Effectiveness of TeleCTG in Reducing Neonatal Morbidity and Mortality: A Clinical Evaluation

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ABSTRACT

Infant mortality remains a major public health challenge in Indonesia, with rates still exceeding the Sustainable Development Goals (SDGs) target. Digital health innovations, such as TeleCTG, have been introduced to improve accessibility and quality of maternal care by enabling remote fetal monitoring. This study aimed to evaluate the effectiveness of TeleCTG in reducing neonatal morbidity and mortality. A retrospective cohort design was conducted using secondary data from Puskesmas Pakutandang, involving 78 pregnant women at ≥28 weeks of gestation or with risk factors. The exposure group consisted of 34 mothers who underwent TeleCTG examinations, while the non-exposure group included 44 mothers who received routine antenatal care without TeleCTG. Infant outcomes, including mortality and Apgar scores at 1/5/10 minutes, were analyzed using Fisher's Exact Test and logistic regression with a 95% confidence interval. The results showed a significant association between TeleCTG use and reduced infant mortality (p=0.033; RR 1.158, 95% CI 1.030–1.302), while no significant effect was observed on Apgar scores <7 at 1/5/10 minutes (p=0.065). In conclusion, TeleCTG has the potential to lower infant mortality and support maternal health services, although further research with intrapartum monitoring is warranted to strengthen evidence of its effectiveness.

KEYWORDS

Apgar score; effectiveness; neonatal mortality; TeleCTG; telehealth

INTRODUCTION

One of the primary objectives of the Sustainable Development Goals (SDGs) is to reduce both maternal and infant mortality rates (World Health Organization, 2019). Based on the Indonesian Demographic and Health Survey (IDHS), infant mortality has shown a consistent decline in Indonesia, though the country has not yet met the Sustainable Development Goals (SDGs) target (Sajedinejad et al., 2015). In 2017, the Infant Mortality Rate (IMR) was 24 per 1,000 live births, with a Neonatal Mortality Rate (NMR) of 15 per 1,000. This represented a notable improvement from 2012, when the IMR was 32 per 1,000 and the NMR was 19 per 1,000. While the IMR also decreased from 35 per 1,000 in 2007, the NMR remained the same. This downward trend continues from 2002, which had an IMR of 44 per 1,000 and an NMR of 23 per 1,000 (World Health Organization, 2019). Despite this progress, Indonesia's IMR remains well above the 2030 SDGs target of 12 per 1,000 live births. The persistent high rates of infant mortality are partly attributed to the uneven distribution and limited accessibility of healthcare services across the country (Nurrizka, RH., Wahyono, 2018). Significant disparities exist in access, quality, and affordability of healthcare, which contribute to the ongoing challenges in reducing these mortality rates (Laksono et al., 2020).

To address disparities in healthcare access, internet-based technology can be leveraged to provide healthcare services and information. The implementation of digital health solutions facilitates remote consultation, reducing the need for in-person visits (Kementerian Kesehatan RI., 2020). The Indonesian government has collaborated with the United Nations Development Programme (UNDP) to formulate a digital health transformation strategy for 2024. This strategy aims to address the demands for public healthcare transformation by meeting the need for connectivity in healthcare services (United Nation (UN), 2019). The Ministry of Health of the Republic of Indonesia has also established a strategy for utilizing technology- and information-based healthcare services, as outlined in the 2017 Regulation of the Minister of Health, Number 46, regarding the National e-Health Strategy (Bobo, FT., Yesuf, EA., Woldie, 2017). Generally, e-health encompasses both health informatics and telehealth. The expansion of telehealth services has the potential to reduce health disparities in pregnancy care, bridge cultural gaps, and improve health outcomes by increasing access to affordable care at home. The American College of Obstetricians and Gynecologists (ACOG) supports telehealth as a means to improve access to maternal care, viewing it as a strategy to reduce maternal morbidity and mortality (Sri, H., Mubarokah, 2018). ACOG asserts that the opportunity presented by telehealth is to enhance current standards of care, not to replace them (Denicola, 2020).

One such telehealth application for maternal care in Indonesia is TeleCTG, a portable cardiotocography (CTG) device utilizing Internet of Medical Things (IoMT) technology (Suharmiati,S., Laksono, A., Astuti, 2013). This device monitors fetal well-being and helps detect risk factors in both the mother and fetus, providing a crucial tool for remote maternal health surveillance (Kaligis, Retor A.W., Anshari, Faridhian., Devi, 2021). The typical tools used for routine maternal and fetal examinations are ultrasound and Doppler. Unlike these devices, TeleCTG focuses on capturing the fetal heart rate and monitoring fetal movement, and it is capable of directly reporting the condition of both to an obstetrician at a nearby hospital. A study conducted during the COVID-19 pandemic found that in 2020, there were no maternal deaths among mothers who received examinations with TeleCTG during their pregnancy, whereas there were 11 maternal deaths among those who did not (Kaligis, Retor A.W., Anshari, Faridhian., Devi, 2021). The early detection of risk factors during pregnancy improved, leading to a 42% reduction in obstetric complications at primary healthcare centers (Puskesmas) equipped with TeleCTG. The use

of TeleCTG also increased the number of maternal visits at 14 Puskesmas, with 69.1% of patients agreeing and 10.9% strongly agreeing with its implementation. Midwives at these 14 Puskesmas in Kupang Regency stated that they were more comfortable with the presence of TeleCTG to support their services and assist in diagnosing pregnant mothers with risk factors. Therefore, the use of TeleCTG presents a solution to the challenges in maternal and child healthcare, particularly given the limited number of doctors and specialist physicians in Indonesia, where the majority of the 10,134 Puskesmas do not have a doctor on duty 24 hours a day. This technology thus has the potential to enhance both the quality and equity of healthcare services. There is a lack of clinical evidence regarding the impact of TeleCTG use on perinatal outcomes, specifically concerning both morbidity and mortality. The innovation of TeleCTG in maternal care is a tangible testament to the rapid advancement of digitalization in healthcare services. Based on these conditions, the researchers are interested in examining the effectiveness of using TeleCTG on perinatal outcomes (Susiarno et al., 2021).

RESEARCH METHOD

This study employs a retrospective cohort design. A cohort study is a type of research where investigators identify a group of individuals exposed to a risk factor (exposed group) and another group not exposed (non-exposed group). Both groups are then followed up to compare the incidence of a disease or the mortality rate from it. In a retrospective cohort study, both the risk factor and the disease have already occurred prior to the start of the study, so these variables are measured using historical records. In this specific study, the exposure or risk factor is the use of TeleCTG in maternal care. The follow-up is based on secondary data, and the disease or outcome is the neonatal outcome of pregnant mothers monitored at Puskesmas Pakutandang. The data for this study was obtained from the examination records of pregnant women at Puskesmas Pakutandang, specifically within the villages of Cikoneng, Sagaracipta, Babakan, Gunung Leutik, and Pakutandang. The research was conducted using the data entries from TeleCTG examinations within the Sehati application.

The sampling for this study utilizes a total sampling technique. This sampling approach involves analyzing all available data from pregnant women at or beyond 28 weeks of gestation, or those with risk factors, who have either undergone a TeleCTG examination or not, within the area of Puskesmas Pakutandang.The sample is divided into two groups: the exposure group and the non-exposure group. The exposure group consists of historical data from all pregnant women with a gestational age of ≥28 weeks or those with risk factors who received a TeleCTG examination in October 2022. The follow-up of their pregnancy outcomes included 34 respondents, with data sourced from the TeleCTG pilot study team at Puskesmas Pakutandang. The non-exposure group, totaling 44 respondents, was derived from routine antenatal care (ANC) examination data collected by village midwives in October 2022, without the use of TeleCTG, with their outcomes also being followed up. The total sample size for the study is 78.

In this study, the independent variable is the use of TeleCTG examinations on pregnant women. The dependent variables are (1) Infant mortality, which includes cases of intrauterine fetal death (IUFD) or stillbirth, as well as newborn or neonatal death, all within the Puskesmas Pakutandang area, and (2) The Apgar score of newborns at 1/5/10 minutes, for infants born to mothers who were examined with TeleCTG in October 2022 within the Puskesmas Pakutandang area. Quantitative data collection was performed using secondary data, specifically from the compiled reports of the TeleCTG trial examinations conducted by the TeleCTG Trial Team from October 2022 to July 2023 at Puskesmas Pakutandang,

supplemented with data from the Maternal Cohort at the same Puskesmas. Data analysis included univariate analysis and bivariate analysis using the Fisher's Exact Test. Multivariate analysis was employed to determine the probability of the independent variable influencing infant mortality and newborn Apgar scores at 1/5/10 minutes. This was conducted using a logistic regression test. The level of significance for all statistical tests conducted was set at $p<0.05$, with a confidence interval (CI) of 95%.

RESULT AND DISCUSSION

Univariate analysis revealed the characteristics of the respondents across eight categories: age, gravidity, risk factors, history of pregnancy-related illnesses, infant mortality, and APGAR scores of less than 7 at 1/5/10 minutes. In terms of age, the majority of pregnant women in both groups were between 20 and 35 years old, with 24 respondents (70.58%) in the exposure group and 32 respondents (72.73%) in the non-exposure group. Regarding gravidity, most were in their second to fourth pregnancy, accounting for 24 respondents (70.59%) in the exposure group and 36 (81.82%) in the non-exposure group. For risk factors, most pregnant women did not have a history of conditions such as large babies, C-sections, vacuum/forceps delivery, manual placenta removal, or blood transfusions; this represented 29 respondents (85.30%) in the exposure group and 39 (88.64%) in the non-exposure group. Similarly, the majority did not have a history of pregnancy-related illnesses, with 32 respondents (94.12%) in the exposure group and 41 (93.18%) in the non-exposure group. The analysis of infant mortality showed that most mothers did not experience a case of infant death, with 34 respondents (100%) in the exposure group and 38 (86.36%) in the non-exposure group. Furthermore, the majority of mothers did not deliver a baby with an APGAR score of less than 7 at 1/5/10 minutes, which included 34 respondents (100%) in the exposure group and 39 (88.64%) in the non-exposure group.

Table 1. Respondent Characteristics

No	Variable	Exposure Group		Non-Exposure Group	
		Frequency (n-34)	Percentage (%)	Frequency (n-44)	Percentage (%)
1.	Ages				
	• <20 years	1	2.94	2	4.55
	• 20-35 years	24	70.58	32	72.73
	• >35 years	9	26.48	10	22.72
2.	Gravida				
	• 1	6	17.65	8	18.18
	• 2-4	24	70.59	36	81.82
	• ≥5	4	11.76	0	0
3.	Risk Factor				
	• Present	5	14.70	5	11.36
	• Absent	29	85.30	39	88.64
4.	History of Pregnancy Diseases				
	• Asthma	1	2.94	0	0
	• Hypertension	1	2.94	3	6.82
	• Absent	32	94.12	41	93.18
5.	Infant Mortality				
	• Yes	0	0	6	13.64
	• No	34	100	38	86.36
6.	APGAR Score <7 at 1/5/10 minutes				
	• Yes	0	0	5	11.36
	• No	34	100	39	88.64

Bivariate analysis results show a statistically significant influence of maternal examinations using TeleCTG on the incidence of infant mortality, with a p-value of 0.033 (p<0.05). Pregnant women who underwent a TeleCTG examination were 1.158 times more likely to not experience infant mortality compared to those who did not, with a relative risk ranging from 1.030 to 1.302 (95% CI), as shown in Table 2.

Table 2. Analysis of the Use of TeleCTG in Maternal Examination of Infant Mortality Incidents

		Infant Mortality Incident				*p-value*	RR (95%CI)
		Yes		No			
		N	%	N	%		
Maternal Examination	With TeleCTG	0	0	34	100	0.033	1.158 (1.030-1.302)
	Without TeleCTG	6	13.64	38	86.36		
	Total	6	13.64	72	186.36		

Bivariate analysis also showed that there was no statistically significant influence between maternal examinations using TeleCTG and not using it on the incidence of Apgar scores below 7 at 1/5/10 minutes, with a p-value of 0.065 (p>0.05). Pregnant women who underwent a TeleCTG examination were 1.128 times more likely to not have a baby with an Apgar score below 7 at 1/5/10 minutes, with a relative risk ranging from 1.015-1.254 (95% CI), as shown in Table 3.

Table 3. Analysis of the Use of TeleCTG in maternal examinations of the occurrence of APGAR Scores of Babies <7 at 1/5/10 minutes

		APGAR Scores of Babies <7				*p-value*	RR (95%CI)
		Yes		No			
		N	%	N	%		
Maternal Examination	With TeleCTG	0	0	34	100	0.065	1.128 (1.015-1.254)
	Without TeleCTG	5	11.36	39	88.64		
	Total	5	11.36	73	188.64		

In addition, bivariate analysis was also conducted to examine the relationship between the variables of age, gravidity, risk factors, and disease history on the incidence of infant mortality and Apgar scores of less than 7 at 1/5/10 minutes, as shown in Table 4.

Table 4. Bivariable Analysis of Age, Gravida, Risk Factors, and History of Diseases with Dependent Variables

No		Dependent Variable	
		Infant Mortality Incident p-value	APGAR score <7 p-value
	Independent Variable		
1	Age	0,297	0,482
2	Gravida	0,211	0,210
3	Risk factor	0,019	0,111
4	History of Diseases	0,302	0,240

Multivariable analysis was employed to identify the variables that had the greatest influence on the dependent variables, namely infant mortality and low APGAR scores (<7) at the 1/5/10 minutes. In this analysis, a multiple logistic regression model was constructed using the enter method to assess potential confounding variables based on changes in the odds ratio (OR). The multivariable analysis was performed exclusively on the dependent variables of infant mortality and low APGAR scores (<7) at the 1/5/10 minutes. Multivariable analysis was conducted to determine the independent association between the predictor and outcome variables. Candidate variables included in the logistic regression

analysis for infant mortality were the main variable, namely the use of TeleCTG in maternal examination, and other variables with a p-value <0.25, namely gravida and maternal risk factors.

Table 5. Logistic Regression Model I on the Dependent Variable of Infant Mortality Incident

Variable	S.E.	*p-value*	OR
Gravida		0.991	
Gravida (1)	7.033E3	0.996	1.133E15
Gravida (2)	3.737E3	0.996	1.596E7
Gravida (3)	1.376	0.363	0.286
TeleCTG	6.612E3	0.996	0.000
Risk factor	3.737E3	0.997	2.235E8

Table 6. Logistic Regression Model II on the Dependent Variable of Infant Mortality Incident

Variabel	S.E.	*p-value*	OR	OR change
TeleCTG	6.812E3	0.998	0.000	0
Gravida		0.930		
Gravida (1)	7.256E3	0.998	1.429E8	99,99998739
Gravida (2)	1.330	0.674	0.571	100
Gravida (3)	1.314	0.207	0.190	33,566

Table 7. Logistic Regression Model III on the Dependent Variable of Infant Mortality Incident

Variable	S.E.	*p-value*	OR	OR Change
Risk factor	1.093	.008	18.000	1,00E+02
TeleCTG	6.319E3	.998	0.000	0

Based on the three logistic regression models, maternal risk factors and gravida were identified as confounding variables. Model adequacy was assessed using the Iteration History, which showed that the model prior to including the independent variables met the goodness-of-fit criteria (-2 Log Likelihood < Chi-square table value; 42.306 < 92.8083). The Hosmer–Lemeshow test further indicated no significant lack of fit between the independent variables and the outcome (p > 0.05; 1.00 > 0.05). From the logistic regression analysis across the three models, the p-value for the use of TeleCTG in maternal examination was 0.998 (>0.05), indicating that TeleCTG use during maternal assessment had no significant effect on infant mortality.

Candidate variables included in the logistic regression analysis for APGAR scores <7 at the 1/5//10 minutes were the main variable, namely the use of TeleCTG in maternal examination, and other variables with a p-value <0.25, including gravida, maternal risk factors, and maternal medical history.

Table 8. Logistic Regression Model I on the Dependent Variable of APGAR scores <7 at the 1/5//10 minutes

Variable	S.E.	*p-value*	OR
Gravida		0.991	
Gravida (1)	7.205E3	0.995	9.722E20
Gravida (2)	4.580E3	0.995	3.143E13
Gravida (3)	1.376	0.363	0.286
Risk Factor	4.580E3	0.994	2.200E14
TeleCTG	6.933E3	0.994	0.000
History of Disease	1.604E3	0.996	0.000

Table 9. Logistic Regression Model II on the Dependent Variable of APGAR scores <7 at the 1/5//10 minutes

Variable	S.E.	*p-value*	OR	OR Change
TeleCTG	6.758E3	0.996	0.000	0
Gravida		0.991		
Gravida (1)	7.157E3	0.996	4.233E14	1,00E+02
Gravida (2)	3.846E3	0.996	2.324E7	1,00E+02
Gravida (3)	1.376	0.363	0.286	0
Risk Factor	3.846E3	0.996	8.135E7	1,00E+02

Table 10. Logistic Regression Model III on the Dependent Variable of APGAR scores <7 at the 1/5//10 minutes

Variable	S.E.	*p-value*	OR	OR Change
TeleCTG	6.735E3	0.998	0.000	0
Gravida		0.837		
Gravida (1)	7.286E3	0.998	1.441E8	1,00E+02
Gravida (2)	1.602	0.750	1.666	1,00E+02
Gravida (3)	1.339	0.257	0.219	23,426
History of Disease	0.792	0.541	0.616	0

Table 11. Logistic Regression Model IV on the Dependent Variable of APGAR scores <7 at the 1/5//10 minutes

Variable	S.E.	*p-value*	OR	OR Change
TeleCTG	6.622E3	.998	0.000	0
History of Disease	0.812	.837	0.846	0
Risk Factor	1.259	.121	7.050	1,00E+02

Based on the four logistic regression models, maternal medical history, gravida, and maternal risk factors were identified as confounding variables. Model adequacy was evaluated using the Iteration History, which showed that the model prior to the inclusion of independent variables met the required criteria (-2 Log Likelihood < Chi-square table value; 37.145 < 92.8083). The Hosmer–Lemeshow test indicated no significant lack of fit between the independent variables ($p > 0.05$; $1.00 > 0.05$). From the logistic regression analysis across the three models, the adjusted p-value for the use of TeleCTG in maternal examination was 0.998 (>0.05), suggesting that the use of TeleCTG in maternal assessment had no significant effect on APGAR scores <7 at the 1/5/10 minutes.

The effectiveness of using the TeleCTG device can be measured by pregnancy outcomes (Kaligis, Retor A.W., Anshari, Faridhian., Devi, 2021). In this study, pregnancy outcomes were assessed based on the incidence of infant mortality and perinatal outcomes, specifically APGAR scores below 7 at 1/5/10 minutes. Based on the the results showed that there was no significant influence of TeleCTG use on the incidence of infant mortality or perinatal outcomes as measured by APGAR scores below 7 at 1/5/10 minutes. A 2015 study by Grivell, et al. states that the effectiveness of maternal healthcare services can be measured by improvements in the quality of and access to care during the antenatal, intrapartum, and postpartum periods. The improved quality of maternal care itself can be observed from patient outcomes within the healthcare service (Grivell et al., 2015). CTG is a device widely used during pregnancy to assess fetal well-being, especially in high-risk pregnancies with an increased chance of complications. To evaluate the effectiveness of CTG use, it is necessary to identify perinatal or infant deaths, as well as preventable deaths. Furthermore, it is also important to identify outcomes such as the rate of Caesarean sections and secondary outcomes like an APGAR score of less than 7 at 5 minutes, or the incidence of admission to a neonatal special care unit (Markam & Ghanghoria, 2024).

A study by Freeman, et al. indicates that CTG (cardiotocography) is a beneficial non-invasive fetal monitoring method and is the most widely used tool for detecting the

possibility of poor fetal outcomes, particularly birth asphyxia (Freeman et al., 1982). Birth asphyxia is a common cause of neonatal morbidity and mortality, with significant long-term effects. The early identification of fetal distress and timely intervention can prevent a large number of asphyxia cases at birth. Among various fetal monitoring methods, CTG is the most frequently used for detecting fetal stress, which can lead to accelerated delivery to prevent further complications (Miyata et al., 2025).

Beyond its influence on asphyxia, Cardiotocography (CTG) is also closely linked to the incidence of infant mortality. CTG is a popular method for monitoring fetal well-being and assisting obstetricians in making delivery decisions to improve perinatal outcomes. Labor imposes physiological stress on the fetus by disrupting the supply of oxygenated blood in the villous space (Devane et al., 2017). If the fetus has an underlying oxygen deficit, late and variable decelerations will be observed. Thus, cardiotocography is a good screening method for the early detection of fetal distress, allowing for timely intervention to prevent perinatal morbidity and mortality. Although CTG itself may lead to an increase in operative interventions or Caesarean section deliveries, it can also significantly reduce perinatal mortality rates (Blix et al., 2024).

Based on the findings of this study, it was concluded that TeleCTG does not have a statistically significant influence on the incidence of infant mortality, or APGAR scores of less than 7 at 1/5/10 minutes. The TeleCTG examination was performed only once, in October 2022, and was not repeated near delivery or during the intrapartum period. However, a 2022 study by Singh, et al. on the difference in effectiveness of CTG use during the antepartum and intrapartum periods found that intrapartum CTG monitoring has a significantly higher effectiveness in maintaining positive pregnancy outcomes (Singh et al., 2022). This is because, during labor, placental blood flow decreases during uterine contractions. This reduction can put the fetus at risk of low oxygenation. Hypoxia is considered to be responsible for a proportion of perinatal deaths and cases of cerebral palsy (CP). CTG monitoring was introduced as a screening tool to detect fetal hypoxia so that corrective action, such as an immediate operative procedure like a Caesarean section, can be taken. CTG (Cardiotocography) can record and display both the fetal heart rate and uterine rhythm over time, which makes it possible to examine the relationship between the two. The pattern of the fetal heart rate is considered to provide physiological information about fetal oxygenation. Therefore, CTG monitoring during the intrapartum period is a more appropriate time to predict the likelihood of birth asphyxia, which can help prevent infant mortality (Jia et al., 2023).

Furthermore, pregnancy outcomes such as infant mortality and infant asphyxia (indicated by an APGAR score of <7 at 1/5/10 minutes) are also influenced by other factors, including maternal age, existing risk factors, history of pregnancy-related illnesses, and gravidity. Regarding infant mortality events, the influence of TeleCTG use on the incidence of infant mortality is affected by confounding variables such as the mother's gravidity and risk factors (Lean et al., 2017). Based on a study, concerning the relationship between gravidity and complications in pregnancy outcomes, it was shown that primigravida and gravida ≥ 4 are factors in the emergence of problems during pregnancy and childbirth. Mothers with gestational primigravida are more susceptible to blood pressure issues, including pre-eclampsia, hemorrhage, miscarriage, preterm labor, congenital abnormalities, and intrauterine growth restriction, all of which can lead to fetal death (Gaikwad et al., 2024).

Furthermore, a study by Soewandhi, et al., in 2020 explained that neonatal asphyxia is the result of intrapartum fetal hypoxia/ischemia and a resuscitation action that can immediately restore the condition of the newborn. Causes of neonatal asphyxia include hypertension in pregnancy, post-term pregnancy, maternal narcotics during labor, uterine

contractions (hypertonic or uterine tetany), umbilical cord disorders, and hypovolemic shock (Soewandhie et al., 2020). Risk factors for neonatal asphyxia include maternal age, maternal education, parity, anemia during pregnancy, prolonged labor, premature rupture of membranes, low birth weight, and very low birth weight in neonates. Preeclampsia and obesity in pregnancy can also increase the risk of neonatal asphyxia. These factors certainly influence the analysis of TeleCTG use in infants with an APGAR score of <7 or who experience asphyxia (Gaikwad et al., 2024).

CONCLUSION

The findings of this study indicate that the use of TeleCTG did not exert a significant impact on neonatal mortality rates or APGAR scores <7 at the /5/10 minutes. Nevertheless, the interpretation of these results is limited by the study design, as TeleCTG monitoring was conducted only once during the antepartum period, rather than throughout the intrapartum phase when fetal distress is more likely to occur. Evidence from previous studies highlights that intrapartum CTG monitoring is considerably more effective in detecting fetal hypoxia, a leading cause of asphyxia and perinatal mortality. Moreover, maternal factors such as age, parity, pre-existing conditions, and other obstetric risks were identified as potential confounders influencing pregnancy outcomes. These limitations underscore the necessity for future research to evaluate TeleCTG use during the intrapartum period and to rigorously control for confounding variables, thereby providing a more robust and accurate understanding of its clinical effectiveness.

REFERENCES

Blix, E., Brurberg, K. G., Reierth, E., Reinar, L. M., & Øian, P. (2024). ST waveform analysis vs cardiotocography alone for intrapartum fetal monitoring: An updated systematic review and meta-analysis of randomized trials. In *Acta Obstetricia et Gynecologica Scandinavica* (Vol. 103, Issue 3, pp. 437–448). John Wiley and Sons Inc. https://doi.org/10.1111/aogs.14752

Bobo, FT., Yesuf, EA., Woldie, M. (2017). Inequities in utilization of reproductive and maternal health services in Ethiopia. *Int J Equity Health*, *16*(1), 1–8.

Denicola, N. (2020). Implementing Telehealth in Practice: ACOG Committee Opinion Summary, Number 798. *Obstetrics and Gynecology*, *135*(2), 493–494.

Devane, D., Lalor, J. G., Daly, S., Mcguire, W., Cuthbert, A., & Smith, V. (2017). Cardiotocography versus intermittent auscultation of fetal heart on admission to labour ward for assessment of fetal wellbeing. In *Cochrane Database of Systematic Reviews* (Vol. 2017, Issue 1). John Wiley and Sons Ltd. https://doi.org/10.1002/14651858.CD005122.pub5

Freeman, R. K., Anderson, G., & Dorchester, W. (1982). A prospective multi-institutional study of antepartum fetal heart rate monitoring. I. Risk of perinatal mortality and morbidity according to antepartum fetal heart rate test results. *American Journal of Obstetrics and Gynecology*, *143*(7), 771–777. https://doi.org/10.1016/0002-9378(82)90008-4

Gaikwad, V., Bhadoriya, A., & Gaikwad, S. (2024). A Comparative Study of Fetal and Maternal Outcomes in Registered and Unregistered Antenatal Cases in a Tertiary Care Center. *Cureus*. https://doi.org/10.7759/cureus.66066

Grivell, R. M., Alfirevic, Z., Gyte, G. M. L., & Devane, D. (2015). Antenatal cardiotocography for fetal assessment. *Cochrane Database of Systematic Reviews*, *2015*(9), 1–39. https://doi.org/10.1002/14651858.CD007863.pub4

Jia, Y.-J., Ghi, T., Pereira, S., Gracia Perez-Bonfils, A., & Chandraharan, E. (2023). Pathophysiological interpretation of fetal heart rate tracings in clinical practice. *American Journal of Obstetrics and Gynecology*, *228*(6), 622–644. https://doi.org/https://doi.org/10.1016/j.ajog.2022.05.023

Kaligis, Retor A.W., Anshari, Faridhian., Devi, S. P. (2021). Utilization of TELECTG in Empowering Midwives Through The Diffusion of Innovation Approach. *Proceedings of the 4th International Conference on Communication & Business*.

Kementerian Kesehatan RI. (2020). Indikator Program Kesehatan Masyarakat dalam RPJMN dan Rentra Kementerian Kesehatan 2020-2024. *Katalog Dalam Terbitan. Kementerian Kesehatan RI*, 1–99. https://kesmas.kemkes.go.id/assets/uploads/contents/attachments/ef5bb48f4aaae60ebb724caf1c534a24.pdf

Laksono, A. D., Rukmini, R., & Wulandari, R. D. (2020). Regional disparities in antenatal care utilization in Indonesia. *PLoS ONE*, *15*(2), 1–13. https://doi.org/10.1371/journal.pone.0224006

Lean, S. C., Derricott, H., Jones, R. L., & Heazell, A. E. P. (2017). Advanced maternal age and adverse pregnancy outcomes: A systematic review and meta-analysis. *PLoS ONE*, *12*(10). https://doi.org/10.1371/journal.pone.0186287

Markam, R., & Ghanghoria, V. (2024). Study of intrapartum cardiotocography and its correlation with perinatal outcome in high risk pregnancy. *The New Indian Journal of OBGYN*, *11*(1), 79–84. https://doi.org/10.21276/obgyn.20252024.11.1.15

Miyata, K., Shibata, C., Fukunishi, H., Hemmi, K., Kinoshita, H., Hirakawa, T., Urushiyama, D., Kurakazu, M., & Yotsumoto, F. (2025). Cardiotocography-Based Experimental Comparison of Artificial Intelligence and Human Judgment in Assessing Fetal Asphyxia During Delivery. *Cureus*. https://doi.org/10.7759/cureus.78282

Nurrizka, RH., Wahyono, TYM. (2018). Disparitas Kematian Maternal di Indonesia: Studi Ekologi dengan Analisis Spasial. *Media Kesehat Masy Indones*, *14*(2), 119.

Sajedinejad, S., Majdzadeh, R., Vedadhir, A. A., Tabatabaei, M. G., & Mohammad, K. (2015). Maternal mortality: A cross-sectional study in global health. *Globalization and Health*, *11*(1), 1–13. https://doi.org/10.1186/s12992-015-0087-y

Singh, S. K., Kumar, R., Agarwal, A., Tyagi, A., & Bisht, S. S. (2022). Intrapartum cardiotocographic monitoring and its correlation with neonatal outcome. *Journal of Family Medicine and Primary Care*, *11*(11), 7398–7405. https://doi.org/10.4103/jfmpc.jfmpc_1525_22

Soewandhie, G. H. M., Sekarwati, T. A., Darsini, N., & Husada, D. (2020). Risk Factors for Neonatal Asphyxia Occurrence at General Hospital Dr. M. Soewandhie, Surabaya. *Indian Journal of Public Health Research & Development*, *11*(04), 866–871. https://doi.org/10.37506/ijphrd.v11i4.7757

Sri, H., Mubarokah, K. (2018). Kondisi Demografi Ibu dan Suami pada Kasus Kematian Ibu. *Higeia J Public Heal Res Dev [Internet]*, *3*(5), 99–108.

Suharmiati,S., Laksono, A., Astuti, W. (2013). UP Review Kebijakan tentang Pelayanan Kesehatan Puskesmas di Daerah Terpencil Perbatasan. *Bul Penelit Sist Kesehat*, *16*(2), 109–116.

Susiarno, H., Agustian, D., Nurdiawan, W., Waluyo, A., Adnani, Q., & Gumilang, L. (2021). *Model Pelayanan Kesehatan Maternal di Fasilitas Kesehatan Tingkat Pertama Berbasis Internet of Medical Things (Lentera Í-Met)* (pp. 5–7).

United Nation (UN). (2019). The sustainable development goals report 2019. *United Nations Publication Issued by the Department of Economic and Social Affairs*, 64.

World Health Organization. (2019). Trends in maternal mortality: 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. Geneva: World Health Organization; 2019. In *WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division*.