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Health Workers' Competence in Home Blood Pressure Measurement-Based Hypertension Management in a Remote Border Region of Indonesia

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ABSTRACT
Home Blood Pressure Measurement (HBPM), although strongly recommended for optimizing hypertension control and identifying white-coat and masked hypertension, remains suboptimally implemented in rural and resource-constrained border settings, primarily due to limited competence among frontline health workers. This study aimed to assess health workers' competence related to HBPM-based hypertension management in a remote border region of Indonesia. A cross-sectional study was conducted among 331 health workers, including nurses, midwives, physicians, pharmacists, and allied health professionals. A validated 21-item questionnaire assessed three HBPM knowledge domains: fundamental concepts, clinical benefits, and technical implementation. Data were analyzed using descriptive statistics, chi-square tests, and multivariate logistic regression. Overall, 58.0% of participants demonstrated good HBPM-related knowledge. Knowledge scores were highest in the clinical benefits domain, while technical implementation showed the lowest performance. Only 14.8% correctly identified differences between home and clinic blood pressure values, and 26.6% recognized the need to discard first-day readings. Nurses (AOR = 3.5; 95% CI: 1.07–11.53) and midwives (AOR = 5.1; 95% CI: 1.44–18.15) were significantly more likely to have good knowledge compared to other professions. Gender and education level were not significant predictors. Although general awareness of HBPM among health workers was adequate, substantial gaps in technical knowledge persist. Strengthening practical HBPM training, particularly for nurses and midwives as frontline providers, is essential to improve hypertension management in underserved border regions.

Keyword: Border region, Health workers, Home blood pressure measurement, Hypertension, Low-resource settings

1. Introduction

Hypertension remains a critical global public health concern with substantial impact on morbidity and mortality. Hypertension is a leading cause of cardiovascular disease, stroke, and premature mortality (Ching *et al.*, 2023), serving as a major health challenge globally, including Indonesia (Berek et al., 2021). This disease contributes to high premature death (Evans *et al.*, 2021; Ma and Chen, 2022) due to low awareness and poor control rates (Ching *et al.*, 2023). Several studies have shown that high blood pressure is associated with an increased risk of cardiovascular disease (Turana et al., 2023; Jacobs et al., 2022). According to the World Health Organization (WHO), 1.28 billion adults worldwide have hypertension, with less than half being diagnosed (42%) and only one-fifth (21%) achieving control. This massive burden is complicated in low- and middle-income countries (LMICs), where fragile health systems, limited workforce capacity, and inequitable access to care continue to hinder effective hypertension management. Regional Health Research (Riskesdas)

Report and Indonesian Health Surveys in 2013, 2018, and 2023 showed fluctuations in the incidence of hypertension at 25.8%, 34.1%, and 30.8%, respectively (Kementerian Kesehatan RI, 2023; Riskesdas, 2018). Although there was a decrease in the last 5 years, this disease remained a serious challenge due to the absence of typical symptoms (the silent killer) (Kementerian Kesehatan RI, 2023; Riskesdas, 2018). The 2023 Indonesian Health Survey recorded the prevalence of hypertension based on sphygmomanometer measurements, which found an incidence of 10.7% in the 18-24 year age group and 17.4% in the 25-34 year age group. Among these cases, only a small proportion of patients were diagnosed and received adequate treatment (Kementerian Kesehatan RI, 2023). Therefore, there is a need to control blood pressure and reduce the risk of cardiovascular mortality and morbidity.

Effective Effective hypertension management fundamentally depends on accurate and consistent blood pressure control and monitoring (Tsai *et al.*, 2025; Yeh, Lin and Tsai, 2025). To improve control, self-monitoring of blood pressure using the Home Blood Pressure Measurement (HBPM) method is one of the recommended methods (Kario, 2021; Wang *et al.*, 2021, 2023; Ching *et al.*, 2023; Turana *et al.*, 2023). HBPM is a self-measurement of blood pressure performed at home or outside a healthcare facility that functions as a complement and has been shown to increase compliance with antihypertensive treatment (Scottish Health Technology Group, 2025). It helps detect white-coat and masked hypertension, offering cost-effective, accurate, and evidence-based monitoring results. Despite guideline support, uptake in rural and underserved areas remains limited by weak infrastructure (Kario *et al.*, 2024).

Another major limitation is the lack of competency among health workers in HBPM protocols and poor integration into primary healthcare workflows. Despite growing attention to HBPM, there is little information about health workers' knowledge across conceptual understanding, clinical application, and technical implementation, specifically in underserved regions (12,3). Previous studies have mostly focused on physicians or urban populations, neglecting frontline nurses and midwives in LMIC settings, particularly in Indonesia.

The Indonesia–Timor Leste (RI–RDTL) border region faces poor health infrastructure, staff shortages, and high non-communicable disease (NCD) (Sebong *et al.*, 2026). Currently, there is no published study on these competencies of health workers in implementing HBPM in RI-RDTL or other similar remote regions. Understanding these competencies is key to building training programs and improving national hypertension control strategies. Therefore, this study aims to identify the competencies of health workers related to HBPM-based hypertension management in a remote border region of Indonesia. The results provide valuable insight into local capacity-building, with a scalable model for strengthening hypertension care in other resource-limited settings worldwide.

2. Methods

2.1. Study Design

A cross-sectional descriptive study was carried out from June to September 2024 across three districts in the RI–RDTL border region. These districts represented remote, resource-limited regions characterized by limited healthcare infrastructure, workforce scarcity, and high NCD burden. Specifically, the experiment targeted frontline health workers engaged in community-level hypertension services, including public health centers and local clinics.

2.2. Setting and Samples

This study included 331 licensed health professionals, comprising nurses, midwives, doctors, pharmacists, and other health personnel actively delivering services in the three districts. Participants were recruited through purposive sampling, with inclusion criteria emphasizing active participation in hypertension screening, counseling, or chronic disease follow-up. The minimum required sample size was calculated using the Lemeshow formula for cross-sectional surveys, assuming a 60–81% prevalence of adequate HBPM knowledge (based on previous estimates), a 95% confidence level, and a 20% allowance for nonresponse.

2.3. Measurement and Data Collection

The competencies of HBPM were measured using a structured and domain-specific questionnaire comprising 21 items categorized into three core domains. These included (1) fundamental concepts of HBPM, (2) clinical benefits and diagnostic relevance, and (3) procedural implementation of HBPM. The instrument was adapted from international HBPM guidelines and previous validated tools. A review was conducted by

four experts in family medicine and primary care for content validity, with a Scale-Content Validity Index (S-CVI) was 0.91. For clarity and appropriateness, face validity and pilot testing were conducted among 30 health workers outside the study region. The instrument showed acceptable internal consistency (Cronbach's α = 0.668). Each item was scored dichotomously, where correct answers were assigned 1 point and incorrect or "don't know" had 0. Total scores were categorized as "good knowledge" for values ≥76 (based on pretest mean cutoff), and "poor knowledge" for scores below the threshold. Subsequently, data collection was performed using an online self-administered questionnaire. Participants provided informed consent electronically before accessing the questionnaire. To minimize response bias and improve data quality, instruction emphasized individual completion without discussion or reference materials.

2.4. Data Analysis

Descriptive statistics (mean, SD, frequency, and percentage) summarized participant characteristics and knowledge scores. Chi-square and logistic regression analyses identified predictors of HBPM knowledge, using $p < 0.25$ for inclusion and $p < 0.05$ as the significance level in SPSS.

2.5. Ethical Considerations

This research has undergone an ethical review and obtained approval from the Health Research Ethics Commission with Number DP.04.03/e-KEPK.1/1294/2025 so that it is suitable to be carried out in accordance with research principles that uphold the rights and dignity of respondents. Participation was voluntary, and all personal identifiers were removed during data processing.

3. Results

3.1. Characteristics

A total of 331 health workers participated in this study, with a median age of 36 years (IQR = 9), and a majority were female (79.2%). The majority of participants held a Diploma 3 in nursing (60.7%), followed by Bachelor's/Nursing degrees (35.1%), and postgraduate degrees (4.2%). By profession, nurses comprised the largest group (68.3%), followed by midwives (20.2%), physicians (4.8%), pharmacists (2.4%), and other allied health professionals (4.2%). Approximately over half (56.5%) had more than 10 years of service. Most respondents held civil servant status (57.4%). Table 1 and 2 contained the characteristics of participants.

3.2. Knowledge Level of HBPM

The mean knowledge score (Table 1) was 73.48 ± 11.57, categorized as "moderate." Based on the results, 192 participants (58.0%) showed good knowledge of HBPM, while 139 (42.0%) were classified as having poor knowledge (Table 2). The lowest scores were observed in the domain of implementation procedures.

Table 1 Participant Characteristics by Age and HBPM Knowledge Score (n=331)

Variables	Mean/Median	SD	Min – Max	95% CI
Age	36.98	6.73	21 – 58	36.26 – 37.72
Mean HBPM Knowledge Score	73.48	11.57	33.33 – 95.24	72.28 – 74.78

Table 2 Participant Characteristics by Gender, Education, Profession, Length of Service as a Health Worker, Employment Status, and HBPM Knowledge Level (n=331)

Variables	Frequency (n)	Percentage (%)
Gender:		
Male	69	20.8
Female	262	79.2
Education:		
Diploma	201	60.7
Bachelor's	116	35.1
Master's	14	4.2

Table 2 Continued

Variables	Frequency (n)	Percentage (%)
Profession:		
Nurse	226	68.3
Midwife	67	20.2
Doctor	16	4.8
Pharmacist	8	2.4
Other	14	4.2
Length of service as a health worker:		
1-5 years	74	22.4
6-10 years	70	21.1
>10 years	187	56.5
Employment Status:		
Civil Servant	190	57.4
Government Workers with a Work Agreement	62	18.7
Contract	44	13.3
Other (Private Hospital, Clinic, etc.)	35	10.6
Health Workers' Knowledge Level about HBPM:		
Good	192	58.0
Poor	139	42.0

Other professions: Sanitarian, Public Health, Nutrition, Dental Therapist, Epidemiologist

3.3. Bivariate Association

Chi-square analysis (Table 3) showed a significant association between professional background and knowledge level (p = 0.037). Based on the results, nurses and midwives had a significantly higher proportion of good knowledge compared to other professions. There was no statistically significant association found between knowledge level and age, gender, education, length of service, domicile, or employment status. Variables with a p-value <0.25 were included in a multiple logistic regression.

Table 3 Relationship between Sociodemographic Characteristics and Knowledge Level about HBPM (n=331)

Variables	Good Knowledge, n(%) 192 (58.0)	Poor Knowledge, n(%) 139 (42.0)	p-value
Gender:			
Male	35 (50.7)	34 (49.3)	0.170
Female	157 (59.9)	105 (40.1)	
Education:			0.066
Diploma	125 (62.2)	76 (37.8)	
Bachelor's	60 (51.7)	56 (48.3)	
Master's	7 (50.0)	7 (50.0)	
Professional Background:			0.037*
Nurse	132 (58.4)	94 (41.6)	
Midwife	45 (67.2)	22 (32.8)	
Doctor	9 (56.3)	7 (43.8)	
Pharmacist	2 (25.0)	6 (75.0)	
Other (Sanitarian, Public Health, Nutrition, Dental Therapist, Epidemiologist)	4 (28.6)	10 (71.4)	
Length of Service:			0.639
1-5 years	41 (55.4)	33 (44.6)	
6-10 years	41 (58.6)	29 (41.4)	
>10 years	110 (58.8)	77 (41.6)	

Table 3 Continued

Variables	Good Knowledge, n(%) 192 (58.0)	Poor Knowledge, n(%) 139 (42.0)	p-value
Worker Status:			0.348
Civil Servant	108 (56.8)	82 (43.2)	
Government Workers with a Work Agreement	35 (56.5)	27 (43.5)	
Contract	26 (59.1)	18 (40.9)	
Other (Private)	23 (65.7)	12 (34.3)	

Note: * is significant at $\alpha < 0.05$

3.4. Multivariate Logistic Regression

Multivariate analysis (Table 4) revealed that being a nurse or midwife was independently associated with higher odds of having good HBPM knowledge. Nurses were 3.5 times more likely (95% CI: 1.07–11.53, p = 0.038), and midwives were 5.1 times more likely (95% CI: 1.44–18.15, p = 0.012) to have good knowledge compared to other health professions. Gender and education level were not significant predictors.

Table 4 Factors Related to HBPM Knowledge Based on Multiple Logistic Regression (n=331)

Variables	Adjusted OR1	95% CI2 (Lower, upper)	p-value
Gender:			
Male	1		
Female	0.9	0.40 – 1.17	0.170
Profession:			
Others (Sanitarian, Public Health, Nutrition, Dental Therapist, Epidemiologist)	1		
Nurse	3.5	1.07 – 11.53	0.038*
Midwife	5.1	1.44 – 18.15	0.012*
Doctor	3.2	0.70 – 14.74	0.133
Pharmacist	0.8	0.12 – 6.01	0.857
Education:			
Diploma	1		
Bachelor's	1.65	0.56 – 4.87	0.369
Master's	1.07	0.35 – 3.25	0.903

3.5. Knowledge Item Analysis

Detailed item-level analysis (Table 5) showed that knowledge was highest for the benefit-related items. For example, 99.4% correctly identified HBPM as a useful tool in hypertension management, and 97.9% agreed on diagnostic utility. However, misconceptions were observed in implementation-related items, where only 14.8% correctly answered that HBPM values differed from clinic measurements, and 26.6% were aware of discarding the first-day readings. A significant 60.1% mistakenly believed HBPM should be performed in the morning.

Table 5 Distribution of True and False Answers Regarding HBPM-Based Hypertension Management in Health Workers (n=331)

No	Question	True		False	
		f	%	f	%
1	HBPM is a useful adjunct in the diagnosis of hypertension.	324	97.9	7	2.1
2	HBPM is a useful adjunct in hypertension management.	329	99.4	2	0.6
3	HBPM provides good prognostic value.	303	91.5	28	8.5
4	HBPM is equivalent to office measurement in diagnosing uncontrolled hypertension.	267	80.7	64	19.3
5	HBPM can be an alternative to ambulatory blood pressure measurement (ABPM).	276	83.4	55	16.6
6	HBPM can be used to diagnose isolated hypertension found in office measurements.	273	82.5	58	17.5
7	HBPM can be used to diagnose masked hypertension.	289	87.3	42	12.7
8	HBPM is used to assess the effects of treatment.	304	91.8	27	8.2
9	HBPM is used to diagnose true resistant hypertension.	259	78.2	72	21.8
10	HBPM can improve adherence to long-term treatment.	318	96.1	13	3.9
11	HBPM can optimize blood pressure control in patients with high cardiovascular risk and pregnancy.	309	93.4	22	6.6
12	The average blood pressure of at least 12 readings over 3 consecutive days should be used to assess the effectiveness of HBPM.	245	74.0	86	26.0
13	The blood pressure value measured on the first monitoring day should be discarded.	88	26.6	243	73.4
14	Mean values >135 or >85 mmHg are considered elevated.	252	76.1	79	23.9
15	Home blood pressure values do not differ from general clinic blood pressure values.	49	14.8	282	85.2
16	HBPM should only be taken in the morning.	132	39.9	199	60.1
17	HBPM should be taken at approximately the same time each morning of monitoring.	283	85.5	48	14.5
18	HBPM can be taken after meals.	158	47.7	173	52.3
19	HBPM should be taken before taking medication.	286	86.4	45	13.6
20	HBPM should be taken before urination.	167	50.5	164	49.5
21	Two measurements should be taken 1 minute apart each time during HBPM.	197	59.5	134	40.5

4. Discussion

This study provides new domain-specific insights into the knowledge of frontline health workers regarding HBPM in a remote and underserved border region of Indonesia. Although more than half of the participants (58.0%) showed an adequate level of HBPM knowledge, critical gaps were observed in the technical implementation domain. These results are significant for Indonesia as well as other low- and middle-income countries (LMICs) facing similar structural barriers to hypertension management in rural and border regions (Kario, 2021; Parati, Stergiou, et al., 2021; Berek et al., 2022; Cheng et al., 2020; Kabutoya et al., 2020).

The overall moderate knowledge level observed is in line with previous studies conducted among physicians in urban settings, which report variable familiarity with HBPM practices (Kario, 2021; Turana et al., 2023). However, this study provides a granular view, where conceptual, clinical, or procedural issues require urgent attention. Low scores on HBPM timing and interpretation show that many health workers understand its purpose but not its practice. Only 14.8% knew that home and clinic readings differed, a misconception also reported in 50% of Malaysian students (Ching *et al.*, 2023). The majority (60%) also believed HBPM was a morning-only task, contradicting guidelines. These gaps show the need for skills-based training and major clinical implications. These findings highlight critical gaps that may affect the accuracy of hypertension diagnosis and management

Although 87.3% had answered correctly regarding the benefits of HBPM for diagnosing isolated and masked hypertension, 12.7% provided incorrect responses. These results were different from the previous study, where 59.5% of medical students in Malaysia answered correctly (Ching *et al.*, 2023). Another report in physician populations showed higher awareness of 80 to 90% of physicians in Japan and Hungary, reporting

using HBPM to diagnose isolated hypertension in the clinic (Kabutoya et al., 2020; Kaya, 2025; Kim & Shin, 2023). Therefore, some health workers still provided wrong answers, showing the need to emphasize expanding education or knowledge regarding the correct use of HBPM in the clinical setting as one of the strategies for hypertension management.

This study showed a strong association between professional background and HBPM knowledge. Nurses and midwives were significantly more likely to demonstrate good knowledge than pharmacists, physicians, and other allied health professionals. The results were consistent with the operational reality in decentralized health systems, where non-physician providers often lead hypertension counseling, medication adherence monitoring, and patient education (Ogodo, 2021; Lora Mantilla *et al.*, 2025). Therefore, targeting these professionals with HBPM training would produce the greatest impact on hypertension control at the community level, particularly in remote settings with limited physician coverage (Lee and Fisher, 2023; Mills *et al.*, 2024).

This study provides important evidence by addressing a major gap in how HBPM is widely used in LMICs' healthcare (Clapham et al., 2025; Correa, 2025). Most existing literature focuses on urban hospital settings, but this study captures real-world practice in a fragile border region, showing why global guidelines must adapt to local realities. The method identifies key gaps and offers a model for HBPM integration elsewhere while guiding policies on training and support for frontline providers. Despite the significant contribution, this study has numerous limitations. The cross-sectional design precludes causal inference, and the reliance on self-reported data may result in measurement inaccuracies and limited precision in capturing actual clinical practices.. Results from one border region may not generalize, suggesting that future work should use observational or qualitative methods to test HBPM interventions and explore practice gaps.

5. Conclusion

In conclusion, this study shows that general awareness of HBPM among health workers in the RI–RDTL border region is relatively high. However, there are still substantial knowledge gaps in technical understanding and practical application. These deficiencies, particularly in measurement and interpretation, limit effective integration into primary health care. Although nurses and midwives show higher competency, the results support targeted training and task-shifting to accelerate HBPM adoption in resource-limited settings.

Recommendations: The proposed recommendations emphasize the need to strengthen the systematic implementation of Home Blood Pressure Measurement (HBPM) within healthcare services. Structured training programs on HBPM should be developed and integrated into national non-communicable disease management frameworks to enhance the capacity of health workers. Nurses and midwives should be empowered as key drivers of HBPM implementation through supportive supervision and continuous training. In addition, policy guidelines are required to standardize HBPM procedures to ensure safety and accuracy in clinical practice. Cross-country collaboration is also essential to harmonize HBPM protocols and facilitate the exchange of knowledge and best practices. Furthermore, additional research is needed to evaluate the impact of HBPM-based interventions on patient outcomes. By bridging the gap between knowledge and practice, health systems can optimize HBPM as an effective, low-cost, and sustainable tool for hypertension control in resource-limited settings.

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