

Association of Knowledge and Adherence to Preventing Hypertension Complications with Hypertension Status in Primary Health Care Settings: A Short Report from Serang City, Indonesia

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ABSTRACT

Hypertension is a major risk for cardiovascular disease, leading to global morbidity and mortality. An estimated 33.1% of adults aged 30-79 years have hypertension globally, with nearly two-thirds living in LMIC. Effective hypertension control depends on patient knowledge about complication prevention and adherence to preventive guidelines. This study aims to evaluate the association of knowledge and adherence to Preventing Hypertension Complications with Hypertension Status in Primary Health Care Settings in Serang City, Indonesia. This cross-sectional study included 83 hypertensive patients at Taktakan PHC, recruited through consecutive sampling. Data were collected through face-to-face interviews using the Hypertension Knowledge Level Scale and an adapted instrument. Most participants had uncontrolled hypertension (71.1%), low to moderate knowledge (79.5%), and poor adherence to complication prevention (65.1%). After adjusting for confounding variables, poor knowledge (OR=4.62; 95% CI: 1.01-21.22) and poor adherence to preventive measures for complications (OR=6.51; 95% CI: 1.69-25.09) increased the risk of uncontrolled hypertension. This highlights the importance of education and adherence-focused strategies in improving blood pressure and preventing long-term complications.

Keywords: Hypertension, blood pressure control, treatment adherence, patient knowledge, primary health care.

INTRODUCTION

An important risk factor that contributes to cardiovascular disease, morbidity, and mortality is hypertension [1]. Hypertension is diagnosed when systolic blood pressure is ≥ 140 mmHg and/or diastolic pressure is ≥ 90 mmHg, according to the European Society of Hypertension (ESH) guidelines. Controlled hypertension is defined as systolic blood pressure ≤ 140 mmHg and diastolic blood pressure ≤ 90 mmHg. Globally, an estimated 1.28 billion adults aged 30-79 years (33.1%) had hypertension in 2019. In Southeast Asia, prevalence reached 32.4% [2]. In Indonesia, the Indonesian Health Survey (2023) reported that the prevalence of hypertension was 30.8% among adults, with a gap between measured hypertension (26%) and physician diagnosis (5.9%). Treatment and control of hypertension remained low, specifically among productive adults. In Banten Province, the prevalence reached 29.47%, and hypertension was the most common noncommunicable disease (NCD) in Serang City, where the Taktakan Primary Health Center was one of the highest cases [3].

Hypertension can cause disability, mortality, and economic burden due to the cost of care for diseases such as heart disease, chronic kidney disease, and

stroke [4]. Previous studies indicate that greater knowledge to support behavioural change and prevent complications has remained inconsistent across regions [5]. Adherence to therapy is also important, but the evidence shows different associations with blood pressure control [6]. By identifying existing knowledge gaps in preventing hypertension complications and the lack of studies at the Primary Health Center (PHC), this indicates that further research is needed to clarify. This study aims to evaluate the association of knowledge and adherence to Preventing Hypertension Complications with Hypertension Status in Primary Health Care Settings in Serang City, Indonesia.

METHODS

This study adopted a cross-sectional design, collecting data at a single point in time. Research was conducted at Taktakan Primary Health Center (PHC) in Serang City, Indonesia, between February 2025 and April 2025. The study protocol was approved by the Institutional Review Board of the Faculty of Medicine and Health Sciences, Sultan Ageng Tirtayasa University (IRB No. 40/UN.43.20/KEPK/2025). The research data were collected from patients with hypertension at Taktakan PHC, Serang City, Indonesia.

The inclusion criteria required participants to be patients who had received services at Taktakan PHC in 2024, be aged 18 years or older, be diagnosed with essential (primary) hypertension, have complete medical records,

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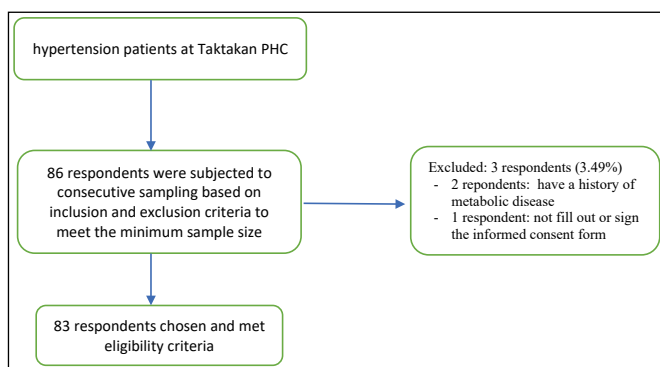


Fig. (1): Sampling process.

and have made at least 1 hypertension-related visit within the 3 months before data collection. Participants also needed to be literate in Indonesian and willing to take part in the entire research process. Exclusion criteria included having a health-related educational background, incomplete questionnaire data, or other existing metabolic diseases. Medical records were used only to identify and verify eligible respondents, not to extract study variables.

All eligible participants were recruited consecutively during this study. Data collection took place within a designated timeframe, aligned with service schedules and research permissions at Taktakan Primary Health Center in Serang City. 83 respondents met the eligibility criteria, as shown in Fig. (1).

The collection of medical records began with obtaining research approval from the Head of Taktakan PHC, followed by formal communication with the medical records staff responsible for hypertension patients. Data and information from the medical records of hypertensive patients who met the inclusion and exclusion criteria were collected with staff assistance. Participants completed questionnaires after providing written informed consent and permission. Respondents completed questionnaires assessing their knowledge of hypertension and their adherence to measures to prevent hypertension complications, which were administered simultaneously, consistent with the cross-sectional design. Data collection involved administering a questionnaire to collect general data on respondent characteristics, which was conducted through interviews using a respondent identity questionnaire. The respondents were asked to read the questionnaire instructions. The researchers provided the opportunity for them to ask questions if anything was unclear and to complete the questionnaire with the researcher nearby. Before the interviews, the researchers obtained informed consent from the subjects.

Blood pressure was measured using a validated non-mercury sphygmomanometer, with periodic calibration every 6-12 months and appropriate cuff selection based on arm circumference. Additionally, hypertension status was obtained from medical records dating back at least 3 months, but repeated measurements were

not performed. Hypertension status is divided into controlled and uncontrolled hypertension. Controlled hypertension status was defined as a hypertensive patient with systolic blood pressure ≤ 140 mmHg and diastolic blood pressure ≤ 90 mmHg, measured during a visit to a healthcare facility within the last 3 months. Knowledge about hypertension complication prevention was gained through experience or observation, helping broaden understanding and deepen awareness of the condition [7].

Data on knowledge of hypertension were obtained through interviews using a Hypertension Knowledge Level Scale (HK-LS) questionnaire, adapted from previous research, with a reliability coefficient of 0.758 (Cronbach's alpha) [8]. The HK-LS questionnaire assessing knowledge of hypertension complication prevention consists of a 22-item closed-ended questionnaire with three response options (true, false, or don't know). The questionnaire covered the definition of hypertension, drug compliance with hypertension, medical treatment of hypertension, lifestyle related to hypertension, the personal diet of patients, and the complications of hypertension. The categorization criteria for the knowledge level were high and low-moderate. The low level included scores 0-7, the moderate level included scores 8-15, and the high level included scores 16-22. The complete questionnaire is provided in the supplementary file (S1).

The questionnaire used to assess adherence to hypertension complication prevention in this study was also adapted, and the categorization criteria for adherence to hypertension complication prevention level were adherent and not adherent [9]. The questionnaire on adherence to hypertension complication prevention included 11 items with yes/no options. Validity testing using Pearson's Product-Moment correlation showed that all items were valid, with a calculated r value exceeding the table r value (corrected total item correlation > 0.3809), and reliability testing using Cronbach's Alpha yielded a value of 0.885. The questionnaire included patients' salt intake, physical activity, antihypertensive medication, consumption of risk foods, maintenance of a balanced diet, smoking habit, monitoring of blood pressure, consumption of alcohol, and patients' stress prevention. Adherence to hypertension complication prevention was defined as the patient's willingness to follow the care provided by healthcare providers. This commitment was based on an understanding of the plan, including the potential benefits and the associated risks. The complete questionnaire is provided in the supplementary file (S2).

Other variables collected included demographic data and health facilities. The questionnaire on access to health facilities was developed following a review of previous studies [10]. It was found to be reliable, with Cronbach's Alpha yielding a value of 0.724. The validity was also confirmed with other relevant field experts. This questionnaire consisted of 10 items using a Likert

scale, from strongly disagree (score 1) to strongly agree (score 4). Data were categorized based on total score into easy-to-access (score 21-40) and difficult-to-access (score 1-20). The questionnaire items included the accessibility of health facilities, the service hours of health services, the treatment costs of health care, the communication of healthcare providers, the beliefs of patients regarding health care services, the procedures of health care services, the privacy of treatment, and the satisfaction with health services. Access to health services is defined as an individual's ability to obtain and use health services in accordance with their needs. The complete questionnaire is provided in the supplementary file (S3).

The processing data included editing, scoring, data entry, coding, and tabulation. The analysis was conducted using Stata version 16 (Stata Corp., College Station, TX, USA). Unadjusted Odds ratios (ORs) with 95% confidence intervals (CIs) were computed using binary logistic regression. If $p < 0.25$ was found in the univariate analysis, multivariable logistic regression was conducted to adjust for confounding factors and to develop a parsimonious, well-fitting model. The statistical significance of the final regression model was set at $p < 0.05$.

RESULTS

The characteristics of patients showed that most were aged 18-59 years (79.5%), with an average age of 49.13 ± 13.30 years. Besides, the patients were women (75.9%), most had completed only senior high school (66.3%), and they were unemployed (53.0%). Most patients (59.0%) found it relatively difficult to access the health service. Most respondents had uncontrolled hypertension (71.1%). In terms of knowledge level, the majority fell into the moderate category (55.4%). Meanwhile, regarding adherence, most participants were classified as non-adherent (65.1%). Most respondents in this study had uncontrolled hypertension (71.1%). The knowledge level of hypertension was at a low to moderate level (79.5%). The recategorization of the knowledge variable to simplify data classification makes it more effective for statistical analysis. Besides, this recategorization was based on data distribution and the more meaningful analytical structure. The adherence to hypertension complication prevention was predominantly non-adherent to treatment (65.1%), as shown in Table 1.

Table 2: The relationship between independent variables and hypertension status ($n = 83$).

Variables	Uncontrolled Hypertension		Controlled Hypertension		Crude*	p-value	Full-model ^{LR}
	n	%	n	%			
Knowledge Level							
Low-Moderate	51	77.3	15	22.7	3.83 (1.29-11.38)	0.049	4.62 (1.01-21.22)
High	8	47.1	9	52.9	1.00 (reference)		1.00 (reference)
Adherence level							
Not Adherent	45	83.3	9	16.7	5.36 (1.96-14.67)	0.006	6.51 (1.69-25.09)
Adherent	14	48.3	15	51.7	1.00 (reference)		1.00 (reference)

Table 1: Respondent characteristics ($n=83$).

Characteristics	Frequency Distribution	
	n	%
Age (years old)		
18-59 years old	66	79.5
>60 years old	17	20.5
Gender		
Man	20	24.1
Woman	63	75.9
Education Level		
>Senior High School	28	33.7
< Senior High School	55	66.3
Work Status		
Working	39	47.0
Not Working	44	53.0
Access to Health Services		
Easy to access	34	41.0
Difficult to access	49	59.0
Knowledge Level		
High	17	20.5
Low-Moderate	66	79.5
Adherence Level		
Adherent	29	34.9
Not Adherent	54	65.1
Hypertension Status		
Controlled Hypertension	24	28.9
Uncontrolled Hypertension	59	71.1

The bivariate analysis showed that 52.9% of patients had high knowledge in the controlled hypertension group. In contrast, 77.3% patients had low to moderate knowledge levels in the uncontrolled hypertension group. The association was statistically significant ($OR=3.83$; 95% CI: 1.29-11.38, $p=0.018$), indicating that patients with low to moderate knowledge were 3.83 times more likely to have uncontrolled hypertension than those with high knowledge. Besides, 51.7% of patients in the controlled hypertension group were adherent, while 83.3% were not adherent in the uncontrolled hypertension group. The statistical analysis showed a significant relationship between adherence and uncontrolled hypertension ($OR = 5.36$; 95% CI: 1.96-14.67, $p<0.001$), indicating that non-adherent patients were 5.36 times more likely to have uncontrolled hypertension than adherent patients, as shown in Table 2. The relationships among respondents' age, gender, education level, work status, and access to health services were also assessed in bivariate analysis. The education level of respondents ($OR=4.50$; 95% CI: 1.66-12.19, $p=0.003$), work status of

Variables	Uncontrolled Hypertension		Controlled Hypertension		Crude*	p-value	Full-model ^{LR}
	n	%	n	%			
Age (years old)							
>60 years old	15	88.2	2	11.8	3.75 (0.87-17.93)	0.087	5.73 (0.77-42.41)
18-59 years old	44	66.7	22	33.3	1.00 (reference)		1.00 (reference)
Gender							
Woman	47	74.6	16	25.4	1.96 (0.69-5.55)	-	-
Man	12	60.0	8	40.0	1.00 (reference)		
Education Level							
< Senior High School	45	81.8	10	18.2	4.50 (1.66-12.19)	0.065	3.33 (0.93-11.92)
>Senior High School	14	50.0	14	50.0	1.00 (reference)		1.00 (reference)
Work Status							
Not Working	38	86.4	6	13.6	5.43 (1.91-15.35)	0.075	3.12 (0.89-10.89)
Working	21	53.8	18	46.2	1.00 (reference)		1.00 (reference)
Access to health services							
Difficult to access	39	79.6	10	20.4	2.73 (1.04-7.13)	0.119	2.81 (0.77-10.29)
Easy to access	20	58.8	14	14	1.00 (reference)		1.00 (reference)

*Values are presented as odds ratio (95% confidence interval)

^f Fisher's Exact Test

^{cs} chi-square test

^{LR} Logistic Regression, significant at $p < 0.25$ (or $p > 0.25$ for a variable considered sufficiently important) and analyzed in the full model.

respondents (OR=5.43; 95% CI: 1.91-15.35, $p = 0.001$), and access to health services (OR=2.73; 95% CI: 1.04-7.13, $p = 0.040$) showed a significant relationship to uncontrolled hypertension.

Result of full model showed that the low-moderate knowledge level (aOR=4.62; 95% CI: 1.01-21.22, $p = 0.049$), non-adherence (aOR=6.51; 95% CI: 1.69-25.09, $p = 0.006$), age of ≥ 60 years (aOR=5.73; 95% CI: 0.77-42.41, $p = 0.087$), not attending senior high school (aOR=3.33; 95% CI: 0.93-11.92, $p = 0.065$), not working (aOR=3.12; 95% CI: 0.89-10.89, $p = 0.075$), and access to health services (aOR=2.81; 95% CI: 0.77-10.29, $p = 0.119$) were associated to higher odds of uncontrolled hypertension.

DISCUSSION

Hypertension is increasingly observed among adults of productive age, which, in previous literature, has been associated with lifestyle factors, psychosocial stress, and environmental factors [11]. Low compliance with treatment can arise, among other things, due to a lack of knowledge, which can hinder understanding of hypertension itself and the control and prevention of hypertension. Based on previous studies, it was also stated that most respondents were no longer working and had even retired. In addition, low physical activity, especially among smokers, can stimulate increased pressure and load on the cardiovascular system, thereby increasing the risk of hypertension [12]. Obstacles due to geographic conditions, inadequate transportation, or uneven distribution of facilities can indicate limited access to health facilities. Based on these findings, it can be seen that sociodemographic factors such as gender, age, education level, employment status, and access to affordable health services play an important role in determining adherence to treatment and overall control of hypertension [13]. Respondents' knowledge

level plays a crucial role in understanding how to take medication regularly, maintain a healthy diet, engage in appropriate physical activity, and monitor blood pressure regularly, ultimately contributing to maintaining controlled blood pressure. Respondents with lower educational backgrounds were more likely to lack knowledge, underscoring the need for an optimal educational strategy tailored to the community's literacy level [14]. Consistent with these reports, our findings indicate an association between knowledge level and blood pressure control, supporting the interpretation that knowledge may function as an important correlate of adherence behaviour rather than a determinant.

Sociodemographic characteristics, including age, gender, education level, employment status, and access to health services, were associated with hypertension control in this sample. Comparable cross-sectional studies conducted in primary care and community settings have reported similar patterns, suggesting that these factors may act as contextual correlates influencing treatment behaviour and health-service utilization [15]. Access to healthcare services was also associated with blood pressure control. Participants reporting easier access tended to have better control, which is consistent with findings from other observational studies indicating that accessibility and affordability of care are linked to improved hypertension management indicators [16]. However, given the observational nature of the data, these relationships cannot establish causality.

In our study, the higher proportion of female respondents may reflect differences in healthcare-seeking behaviour rather than biological susceptibility, and therefore should be interpreted cautiously. In this study, hypertension also mostly occurs in individuals of age 18-59 years, which indicates an association between unhealthy lifestyle factors, high levels of stressors associated with daily

activities, and psychosocial environmental conditions that often occur in this age group. Chronic stress can elevate blood pressure by activating the sympathetic nervous system and the hormonal system, including norepinephrine, angiotensin II, aldosterone, and vasopressin. This can lead to persistent hypertension and structural changes in the cardiovascular system. Unhealthy lifestyles, including a high salt diet, lack of optimal physical activity, and smoking, can exacerbate the risk of hypertension. Furthermore, when accompanied by socioeconomic problems, hypertension control and management become even more difficult, especially when accompanied by limited access to healthcare facilities [17].

The study found that a majority of female respondents, indicating that women are more aware of healthcare services, particularly in early detection and healthcare behaviours. Furthermore, women's social roles, higher health awareness, and more free time, especially for those not working, may significantly contribute to healthcare utilization. However, physiologically, it's also worth noting that decreased estrogen levels in women after menopause can also increase the risk of hypertension [18, 19]. A decrease in estrogen levels in women can also reduce HDL levels, increase LDL levels, accelerate the atherosclerosis process, and increase the activity of the renin-angiotensin-aldosterone system, thereby contributing to an increase in blood pressure [20].

Other contributing factors include access to healthcare services. Easier access to healthcare services is associated with better-controlled blood pressure, potentially acting as a protective factor. Furthermore, affordability also depends on geographic conditions, socioeconomic factors, and the lack of standardized infrastructure across regions. This may explain the inconsistency in research findings and results across different sociodemographic settings, particularly in more advanced healthcare systems [21].

Medication adherence showed a statistically significant association with hypertension control. This finding aligns with prior cross-sectional research demonstrating that individuals categorized as adherent are more likely to have controlled blood pressure [22]. While adherence is widely recognized as an important component of hypertension management, our results should be interpreted as supporting its role as a correlated factor rather than evidence of a causal effect. Patient medication adherence encompasses pharmacological medication procedures, daily salt restriction, physical activity, and routine blood pressure monitoring to prevent complications and maintain stable blood pressure. Poor medication adherence can increase the severity of hypertension and potentially lead to serious complications, such as stroke and cardiovascular disease. Therefore, hypertension control requires increased patient knowledge, along with strengthening

medication adherence behaviour and supporting adherence, particularly at the primary care level [21].

The strengths of this study include the use of a well-validated questionnaire to assess knowledge and adherence. Furthermore, the study was conducted in a community health centre with a relatively high prevalence of hypertension, making it relevant to hypertension and representative of actual community conditions. The use of multivariable analysis allows for the identification of significant associations and their strength. This study also considers potential confounding factors, including education, employment, access to healthcare, age, and gender. This approach helps ensure that the detected associations are more objective and less prone to bias.

On the other hand, this study still has several limitations. The choice of a cross-sectional design may further limit the ability to infer causality, so that it can only be interpreted as an association. The observed associations may also be affected by reverse causation. Likewise, non-probability sampling, in this case, consecutive sampling, may compromise population representativeness and introduce selection bias. While recruitment from a single primary health centre limits representativeness and external validity. Although the initial patient pool was substantial, only individuals who met the predefined inclusion criteria, particularly the availability of identity data from medical records and the need for a direct interview, were eligible for inclusion in the analysis. Excluding patients with metabolic diseases may reduce generalizability to the broader hypertensive population. Adherence was assessed using a self-reported instrument, which may be subject to recall and social desirability biases. The analysis results show wide CIs, which were likely less precise, indicate limited precision of the effect estimates, and borderline p-values suggest that the associations should be interpreted cautiously. Although the analysis included selected sociodemographic variables, several potentially important clinical confounders, such as duration of hypertension, antihypertensive medication regimen, comorbid conditions, body mass index, smoking status, dietary patterns, stress, socioeconomic conditions, cultural factors, menopausal status, and family support, were not assessed. The absence of these variables may introduce residual confounding, as these factors are known to influence blood pressure control and patient adherence behaviours.

Overall, the findings of this study are best understood within the framework of associative evidence. The results contribute to existing cross-sectional literature by reinforcing the observed relationships between knowledge, adherence behaviour, sociodemographic context, and blood pressure control in primary care populations, while highlighting the need for longitudinal or interventional studies to clarify causal pathways. Consequently, the observed associations should be interpreted cautiously, and future studies are

recommended to incorporate comprehensive clinical and lifestyle variables to improve model validity and causal inference. This may limit a more comprehensive understanding of the broader context that influences the study results. Nevertheless, this study provides additional meaningful basic insights and serves as a foundation for future research with an in-depth approach.

CONCLUSION

This study demonstrates the critical role of patient knowledge and adherence in hypertension control in a primary care setting. Poor to moderate knowledge is associated with uncontrolled blood pressure, as is non-adherence to treatment. While the results suggest that knowledge level and adherence behaviour may be important factors in hypertension management, the evidence is insufficient to establish directionality or causal pathways. Therefore, implications for clinical practice and health programs should be considered cautiously. Further research using longitudinal or experimental designs with larger and more representative samples is needed to verify these relationships and better understand their temporal and causal dynamics. Besides, this requires patient involvement in health education, regular blood pressure checks, healthy lifestyle habits, and consistent adherence to medication instructions and procedures.

Furthermore, family involvement in daily monitoring and reminders is crucial in supporting patient adherence. For healthcare providers and policymakers, regular monitoring of epidemiological trends in hypertension is crucial for planning effective interventions. Future studies are expected to use a longitudinal research design to track the progression of risk factors until outcomes emerge. Furthermore, probability sampling should be used to ensure that every member of the accessible population has an equal opportunity to participate. Additionally, harmonious collaboration among families, communities, healthcare professionals, and policymakers can enhance the effectiveness of hypertension control, making it more sustainable and impactful.

ETHICS APPROVAL

The study protocol was approved by the Institutional Review Board of the Faculty of Medicine and Health Sciences, Sultan Ageng Tirtayasa University (IRB No. 40/UN.43.20/KEPK/2025). The research data were collected from patients with hypertension at Taktakan PHC, Serang City, Indonesia. All procedures performed in studies involving human participants were conducted in accordance with the ethical standards of the institutional and/or national research committee and the Helsinki Declaration.

CONSENT FOR PUBLICATION

All participants gave written informed consent for the publication of their anonymized data.

AVAILABILITY OF DATA

The datasets generated and analysed in this study are not publicly accessible to protect participant confidentiality; however, they can be obtained from the corresponding author upon reasonable request.

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None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORS' CONTRIBUTION

Conceptualization: IMS, SFA, OR. Data curation: IMS, SFA. Formal analysis: IMS, SFA. Methodology: IMS, SFA, OR. Project administration: IMS, SFA, OR. Visualization: IMS. Writing - original draft: IMS, SFA. Writing - review & editing: IMS.

GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors used ChatGPT (GPT-4, OpenAI) sparingly during manuscript preparation, primarily for language suggestions and minor corrections in some sections. All subsequent content was independently reviewed and edited by the authors, who are solely responsible for the accuracy, interpretation, and scientific content of the published article.

SUPPLEMENTARY MATERIAL

Supplementary material is available on the journal's website.

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