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Implementation of Preeclampsia Risk Factor Screening Using The 2020 Revised Maternal and Child Health (MCH) Handbook and Its Association With Maternal Deaths in Bima Regency, Indonesia: A Cross-sectional Study

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Abstract

Objectives: To evaluate the implementation of preeclampsia risk factor screening using the 2020 revised Maternal and Child Health (MCH) Handbook in Bima Regency, Indonesia, and examine its association with maternal deaths due to preeclampsia.

Materials and Methods: This cross-sectional study was performed in all 21 community health centers in Bima Regency in 2025. A total of 655 MCH handbooks were selected using proportional random sampling to assess the preeclampsia screening documentation. All 30 physicians were included to assess knowledge levels using a validated questionnaire. The occurrence of preeclampsia-related maternal deaths was categorized by health center. Analyses included chi-square, independent t-test, and Mann–Whitney U test. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated.

Results: Overall, 70.4% of MCH handbooks had complete preeclampsia risk screening. Sixteen physicians (53.3%) demonstrated poor knowledge (score < 85). The median completeness score was significantly lower in health centers with maternal deaths compared to those without (44.19 vs. 92.00; $P=0.045$). A counterintuitive association was observed where physicians with poor knowledge were less likely to be in centers with maternal deaths (OR: 0.089; $P=0.031$; 95% CI: 0.009–0.873). This inverse association may reflect post-audit knowledge improvement, as maternal death audits preceded the knowledge assessment.

Conclusions: Incomplete screening documentation is associated with higher maternal mortality. The association between physician knowledge and mortality appears confounded by reverse causality, as knowledge was measured after post-maternal death audits. Regular evaluation and targeted continuous training remain important to strengthen preeclampsia risk detection and support efforts to reduce maternal mortality.

Keywords: Maternal mortality, Maternal and Child Health Handbook, Preeclampsia risk factor screening

Introduction

Maternal mortality remains a global public health priority under the Sustainable Development Goals (SDGs), which aim to reduce the maternal mortality ratio (MMR) to 70 per 100,000 live births by 2030 (1). In 2024, Indonesia has made progress by reaching a national MMR target of 183 per 100,000 live births. Nevertheless, this level remains substantially higher than the SDGs target, indicating the need for accelerated reductions of maternal deaths, particularly those related to non-obstetric complications such as hypertension during pregnancy (2). Despite the high national level of deliveries attended by professionals, regional disparities and socioeconomic factors continue to create gaps in the quality of obstetric care and screening practices, slowing the progress in reducing the MMR (3). One notable example is Bima Regency, which represents a high-burden setting by ranking 4th highest in maternal mortality rate in the West Nusa Tenggara region according to the West Nusa Tenggara Health Department in 2023. Local Maternal Perinatal Surveillance Response Audit in December 2023 has revealed that most maternal deaths were linked to severe preeclampsia, compounded by delays in referrals and detection of complications (2). These findings underscore persistent gaps in early identification and management of high-risk pregnancies at the primary care level.

Preeclampsia is a pregnancy disorder marked by new-onset hypertension and proteinuria after 20 weeks of gestation. It is a major contributor to maternal morbidity and mortality globally, leading to serious complications, including hepatorenal and coagulation disorders, pulmonary edema, eclampsia, brain injury, and death (4). Given the severe complications associated with preeclampsia, early identification through screening of risk factors is essential (4,5). Indonesia has implemented this preventive approach in the 2020 Revised Maternal and Child Health (MCH) Handbook, which serves as both an educational tool for pregnant women and a record for healthcare providers to monitor antenatal care (ANC). The 2020 revised MCH Handbook promotes early

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Key Messages

- Incomplete preeclampsia screening documentation in MCH handbooks is significantly associated with higher maternal mortality in rural clinics.
- Over half of community healthcare physicians lack sufficient preeclampsia knowledge, highlighting an urgent need for targeted training.
- The inverse association between poor knowledge and maternal deaths suggests that maternal death audits may effectively improve physician knowledge. However, further study is needed to assess pre-audit knowledge levels.

screening for preeclampsia risk factors, which community health center physicians validate in accordance with the concept of preeclampsia risk factor screening based on the American College of Obstetrics and Gynecology (4,6). The use of the MCH handbook can be one of the initiatives to prevent maternal mortality. For example, Japan, as the pioneer of the MCH handbook, has achieved a reduction in the maternal mortality rate to 4 per 100,000 live births from 2010 to 2024, or just about 629 fatalities (7,8).

Effective implementation of the screening approach depends not only on documentation completeness but also on physicians' competence and adherence to screening protocols. Physicians' competence is shaped by their participation in clinical training, which is evaluated based on knowledge, attitude, and skills. Accordingly, the Ministry of Health has organized integrated ANC training programs for community health center physicians to improve their capacity to conduct preeclampsia risk factor screening (9).

Risk-factor screening has been shown to improve early identification of women at risk of preeclampsia (4,10), but evidence remains limited regarding the extent to which preeclampsia risk-factor screening has been implemented in routine practice and whether variation in implementation is associated with maternal mortality in high-burden districts. In particular, the relationship between completeness of MCH handbook screening documentation, physicians' knowledge of screening protocols, and maternal death outcomes has not been examined in Bima Regency.

Objectives

This study aimed to evaluate the effectiveness of preeclampsia risk factor screening using the 2020 revised MCH Handbook in reducing maternal mortality in Bima Regency; specifically, we assessed the completeness of the MCH handbooks and the knowledge level of community health center physicians regarding the screening implementation.

Materials and Methods

Study Design

This cross-sectional observational study was conducted to evaluate the implementation of preeclampsia risk-factor screening using the 2020 revised MCH Handbook and its association with maternal deaths in Bima Regency, Indonesia.

Study Setting

The study was conducted in all 21 community health centers in Bima Regency, West Nusa Tenggara Province, Indonesia. This study used retrospective data from 2023, including ANC records, MCH handbooks, and Maternal Perinatal Death Notification (MPDN) data from that year. However, all data collection was conducted during March–May 2025. The sequence of data collection was as follows: (a) mapping of pregnant women in health center areas (March 2025); (b) administration of physician knowledge questionnaires (March–April 2025); and (c) review of MCH handbooks to assess preeclampsia risk factor screening completeness (April–May 2025).

Participants and Sampling

A total of 655 MCH handbooks from pregnant women who received ANC at participating community health centers in 2023 were selected using proportional random sampling from ANC records in 2023. Sample size was calculated using Lemeshow's formula for cross-sectional studies estimating a proportion: $n = Z\alpha^2 \times p(1-p) / d^2$, where $Z\alpha = 1.96$ for a 95% confidence level, $p = 0.3$ (estimated screening completeness), and $d = 0.035$ (margin of error). This yielded a minimum sample size of 655 handbooks. Inclusion criteria were all handbooks of pregnant women receiving ANC in participating health centers during the study period. MCH handbooks in which the physician who verified the preeclampsia risk factor screening table could not be clearly identified (i.e., missing physician signature or name) were excluded. Handbooks with completely blank screening sections were retained and scored as 0% (incomplete) to avoid selection bias. Using a total sampling, all 30 physicians responsible for ANC were included from across 21 community health centers in Bima Regency. Each physician was linked to the MCH handbooks they completed by cross-referencing the physician's name from the health center mapping with the physician's signature on the preeclampsia screening table in each handbook.

Variables and Measurements

The data obtained from two stages included completeness scores for preeclampsia risk-factor screening and physicians' knowledge levels. The completeness score was assessed by reviewing the screening table in each handbook and calculating the proportion of required items appropriately documented. A completeness score was calculated for each physician based on the proportion of required items appropriately documented. Physicians' knowledge of preeclampsia risk-factor screening was measured using a structured questionnaire developed from national ANC guidelines (Supplementary file 1).

The instrument underwent peer review to assess validity and reliability. The scores were categorized as good (≥ 85) or poor (< 85). The number of health centers experiencing maternal deaths due to preeclampsia was categorized into two categories: those that experienced maternal deaths due to preeclampsia in 2023 and those that did not. The completeness score of preeclampsia factor screening was measured using the mean or median value and presented as a continuous variable (%). Meanwhile, the physicians' knowledge level was categorized into two categories: poor (< 85) and good (≥ 85). The outcome variable was the incidence of maternal deaths in community health centers in 2023, categorized as facilities reporting one or more maternal deaths due to preeclampsia versus those reporting none, according to MPDN data. Therefore, we aggregated physician-level data to the health center level.

Statistical Analysis

Data were processed using Microsoft Excel 365 (Microsoft Corp., Redmond, WA, USA) and analyzed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA). Normality of continuous variables was assessed. Continuous variables were presented as mean ± standard deviation (SD) or median (interquartile range [IQR]). Categorical variables were analyzed using the chi-square test. Associations between screening completeness, physician knowledge, and maternal death occurrence were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). A *P* value < 0.05 was considered statistically significant.

Results

A total of 655 MCH handbooks and 30 physicians across 21 community health centers in Bima Regency were included in the analysis. Among the 30 physicians, 17 (56.7%) were male and 13 (43.3%) female, with most of them (43.3%) having 5–10 years of work experience, and 14 (46.7%) of them had received integrated ANC training. Knowledge assessment showed that 16 physicians (53.3%) had poor knowledge, while 14 (46.7%) showed good knowledge. The baseline characteristics for community health center physicians are presented in Table 1.

Of 21 community health centers, 4 (19.0%) reported at least one preeclampsia-related maternal death in 2023, and 17 (81.0%) reported none. Across 655 reviewed handbooks, 461 (70.4%) had complete preeclampsia screening documentation recorded by physicians, while 194 (29.6%) were incomplete (Table 2).

Community health centers that reported preeclampsia-related maternal deaths had a significantly lower screening completeness score than those without deaths, with a median completeness of 44.2% (range = 11.5–79.1) versus 92% (range = 20–100), respectively (Table 3).

Table 4 presents a descriptive analysis of screening completeness scores stratified by physicians' knowledge level and maternal death occurrence. In centers with maternal deaths, the single physician with poor knowledge had a completeness score of 11.5%, while the six physicians with good knowledge had a median completeness score of 18.2% (IQR: 12.3–79.2%). Statistical comparison between these two groups was not feasible due to the extremely small sample size (n=1 in the poor knowledge category). In centers without maternal deaths, screening completeness scores were similar between physicians with poor and good knowledge (mean=57.3% ± 32.04 vs. 58.9% ± 34.62).

Based on Table 5, at the community health center level, a counterintuitive association was observed where physicians with poor knowledge were less likely to be in centers that experienced maternal deaths compared to those with good knowledge (OR, 0.089; P=0.031; 95% CI, 0.009–0.873). This inverse association may reflect post-audit knowledge improvement, as maternal death audits preceded the knowledge assessment.

Table 1. Physician Characteristics and Knowledge Levels Regarding Preeclampsia Risk-Factor Screening Based on The 2020 Revised Maternal and Child Health Handbook in Bima Regency, 2023

Variable	Frequency (n = 30)	Percent
Gender		
Male	17	56.7
Female	13	43.3
Years of working experience		
< 5 years	10	33.3
5-10 years	13	43.3
>10 years	7	23.3
Received integrated ANC training		
Yes	14	46.7
No	16	53.3
Average number of cases handled per day		
< 20 patients	6	20.0
20–50 patients	12	40.0
>50 patients	12	40.0
Physicians' knowledge level		
Poor (Score <85)	16	53.3
Good (Score ≥85)	14	46.7

ANC: antenatal care.

Discussion

Preeclampsia is still a significant obstetric complication contributing substantially to maternal mortality in Indonesia, with 988 reported cases in 2024 (2). Given that preeclampsia can cause serious multi-organ complications, early identification of women at higher risk during ANC is essential (5,10,11). A meta-analysis study has demonstrated that non-attendance at ANC increases the risk of preeclampsia by up to 2.7 times, underscoring the importance of thorough antenatal visits to enable timely screening and intervention (12). Globally, the National Institute for Health and Care Excellence (NICE) categorizes high-risk pregnancies into major- and moderate-risk indicators based on maternal characteristics and medical history (13). In Indonesia,

Table 2. Distribution of Community Health Centers By Occurrence of preeclampsia-Related Maternal Deaths and Completeness of Preeclampsia Risk-Factor Screening Documentation in MCH Handbook

Variable	Frequency (n)	Percent
Community health centers (n = 21)		
With ≥1 preeclampsia-related maternal death	4	19.0
Without preeclampsia-related maternal death	17	81.0
Completeness of preeclampsia risk factor screening in MCH handbook (n = 655)		
Complete	461	70.4
Incomplete	194	29.6

Table 3. Comparison of Completeness Score of Preeclampsia Risk-Factor Screening Between Community Health Centers (CHC) With and Without Maternal Deaths Due to Preeclampsia

	CHC with maternal deaths due to preeclampsia in 2023 (n = 4)		CHC without maternal deaths due to preeclampsia in 2023 (n = 17)		*P* value[a]
	Median	Min-Max	Median	Min-Max	
Completeness score of preeclampsia risk factor screening	44.2	11.5 – 79.1	92	20 – 100	0.045*

[a] Mann-Whitney U test was used for comparisons of medians between two groups (non-normal distribution).
* $P < 0.05$ was considered statistically significant.

Table 4. Descriptive Analysis of Preeclampsia Risk-Factor Screening Completeness Score by Physicians' Knowledge Level and Maternal Death Occurrence Due to Preeclampsia in Community Health Centers (CHC)

	Physicians' knowledge level	Completeness score		
		n (%)	Median or mean	IQR or SD
CHC with maternal deaths due to preeclampsia[a]	Poor (score <85)	1 (14.3%)	11.5	Not applicable*
	Good (score ≥85)	6 (85.71%)	18.2	12.31 – 79.17
CHC without maternal deaths due to preeclampsia[b]	Poor (score <85)	15 (65.2%)	57.3	± 32.04
	Good (score ≥85)	8 (34.3%)	58.9	± 34.62

* IQR is not applicable for a single object (n=1); [a] Median and IQR was used due to non-normally distributed data; [b] Mean and ± SD was used due to normally distributed data.

Table 5. Association Between Physicians' Knowledge Levels and Maternal Deaths Due to Preeclampsia in Community Health Centers (CHC)

Physicians' knowledge level	CHC with maternal deaths due to preeclampsia	CHC without maternal deaths due to preeclampsia	*P* value[a]	OR (95% CI)
Poor (n = 16)	1 (6.3%)	15 (93.8%)	0.031*	0.089 (0.009–0.873)
Good (n = 14)	6 (42.9%)	8 (57.1%)		

[a] *P* values were calculated using Fisher's exact test due to small expected cell counts (<5).
* $P < 0.05$ was considered statistically significant.

these guidelines are compiled into the MCH handbook to standardize screening practices at the primary care level and to facilitate their implementation during routine ANC. Beyond its role as a clinical record, the MCH handbook also functions as an educational tool, improving pregnant women's awareness of danger signs across pregnancy, childbirth, postpartum, and newborn care (14).

In this study, the implementation of preeclampsia risk factor screening using the 2020 revised MCH handbook in Bima Regency revealed that screening completeness reached 70.4%, while more than half of the physicians demonstrated poor knowledge of preeclampsia risk factors. These findings align with the 2023 Indonesian Health Survey data, which similarly reported deficiencies in screening practices (15). Community health centers that had maternal deaths due to preeclampsia had much lower completion rates for screening forms than those that didn't. Interestingly, although physicians' knowledge levels were associated with maternal death incidence, they did not significantly correlate with screening completeness, indicating other factors may influence screening adherence. This indicates that documentation completeness in the MCH handbook may depend more on procedural or system factors, whereas physician knowledge may influence clinical decision-making and outcomes beyond documentation alone. Qualitative research is necessary to explore these indirect effects on maternal mortality, which quantitative methods alone cannot fully capture.

The small number of physicians with good knowledge (46.7%) highlights an urgent need for targeted training programs. Physicians' knowledge was substantially influenced by factors such as length of working experience, facility level, and engagement in additional on-the-job training (16–18). Health workers with less experience showed more uncertainty in managing pregnancy complications, consistent with findings from other studies (16,18–20). Training opportunities and intensive

educational programs became pivotal in improving knowledge and competence regarding preeclampsia management (19,21,22). A systematic review indicates that short-term educational interventions, when combined with supervision and group problem-solving, are more effective than standalone training in improving healthcare workers' confidence and skills in managing preeclampsia (23).

Maternal deaths from preeclampsia were reported in four community health centers in Bima Regency, which are all located in rural and outreach areas (24), indicating geographic disparities in maternal outcomes within the study setting. Studies in the US show that pre-pregnancy hypertension and preeclampsia are more common in rural than urban areas due to restricted access to obstetric services (25). Similarly, a study in Ecuador revealed that mothers living >20 km from such services had significantly higher risks, with the likelihood of eclampsia increasing by 2.61 times (26). Long wait times, a lack of healthcare workers, and high visit rates are all challenges to preeclampsia management at urban-based hospitals. The gap in communication patterns between rural and urban inhabitants also creates a barrier to speaking with healthcare staff. Rural women often miss ANC due to limited transportation services (27). These findings support the importance of strengthening rural healthcare infrastructure and referral systems to improve pregnancy outcomes.

The significant association between physicians' knowledge and maternal deaths related to preeclampsia shows how important it is for professional development to improve identification and management of risk factors. Interestingly, the odds ratio <1 suggests that physicians who were classified as having poor knowledge were less likely to be observed in centers that reported maternal deaths. This counterintuitive finding may indicate a temporal ambiguity or post-event effects, as community health centers that had experienced maternal deaths due to preeclampsia had undergone maternal death audits and targeted learning processes before the physician knowledge assessment. Feedback from audits may have improved physicians' knowledge levels in these facilities when the measurements were taken. It may have altered health workers' attitudes regarding the consequences of poor practice, as deaths are subject to investigation. Maternal perinatal death audits provide valuable insight for health policymakers to decide corrective actions for preventable causes of death (28,29). This study underscores the significance of continuous learning for physicians in improving healthcare services, particularly in decreasing maternal mortality through preeclampsia risk screening. A study in California identified key areas for improving the quality of care for women with preeclampsia, such as readiness, recognition, and response. One indicator of readiness is healthcare workers' knowledge. Improving healthcare workers' understanding of how to manage blood pressure, give medication, and use standardized terms is important for effective communication and timely diagnosis (11). Regular evaluations of physicians' skills in screening for preeclampsia are necessary to improve healthcare service quality.

Limitations

This study has some limitations that should be considered. First, the cross-sectional design limits causal inference, and reliance on documentation may not fully reflect actual clinical performance. Most critically, the temporal sequence where maternal death audits occur before physician knowledge assessment introduces reverse causality. The knowledge scores measured in this study reflect a post-audit environment rather than baseline knowledge preceding the deaths. Future studies with pre-audit knowledge assessments are needed to establish temporal relationships. Second, the findings are specific to Bima Regency, a rural area with a high maternal mortality burden, and the small sample of 21 health centers limited statistical power for subgroup analyses. Consequently, the findings may not apply to urban settings or areas with distinct healthcare infrastructures. Despite these limitations, the study gives an objective foundation for evaluating preeclampsia screening practices and highlights key areas for improvement. Future research using longitudinal and qualitative methods may provide a deeper understanding of the causal relationship and underlying barriers impacting maternal health outcomes.

Conclusions

Completeness of preeclampsia risk factor screening contributes to maternal mortality in Bima Regency. Although physicians' knowledge was not significantly associated with screening completeness, critical gaps in physician knowledge and rural healthcare barriers remain closely associated with preeclampsia-related maternal deaths. Addressing these disparities requires regular evaluation, targeted continuous training for physicians and strengthened rural health systems, alongside future qualitative studies to explore underlying systemic challenges.

Authors' Contribution

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Conflict of Interests

Authors declare that they have no conflict of interests.

Ethical Issues

Ethical approval was obtained from the Institutional Ethics Committee (reference number: KET-66/UN2.F1/ETIK/PPM-00.02/2025). The study used anonymized secondary data from routine health records and physician questionnaires.

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Supplementary files

Supplementary file 1. Physicians' Knowledge Questionnaire.

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