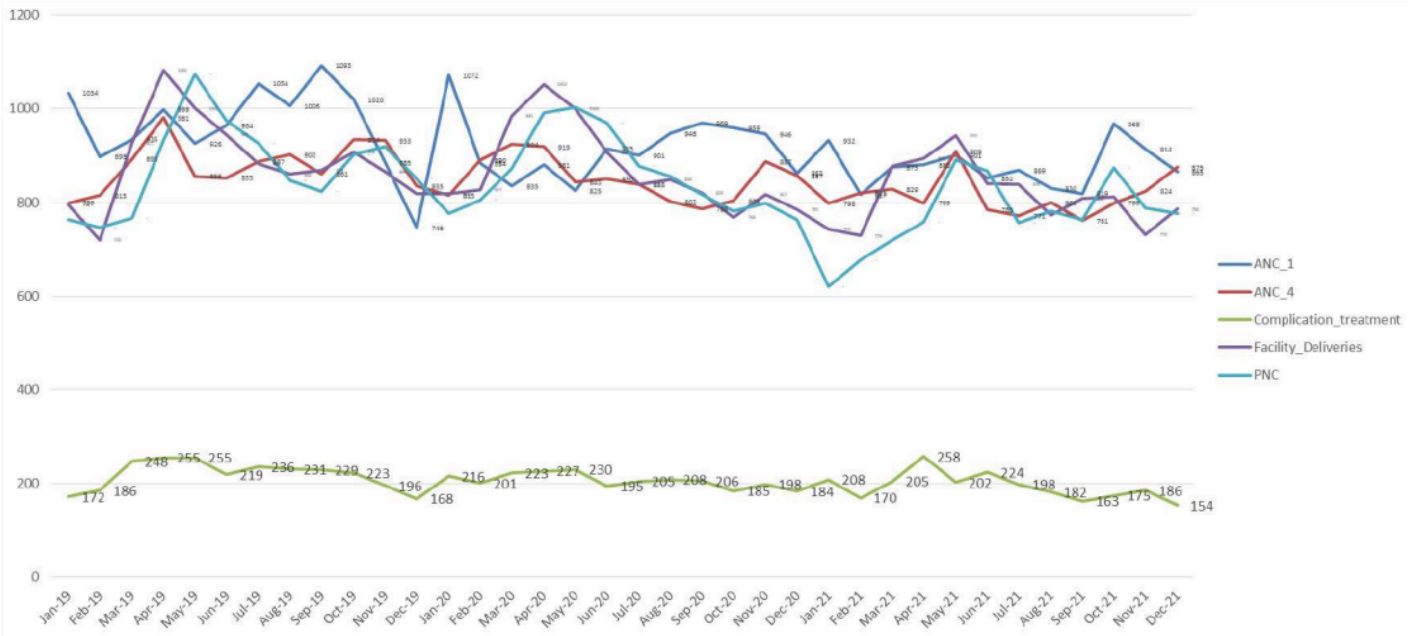

Figure 1. Tren of antenatal care visits K1 (ANC-1), K4 (ANC-4), obstetric complications managed, deliveries assisted by healthcare workers, postnatal care visits in Ngawi Regency from January 2019 - December 2021 (before and during the COVID-19 pandemic)

Table 1. Descriptive summary of the average number of women utilized maternal healthcare before and during the COVID-19 pandemic

Variable	Pre-COVID-19	During COVID-19	Change(%)
First ANC (ANC-1)	956.73	891.86	-6.78
Fourth ANC (ANC-4)	878.53	826.48	-5.92
Obstetric-complication treatment	217.20	198.24	-8.73
Health-facility delivery	887.00	838.81	-5.43
Postnatal care	865.40	815.67	-5.75

Table 2 presents the results of the time-series analysis for healthcare deliveries. The initial number of women who gave birth at healthcare facilities was estimated at 865. Before the pandemic started, there had been an increase of 4 women who gave birth at healthcare facilities. This trend was statistically significant (95% CI 0.70 to 7.15, p=0.023). At the start of the COVID-19 pandemic, the number of women who gave birth in healthcare facilities decreased by 69 (95% CI: -104.87 to -32.73, p=0.001). Compared with the pre-COVID-19 pandemic, the monthly trend in the number of women who gave birth at healthcare facilities after the pandemic declined by 7 women (95% CI: -10.72 to -3.16, p=0.001). This study also found that the number of women who gave birth at healthcare facilities declined by 3 women every month during the pandemic. For the variable of childbirth visits at healthcare facilities, we used an ARIMA (0,0,0) (1,0,0) model. This model was chosen based on the lowest BIC value (8.84), white noise residuals (Ljung-Box p-value =

0.21), and significant seasonal components (seasonal AR lag 12, p-value < 0.001).

Table 2 presents the results of time-series analysis for postnatal care utilization. The results indicated an initial estimate of 837 women who utilized postnatal care during the study period. Our study found that the number of women who utilized postnatal care before the COVID-19 pandemic increased by 6 women every month (95% CI 0.63 to 11.80, p=0.031). The number of postnatal utilization decreased by 106 women per month after the first case was announced (95% CI: -184.60 to -26.49, p=0.011). Compared with the pre-COVID-19 trend, the monthly trend decreased by 11 women after the COVID-19 pandemic (95% CI: -15.50 to -5.51, p=0.000). In addition, a decline of 4 women per month was observed following the COVID-19 pandemic. For the postpartum care visit variable, we used the ARIMA (2,0,1) (1,0,0) model. This model was selected based on the lowest BIC value (8.84), white-noise residuals (Ljung-Box p-value = 0.456), and a significant seasonal component (seasonal AR lag 12, p-value < 0.001).

Table 2. Parameter estimates of interrupted time-series analysis for first and fourth antenatal care utilization, obstetric-complication treatment, health-facility delivery, and postnatal care utilization using the announcement of the COVID-19 pandemic as the interruption

Variable	Interrupted Time-Series (ITS) analysis			
	Estimate	SE	95% CI	*p*
	First antenatal care utilization			
Intercept, β_0	1010.60	37.62	933.86 to 1087.33	0.000
Pre-COVID-19 slope, β_1	-6.89	3.89	-14.82 to 1.04	0.086
Change in the level of the outcome variable immediately after the COVID-19 pandemic, β_2	14.48	47.79	-82.99 to 111.95	0.764
Monthly change in trend, β_3	4.76	4.78	-4.99 to 14.51	0.327
Post-COVID-19 linear trend (β_1+ β_3)	-2.13			
	Fourth antenatal care utilization			
Intercept, β_0	871.59	9.18	852.86 to 890.31	0.000
Pre-COVID-19 slope, β_1	1.44	0.99	-0.57 to 3.45	0.159
Change in the level of the outcome variable immediately after the COVID-19 pandemic, β_2	-53.76	13.09	-80.45 to -27.06	0.000
Monthly change in trend, β_3	-3.41	0.85	-5.14 to -1.67	0.000
Post-COVID-19 linear trend (β_1+ β_3)	-1.97			
	(Obstetric-complication treatment)			
Intercept, β_0	221.93	12.976	196.47 to 247.33	0.000
Pre-COVID-19 slope, β_1	-0.48	1.34	-3.11 to 2.15	0.722
Change in the level of the outcome variable immediately after the COVID-19 pandemic, β_2	0.92	16.48	-31.38 to 33.23	0.956
Monthly change in trend, β_3	-1.26	1.65	-4.50 to 1.97	0.449
Post-COVID-19 linear trend (β_1+ β_3)	-1.74			
	(Health-facility delivery)			
Intercept, β_0	864.52	28.22	809.21 to 919.84	0.000
Pre-COVID-19 slope, β_1	3.92	1.64	0.70 to 7.15	0.023
Change in the level of the outcome variable immediately after the COVID-19 pandemic, β_2	-68.80	18.40	-104.87 to -32.73	0.001
Monthly change in trend, β_3	-6.94	1.93	-10.72 to -3.16	0.001
Post-COVID-19 linear trend (β_1+ β_3)	-3.02			
	(Postnatal care utilization)			
Intercept, β_0	836.89	24.71	786.49 to 887.28	0.000
Pre-COVID-19 slope, β_1	6.22	2.74	0.63 to 11.80	0.031
Change in the level of the outcome variable immediately after the COVID-19 pandemic, β_2	-105.55	38.76	-184.60 to -26.49	0.011
Monthly change in trend, β_3	-10.51	2.45	-15.50 to -5.51	0.000
Post-COVID-19 linear trend (β_1+ β_3)	-4.29			

DISCUSSION

The research findings indicate that maternal healthcare in Ngawi Regency has been disrupted due to the COVID-19 pandemic. This study also found a decrease in several maternal health indicators during the pandemic. Specifically, there were reductions in the first antenatal care (6.78%), fourth antenatal care (5.92%), obstetric-complication treatments (8.73%), health-facility delivery (5.43%), and postnatal care (5.75%). This study showed that fourth maternal healthcare utilization, health-facility delivery, and postnatal care utilization decreased statistically significantly due to the COVID-19 pandemic. Similar reductions in the utilization of maternal healthcare services have also been observed in studies from other countries. Compared to the pre-COVID-19 pandemic situation, the number of fourth antenatal care and health-facility deliveries decreased every month. These results were similar to an interrupted time-series analysis study in Mexico. The number of maternal

healthcare utilization and health-facility deliveries decreased by 27% and 10% during the COVID-19 pandemic [18]. In addition, this study identified a decline in health-facility deliveries during the COVID-19 pandemic compared to pre-pandemic levels. A study in low- and middle-income countries also found that 7 of 18 countries (including Afghanistan, Bangladesh, and Haiti) experienced a decline in postnatal care visits during the COVID-19 pandemic [19]. The number of women who utilized fourth antenatal care, health-facility delivery, and postnatal care was significantly changed by the onset of the COVID-19 pandemic. A study in Southern Iran by Yadollahi et al. reported a decline in utilization of antenatal and postnatal care at the start of the pandemic [20]. Another study in Mozambique also showed that the monthly number of facility deliveries decreased by 71.1 visits at the onset of the pandemic [21].

The COVID-19 pandemic led to a decrease in healthcare utilization in the early period due to the Large-Scale Social Restrictions (PSBB) policy implemented by the central government on March 31st 2020. The implementation of mobility restrictions coincided with the local burden of COVID-19 cases and deaths, causing widespread concern. This may cause mothers to feel anxious and fearful about contracting the virus, leading them to avoid visiting healthcare facilities [22]. According to women, three primary obstacles to obtaining maternal and child healthcare services during the pandemic [23]. These include limited transportation facilities, delayed services, and fear of contracting COVID-19. Consequently, most mothers are unable to attend their scheduled check-ups at healthcare facilities and must borrow money to access private clinics. The pandemic crisis triggered misery across society, especially in the economic sector, as it led to income losses and reduced purchasing power. A study across three districts in Indonesia found that limited economic capacity was one of the factors inhibiting women's access to maternal health services [22]. Mass layoffs of working mothers or husbands can significantly reduce family income. According to a study by [24], mothers with higher economic status have a 1.68 times greater chance of accessing postnatal services. Communities with better economic conditions tend to be able to pay for health services, including postnatal care. Although the National Health Insurance (JKN) program covers health care costs in Indonesia, additional expenses (such as transportation and PPE) remain.

Limited availability of health personnel and Personal Protective Equipment (PPE) impacts the implementation of health services during the pandemic [25]. The surge in COVID-19 cases led health facilities to inevitably shift their focus towards controlling the disease. As a result, several services had to be postponed or closed due to limited isolation rooms and the need to prioritize allocating health workers to control the surge in COVID-19 cases [26]. Apart from that, the scarcity of Personal Protective Equipment (PPE) during the early stages of the pandemic hindered the delivery of health services. Many health workers were unable to use complete PPE, so the risk of infection increased and caused a spike in the number of confirmed cases and deaths among health workers due to COVID-19. During the pandemic, the shortage of Personal Protective Equipment (PPE) also led many mothers to avoid visiting healthcare facilities. They were concerned about the risk of contracting COVID-19 because health workers did not use PPE and had doubts about the equipment's sterility during the pandemic [27].

Limited access to healthcare facilities led to decreased routine visits for maternal healthcare. A study conducted in Thailand found that only 5.1% of the respondents followed the recommended three postpartum visits (within 42 days), whereas 40.0% attended only one visit [28]. Apart from economic factors, postnatal care visits were also influenced by the frequency of antenatal care visits [24], and a complete maternal healthcare utilization visit increased the likelihood of mothers receiving postnatal care as recommended by 1.92 times. Mothers who received comprehensive antenatal care (ANC) $\geq$4 times were more likely to receive counselling and information on postnatal health risks, which can motivate them to attend all postnatal visits [29]. The study's graph shows a decline in the number of fourth antenatal and postnatal visits during the early stages of the pandemic. It suggests that the decrease in the number of fourth antenatal visits may also affect the mother's attendance at postnatal visits. This condition concerns the continuity of essential services.

Limited access to health services led to declining health-facility deliveries, resulting in more mothers giving birth at home due to safety concerns [27]. During a pandemic, people were likely to use health services solely for emergencies to reduce the risk of COVID-19 transmission in healthcare facilities [30]. This study indicates that the decrease in the first antenatal care trend occurred only a month after the first case appeared. It suggests that while some mothers might have deferred their visits to other types of maternal healthcare services, they did not forget to have at least one pregnancy check-up [31].

The reduction in the frequency of health service visits by maternal groups has reduced exposure to health information and the provision of micronutrient

supplements from health facilities. This situation also made it more challenging for healthcare workers to recognize the warning signs of potential complications that pregnant women, postpartum mothers, and newborn babies might experience [32]. Consequently, obstetric complications also increased. According to [7], pregnant women who contract COVID-19 are at a higher risk of experiencing severe pregnancy complications that could affect both the mother and the fetus. These complications include preeclampsia, gestational diabetes, premature birth, and low birth weight babies. This finding could help explain why the graph depicting obstetric complications before and during the COVID-19 pandemic did not show a significant difference. Findings in this study indicate disruptions in access to services during the COVID-19 pandemic, evidenced by a decrease in antenatal care (ANC) visits due to social restrictions, pregnant women being afraid to visit health facilities, disruptions in transportation and emergency referrals, healthcare workers being reassigned to handle COVID-19 patients, labor rooms being repurposed, limited availability of health personnel and Personal Protective Equipment (PPE)resulting in an increased risk of maternal death. Additionally, some low-middle-income countries experienced an increase in untreated complications, delays in emergency obstetric referrals, and a spike in maternal and newborn mortality, which impacts the resilience of the health system.

During the first quarter of the pandemic, the implementation of health services faced numerous challenges. It resulted in a societal process of adaptation and learning. At the beginning of the pandemic, there was much uncertainty among governments, healthcare systems, and individuals due to limited knowledge about COVID-19. However, as more information became available, people's perceptions and behaviours changed [31]. Consequently, preparedness for future crises, governments, and healthcare facilities have begun to improve their approaches to providing health services during the pandemic. During the pandemic, healthcare services implemented various adaptations. Some adaptations include combining different health services into a single visit or modifying services to engage the community [31]. The reduction in maternal healthcare utilization requires continuous monitoring of potential long-term impacts. Better preparation strategies are also needed to reduce adverse effects on health services during future health crises. Several policy responses can help mitigate disruptions to health services during the pandemic. These include strengthening primary health services, investing in essential public health functions, and utilizing digital tools and systems. In Indonesia, several primary health facilities have initiated telemedicine, online-based services, and home-visit programs by village midwives and health cadres to monitor maternal health during the pandemic. These strategies should be accompanied by public campaigns across various media platforms, urging people to seek health services when needed, while controlling excessive news exposure to reduce the fear of seeking treatment in health facilities.

According to this study, based on data, there has been limited research examining the impact of the COVID-19 pandemic on maternal healthcare utilization in Indonesia using interrupted time-series analysis. Our study employs time-series analysis and statistical methods, using all maternal health indicators to provide an objective understanding of the pandemic's impact on mothers. The findings of this research still require significant development and exploration, especially in statistical analysis and research design. This research also did not consider monthly COVID-19 case and death data due to limitations, and does not account for local mobilization restriction policies. The COVID-19 pandemic has exposed vulnerabilities in maternal health services. An investigation into the barriers and drivers of service resilience is needed to prepare the health system for future crises. It is also important to conduct qualitative research to explore factors influencing the use of healthcare services during the pandemic. Although these studies can be challenging, exploring them would be extremely beneficial for enhancing Indonesia's maternal health-care system.

CONCLUSION

This study reveals that the COVID-19 pandemic has disrupted the fourth antenatal care, health facility delivery, and postpartum care in Ngawi Regency. As a result, the number of mothers using these services has declined during the pandemic. The disruption might be due to mobility restrictions, a shift in focus and health resources towards combating COVID-19, and a decrease in the frequency of antenatal care visits. Identifying vulnerable and resilient maternal health indicators is crucial for targeting interventions and prioritizing resources to minimize the risk of further adverse impacts post-COVID-19. Additionally, efforts to prevent and mitigate should be carried out by optimizing door-to-door healthcare services for pregnant women while still prioritizing the safety of healthcare workers, which can be organized through mobile community health centers. Furthermore, policymakers should issue circulars mandating family involvement in assisting pregnant women to facilitate access to

healthcare services, especially antenatal care. This step serves as a strategy to strengthen the continuity of maternal health services during future public health crises.

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Authors' contribution
E.Q, L.N.P, D.A: participated in the conception and design of the review. R, Y.N.R, E.A, L.A: performed the literature review. E.Q, L.N.P, D.A, R, Y.N.R, E.A, L.A drafted the manuscript. E.Q., L.N.P., R, Y.N.R., E.A., L.A: closely reviewed the manuscript for intellectual content and participated in revising and finalizing the manuscript. All authors read and approved the final manuscript.

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Data availability
The data sets generated and analyzed during this study are publicly available. Available at: https://kesehatan.ngawikab.go.id/

Ethics statement
This study obtained ethics approval from the Health Research Ethics Committee, Faculty of Dentistry, Medicine, Universitas Airlangga, No. 214/HRECC.FODM/III/2023.

Conflicts of interest
The authors declare no conflict of interest regarding the publication of this article.

Use of artificial intelligence (AI)
Portions of this manuscript were edited using Grammarly and Mendeley. All AI-assisted content was reviewed and validated by the authors, who take full responsibility for the final content.

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