



WHATSAPP-FACILITATED EMPOWERMENT OF HEALTH CADRES TO IMPROVE KNOWLEDGE AND BLOOD PRESSURE CONTROL AMONG ADULTS WITH HYPERTENSION: A QUASI-EXPERIMENTAL STUDY

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ABSTRACT

Hypertension constitutes a major public health concern and serves as a primary risk factor for cardiovascular disease, stroke, renal failure, and premature mortality. Successful hypertension control necessitates a comprehensive approach that relies not only on pharmacological therapy but also on enhancing patient health literacy. The sustainable empowerment of health cadres through WhatsApp-based education represents an effective strategy for improving patient knowledge, thereby promoting behavioral change and enhancing blood pressure control. To analyze the effect of health cadre empowerment via WhatsApp on the level of knowledge and hypertension control. Methods: This study employed a quasi-experimental design with a pretest-posttest control group approach. Data were collected using a purposive sampling method with specified inclusion and exclusion criteria, a total of 60 respondents were involved, consisting of a control group (n = 30) and an experimental group (n = 30). Knowledge levels and blood pressure were assessed in both groups at baseline and following the intervention. To evaluate the intervention effect, the pre-post change scores of both groups were analyzed using the Wilcoxon signed-rank test. The significance level was set at $p < 0.05$ for all analyses. Prior to the intervention, the majority of respondents in the control group (73.3%) and the experimental group (60.0%) had a sufficient level of knowledge. Following the intervention, all respondents in the experimental group (100%) achieved a good level of knowledge. The mean reduction in systolic blood pressure was ($\Delta = 14.10$ mmHg), and diastolic blood pressure decreased by ($\Delta = 5.3$ mmHg). The Wilcoxon test results indicated a significant difference between blood pressure before and after the intervention, both for systolic ($Z = -4.813$; $p < 0.001$) and diastolic ($Z = -4.489$; $p < 0.001$) measurements. The empowerment of health cadres through WhatsApp-based health education is effective in improving knowledge and reducing blood pressure among hypertensive patients.

Keywords: cadre empowerment; health education; health promotion; hypertension; knowledge; whatsapp

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INTRODUCTION

Hypertension is reported as one of the leading causes of death worldwide (WHO, 2025). Uncontrolled hypertension constitutes a major risk factor for myocardial infarction, stroke, and chronic kidney disease (WHO, 2025). In Indonesia, hypertension is identified as a primary cause of complications arising from stroke, blindness, heart failure, and renal failure (SKI, 2023). According to a WHO report, the number of individuals aged 30–79 years with hypertension globally surged from 650 million in 1990 to 1.4 billion in 2025 (WHO, 2025). This increase has occurred predominantly in low- and middle-income countries, mainly as a consequence of the growing elderly population in those nations (WHO, 2025). Based on data from the 2018 Basic Health Research (Riskesdas) and the 2023 Indonesian Health Survey (SKI), the prevalence of hypertension among the productive age group in Indonesia remains high and shows an increasing trend with advancing age (Riskesdas, 2018; SKI, 2023). This persistently high prevalence, observed at both the global and national levels, emphasizes the pressing need for countries, especially developing ones, to reinforce their prevention and control measures. Although pharmacological therapy has

progressed significantly, the success rate of blood pressure control remains relatively low. One of the factors influencing this condition is the insufficient level of patient knowledge regarding hypertension, its associated risk factors, complications, the imperative of treatment adherence, as well as healthy lifestyle modifications (Falcão et al., 2023).

Knowledge constitutes a predisposing factor that plays a significant role in the formation of health behavior. Patients with a good level of knowledge tend to exhibit higher adherence to treatment, undergo regular health check-ups, adhere to a low-salt diet, increase physical activity, and avoid risk factors that may exacerbate their hypertensive condition (Rosendo-Silva et al., 2023). The optimization of community-based hypertension control programs is influenced by a number of interrelated factors (Keloay et al., 2026). At the facility level, the integrated non-communicable disease post (Posbindu PTM) services have not yet achieved optimal performance due to the limited number and capacity of community health cadres, inadequate distribution of training, and insufficient infrastructure amidst expansive working areas. Meanwhile, from the community perspective, the primary challenges include low health literacy, non-adherence to medication, socioeconomic factors, environmental conditions, and unhealthy lifestyles. The lack of support and recognition for health cadres also constitutes a crucial factor that undermines the sustainability of this program. The present study serves as a continuation of the work by Keloay et al. (2026) and an extension of previous cadre empowerment efforts, with the objective of sustaining communication, information dissemination, education, and continuous cadre mentoring to enhance both public knowledge and hypertension control.

Health cadres serve as the frontline in the prevention of non-communicable diseases (NCDs). The optimization of hypertension promotion and prevention efforts can be achieved by empowering cadres through WhatsApp, a platform that is already widely familiar within the community (Keloay et al., 2026). Empowerment itself is a social process aimed at enhancing an individual's capacity to meet their needs, solve problems, and manage their life independently (Crawford Shearer & Reed, 2004). Health cadres assist health professionals by providing education and disease prevention services within the community. With their strengthened roles, they are able to deliver comprehensive and high-quality promotive, preventive, and early detection services without financial constraints, in order to achieve optimal health outcomes (Kemenkes, 2019).

The global prevalence of hypertension is estimated at 1.4 billion adults aged 30–79 years worldwide suffering from the condition (WHO, 2025). Based on national data, the prevalence of hypertension in Indonesia decreased from 34.1% (Riskesdas, 2018) to 30.8% (SKI, 2023). However, this reduction has not been significant and varies across provinces. For instance, North Sulawesi experienced an increase from 26.3% (Riskesdas, 2018) to 29.2% (SKI, 2023). In the working area of the Tateli Primary Health Center (Puskesmas Tateli), the number of hypertension cases rose from 906 to 2,523 individuals. In the specific research area, namely Kalasey 2 Village, the number of diagnosed hypertension cases was recorded as the highest, totaling 161 individuals (Puskesmas Tateli, 2024).

Based on a preliminary study conducted in April 2025, in which the researchers interviewed health personnel at the Tateli Primary Health Center and several community members, it was found that community adherence remains low, healthy lifestyle practices are insufficient, health literacy is limited, family support is restricted, and factors such as forgetfulness, socioeconomic conditions, environmental issues, and limited access to healthcare services persist. These conditions are at risk of increasing the prevalence of hypertension. If hypertension is not detected or regularly controlled, the consequences are highly complex, encompassing physical, psychological, social, spiritual, and financial domains. The worst outcomes include increased morbidity and mortality. The government has initiated the CERDIK and PATUH programs (Ministry of Health of the Republic of Indonesia, 2020); however, the results have not yet been optimal. Various barriers remain challenging,

including resource limitations, economic constraints, difficulties in access and transportation, as well as a lack of family and social environmental support (Unger et al., 2020).

Therefore, collective efforts are required to address the burden of hypertension in low- and middle-income countries (Mbuthia et al., 2022). Given the scarcity of resources, the empowerment of health cadres at the community level represents a potential solution (Gamage et al., 2020). The study by Augustovski et al. (2018) demonstrated that empowering cadres in health education is effective and has a positive impact on hypertension management in community settings (Vedanthan et al., 2019). Furthermore, smartphone-based educational interventions have been considered feasible and efficient in assisting hypertensive patients to lower their blood pressure and improve their self-management capacity (Li et al., 2019).

Previous studies have demonstrated that the empowerment of health cadres and smartphone-based hypertension education interventions exert a positive impact on hypertension management. However, evidence regarding the role of health cadres in the implementation of non-communicable disease (NCD) interventions at the primary care level remains limited and continues to evolve, particularly in rural areas as well as in low- and middle-income countries (Ingenhoff et al., 2022). Research on the empowerment of health cadres through WhatsApp is of critical importance. Although the role of health cadres in the community is well recognized, existing evidence has predominantly focused on the direct improvement of cadre capacity, leaving a specific gap regarding the ripple effect namely, whether enhanced cadre competencies, continuously supported by structured WhatsApp-based education and mentoring, actually cascade into measurable improvements in community-level hypertension knowledge and blood pressure control. This gap is particularly pronounced in rural and primary care settings, where cadres serve as the frontline link to formal health services, yet empirical data on this distal impact remain scarce. To address this, our study explicitly measures this ripple effect by comparing the changes in community members' hypertension knowledge scores and blood pressure readings assessed through standardized measurement protocols between communities that are handled by health cadres. Beyond merely addressing the acute problem, this community empowerment approach via WhatsApp emphasizes sustainable self-care and long-term health maintenance, recognizing hypertension as a chronic condition requiring continuous community-level engagement. Furthermore, empowered cadres are expected to serve as role models in promoting healthy lifestyle behavioral changes, ultimately contributing to sustained monitoring within their communities. The Objective in this study to analyze the effect of health cadre empowerment via WhatsApp on the level of knowledge and hypertension control.

METHOD

This study constitutes a follow-up investigation from previous research conducted by the investigators, ensuring conceptual continuity while extending the research framework to a distinct population and broader community-level outcomes. The initial study specifically targeted health cadres as subjects, providing a WhatsApp-based empowerment intervention and measuring its direct impact on cadres' knowledge and skills in hypertension management. In contrast, this follow-up study employs an identical intervention strategy but applies it to an entirely different sample, namely community members in rural areas, while shifting the primary outcomes to hypertension knowledge and blood pressure control at the community level. Furthermore, while the initial study assessed outcomes immediately following the 1-month intervention period, this follow-up study measures outcomes at a later time point to capture delayed effects or ripple effects of the intervention at the community level after 3 months of intervention.

Specifically, this study is designed to identify the ripple effect of health cadre empowerment on the communities under their guidance. Therefore, the community sample selected in this study is part of the working area of the health cadres who had been empowered in the first study. Thus, there is a direct linkage between the subjects of the first study (cadres) and the subjects of the second study

(community members). The novelty of this research lies in its attempt to examine cadre performance at the community level through outcomes measured at the community level, namely changes in community knowledge and the success of hypertension control within the assisted areas. In other words, this study not only measures the impact of the intervention on the cadres themselves but also traces the extent to which cadre empowerment is able to transfer its benefits to the communities they serve. The 3-month community intervention protocol, based on the TIDieR checklist (Template for Intervention Description and Replication), is presented in Appendix Table 1.

In this follow-up study, after the cadres in the working area had received training on hypertension management, they were expected to be capable of bridging similar education regarding hypertension management at the community level. This study was conducted over a period of three months using a WhatsApp group application as the primary educational medium. Educational messages were delivered twice per week, following a structured topical schedule implemented over 12 weeks. The materials covered comprehensive topics, including basic hypertension knowledge (definition, signs, symptoms, and risk factors), prevention efforts and lifestyle modifications (low-salt diet, physical activity, and stress management), as well as treatment adherence and routine blood pressure monitoring. Each cadre was assigned a cadre-to-respondent ratio of 1:10 to ensure adequate personalized attention. The twice-weekly mentoring sessions consisted of interactive question-and-answer discussions, reinforcement of weekly topics, and personalized feedback via text and voice messages. Respondent engagement was tracked based on active participation in group discussions and timely responses through the WhatsApp group, with an average attendance/engagement rate of 100% throughout the intervention period. Fidelity monitoring was performed by the primary investigator through periodic audits of message delivery logs and session summaries to ensure strict adherence to the protocol. Meanwhile, the control group received the conventional standard procedure, consisting solely of printed health information leaflets distributed at the primary health center, without any structured digital or active mentoring component. This study employs a quantitative methodology consisting of two phases. Phase 1 involves the development of a cadre empowerment module. Phase 2 utilizes a quasi-experimental design with a pretest-posttest control group approach. The population comprises individuals with hypertension in Kalasey 2 Village, within the working area of the Tateli Primary Health Center. A sample of 60 respondents was selected using purposive sampling, divided into an intervention group ($n=30$) and a control group ($n=30$). The sample size was calculated using G-Power (effect size = 0.5; $\alpha = 0.05$; power = 0.80), adhering to the inclusion and exclusion criteria predetermined by the researchers as follows: Inclusion criteria: Participants eligible for this study are individuals aged between 18 and 65 years who have been formally diagnosed with hypertension by a health professional. They must own a smartphone with an active WhatsApp account and be able to use basic features such as reading messages, viewing images, and sending text messages. At the screening visit, they are required to have a blood pressure reading of systolic ≥ 140 mmHg and/or diastolic ≥ 90 mmHg, as this threshold is necessary for evaluating the hypertension control outcome. All candidates must also be willing to participate by signing an informed consent form. On the other hand, exclusion criteria include the presence of serious health conditions or severe hypertension related complications, such as stroke, heart failure, kidney failure, or dementia. Individuals with severe hearing, visual, or cognitive impairments that would hinder the delivery of the intervention via WhatsApp are also excluded. Additionally, those who have participated in a similar hypertension intervention program—whether from the primary health center or another study—within the last six months will not be eligible for enrollment.

The independent variable in this study was the empowerment of health cadres through WhatsApp (X), while the dependent variables comprised knowledge (Y1) and hypertension control (Y2). Knowledge was assessed using a 25-item Guttman scale questionnaire, adapted and modified from Abdel-All et al. (2018). Each correct response was scored as 1 and each incorrect response as 0,

yielding a total score ranging from 0 to 25, which was subsequently categorized into three levels: poor (scores 0–8), sufficient (scores 9–16), and good (scores 17–25). Following modification and pilot testing in a similar population, the instrument demonstrated adequate content validity ($I-CVI > 0.80$) and internal consistency (Cronbach's $\alpha = 0.85$). Blood pressure was measured using a calibrated digital sphygmomanometer (Omron HEM 7120, validated according to the International Society of hypertension global guidelines). All measurements were performed according to a standardized protocol: after a 5 minute resting period in a seated position, with the back supported, feet flat on the floor, and the arm resting at heart level, two readings were taken at 2 minute intervals, and the average of the two readings was recorded for analysis.

RESULT

Table 1.
Distribution of Respondent Characteristics

Characteristics	Control (n=30)	Experimental (n=30)	Total (n=60)
Age (years)			
18- 25	1 (100.0%)	0 (%)	1 (1.7%)
26-35	0 (%)	0 (%)	0 (%)
36-45	5 (55.6%)	4 (44.4%)	9 (15%)
46-55	10 (52.6%)	9 (47.4%)	19 (31.7%)
>56	14 (45.2%)	17 (54.8%)	31 (51.6%)
Sex			
Male	9 (56.3%)	7 (43.8%)	16 (26.7%)
Female	21 (47.7%)	23 (52.3%)	44 (73.3%)
Education Level			
Elementary School	8 (36.4%)	14 (63.6%)	22 (36.7%)
Junior High School	11 (78.6%)	3 (21.4%)	14 (23.3%)
Senior High School	9 (42.9%)	12 (57.1%)	21 (35%)
Bachelor's Degree	2 (66.7%)	1 (33.3%)	3 (5%)
Marital Status			
Married	30 (100%)	30 (100%)	60 (100%)
Religion			
Christian	30 (100%)	30 (100%)	60 (100%)
Income			
Below Regional Minimum Wage	28 (48.3%)	30 (51.7%)	58 (96.7%)
Above Regional Minimum Wage	2 (100.0%)	0 (0%)	2 (3.3%)

The respondent profile was predominantly characterized by older adults, with the vast majority (83.33%) aged above 45 years, while younger age groups showed minimal participation. Both groups were predominantly female, with a slightly higher proportion in the experimental group (76.7%) compared to the control group (70.0%). Educational backgrounds varied, with junior high school being most common in the control group (36.7%) and elementary school in the experimental group (46.7%). All respondents were married and Christian (100%). Regarding income, nearly all participants (93.3% in the control group and 100% in the experimental group) had earnings below the Regional Minimum Wage, indicating a generally low-income sample.

Table 2.
Distribution of Respondent Knowledge Levels

Knowledge Level	Experimental Group n(%)		Control Group n(%)	
	Pretest	Posttest	Pretest	Posttest
Poor	8 (26.7)	0 (0)	6 (20)	0 (0)
Sufficient	18 (60)	0 (0)	22 (73.3)	11 (36.7)
Good	4 (13.3)	30 (100)	2 (6.7)	19 (63.3)
Total	30 (100)	30 (100)	30 (100)	30 (100)

The research findings indicated that during the pre-test phase, both the experimental and control groups exhibited relatively homogeneous baseline characteristics. The majority of respondents in both groups had knowledge levels categorized as "sufficient," accounting for 73.3% in the control group and 60.0% in the experimental group. Meanwhile, the proportion of respondents with "poor" knowledge remained notably high, at 20.0% and 26.7%, respectively. Only a small fraction of

respondents demonstrated "good" knowledge, with 6.7% in the control group and 13.3% in the experimental group. Following the intervention, both groups demonstrated marked improvement; however, the outcomes between the two groups differed considerably.

In the control group, no respondents remained in the "poor" category (0%). The proportion of respondents in the "sufficient" category decreased from 73.3% to 36.7%, while the "good" category increased from 6.7% to 63.3%. This improvement indicates that the method administered to the control group (the conventional method) was effective in enhancing knowledge; however, it did not fully elevate all respondents to an optimal level of understanding, as 36.7% remained in the "sufficient" category. Post-intervention, all respondents in the experimental group ($n=30$, 100%) were classified within the "good" knowledge category according to the predetermined scoring criteria, whereas no participants were categorized as "sufficient" or "poor." This distribution reflects a considerable improvement relative to baseline measurements. The changes observed in the control group were not as pronounced as those in the experimental group. These findings indicate that the empowerment of health cadres through WhatsApp is capable of significantly improving respondents knowledge regarding hypertension, encompassing its definition, signs and symptoms, risk factors, prevention, treatment, and control.

Variable	Group	Pretest (Mean $\pm$ SD)	Posttest (Mean $\pm$ SD)	Nilai Z	p-value
Knowledge	Experimental	1,87 $\pm$ 0,625	3,00 $\pm$ 0,000	-4,660	<0,001
	Control	1,87 $\pm$ 0,507	2,63 $\pm$ 0,490	-4,796	<0,001

Note: Data are presented as mean $\pm$ standard deviation. SD = Standard Deviation. Wilcoxon signed-rank test was used for within-group comparisons.

Table 3.

Comparison of WhatsApp-Based Health Cadre Empowerment on Hypertension Knowledge

The analysis revealed that the mean knowledge score in the experimental group increased from 1.87 ± 0.625 prior to the intervention to 3.00 ± 0.000 following the intervention, with a Z-value of -4.660. The statistical test results indicated a p-value of <0.001, signifying a significant difference in knowledge scores before and after the WhatsApp-based health cadre empowerment intervention on respondents' knowledge and hypertension control.

In the control group, the mean knowledge score increased from 1.87 ± 0.507 to 2.63 ± 0.490 , with a Z-value of -4.796 ($p < 0.001$). However, this increase in knowledge did not demonstrate an effect as substantial as that observed in the experimental group. The improvement in knowledge within the control group may have been influenced by individual characteristics such as cognitive capacity, educational background, prior experience, and the internal motivation of certain participants.

Although the statistical tests indicated that both interventions were effective ($p < 0.001$), a marked contrast was evident in the practical effect and consistency of outcomes. The experimental group achieved score (3.00 ± 0.000), indicating uniform and homogeneous effectiveness across respondents, with no participant remaining in the lower knowledge categories. However, it should be noted that the inference of overcoming all knowledge-related barriers was not directly measured in this study; rather, this finding demonstrates that the intervention was highly effective in achieving uniformly optimal knowledge outcomes. In contrast, the control group (2.63 ± 0.490) showed improvement from 1.87 but still exhibited variability ($SD = 0.490$), reflecting that the conventional method did not reach all respondents uniformly, and its success was contingent upon individual characteristics (cognitive capacity, education, experience, and motivation). These findings affirm that WhatsApp-based cadre empowerment is more effective in enhancing knowledge and hypertension control compared to interventions without such specific support.

Table 4.
Systolic Blood Pressure Control Outcomes

Group	Pretest (Mean $\pm$ SD)	Posttest (Mean $\pm$ SD)	Nilai Z	p-value
Experimental	151,17 $\pm$ 5,36	137,07 $\pm$ 4,55	-4,813	<0,001
Control	150,67 $\pm$ 5,21	141,87 $\pm$ 6,52	-4,127	<0,001

The research findings demonstrated that the mean systolic blood pressure in the experimental group decreased from 151.17 $\pm$ 5.36 mmHg to 137.07 $\pm$ 4.55 mmHg (Δ = 14.10 mmHg), whereas in the control group, it decreased from 150.67 $\pm$ 5.21 mmHg to 141.87 $\pm$ 6.52 mmHg (Δ = 8.80 mmHg). The reduction observed in the control group did not attain the target of systolic blood pressure control (<140 mmHg) and was comparatively smaller than that of the experimental group, indicating the contribution of the intervention to blood pressure improvement. Furthermore, the lower post-intervention standard deviation in the experimental group reflects a more uniform response compared to the control group.

Table 5.
Diastolic Blood Pressure Control Outcomes

Group	Pretest (Mean $\pm$ SD)	Posttest (Mean $\pm$ SD)	Nilai Z	p-value
Experimental	95,20 $\pm$ 6,80	89,90 $\pm$ 9,60	-3,820	<0,001
Control	94,80 $\pm$ 7,10	91,00 $\pm$ 4,50	-3,347	<0,001

The mean diastolic blood pressure in the experimental group decreased from 95,20 $\pm$ 6,80 mmHg to 89,90 $\pm$ 9,60 mmHg (Δ = 5.3 mmHg), indicating a significant improvement in hypertension control. In the control group, the mean diastolic pressure declined from 94,80 $\pm$ 7,10 mmHg to 91.00 $\pm$ 4.50 mmHg (Δ = 3.8 mmHg). Although a reduction was observed, the post-intervention mean diastolic pressure in the control group remained within the hypertensive range and did not achieve the target of diastolic blood pressure control (<90 mmHg), indicating suboptimal management. The reduction in the control group is presumed to have been triggered by urgent complaints that enhanced medication adherence and spontaneous lifestyle modifications; however, the relatively modest diastolic changes resulted in clinical effects that were not as substantial as the systolic changes.

The experimental group demonstrated that the intervention not only influenced systolic blood pressure but also diastolic blood pressure. Nevertheless, the relatively large standard deviation indicated considerable variation in responses among respondents. This variation may be influenced by factors such as age, duration of hypertension, level of adherence to therapy, psychological conditions, and individual lifestyle factors. The findings of this study indicate that the health cadre empowerment intervention via WhatsApp is effective in assisting respondents in controlling blood pressure, encompassing both systolic and diastolic measurements.

Table 6.
Comparison of Blood Pressure between Experimental and Control Groups

Variable	Experimental Group (Z)	Control Group (Z)
Systolic	-4.813 (30 out of 30 respondents)	-4.127 (23 out of 30 respondents)
Diastolic	-3.820 (25 out of 30 respondents)	-3.347 (14 out of 30 respondents)

Note: Data are presented as mean $\pm$ standard deviation. SD = Standard Deviation. Wilcoxon signed-rank test was used for within-group comparisons.

The results of the Wilcoxon signed-rank test demonstrated that in the control group, systolic blood pressure (Z = -4.127, p < 0.001) and diastolic blood pressure (Z = -3.347, p = <0.001) exhibited significant reductions. In the experimental group, significant reductions were also observed in systolic (Z = -4.813, p < 0.001) and diastolic (Z = -3.820, p < 0.001) measurements. Although both groups demonstrated reductions, the absolute Z -values in the experimental group, as well as the number of respondents showing improvement, were consistently higher than those in the control group for both blood pressure parameters. This finding indicates that the magnitude of change (effect size) in the experimental group was greater than that in the control group. The Wilcoxon test confirmed that the intervention was effective in reducing both systolic and diastolic blood pressure. The greatest effectiveness was observed for systolic blood pressure in the experimental group, where all respondents experienced a reduction following the intervention. Therefore, the research hypothesis positing an effect of the intervention on blood pressure reduction is accepted.

Tabel 7.

The 3-month community intervention protocol, based on the TIDieR checklist (Template for Intervention Description and Replication)

TIDieR Item	Brief Description
1. Brief Name	"WhatsApp-Facilitated Empowerment of Health Cadres to Improve Knowledge and Blood Pressure Control Among Adults with Hypertension: A Quasi-Experimental Study".
2. Why	Rationale: The prevalence of hypertension in the working area of the Tateli Primary Health Center, particularly in Kalasey 2 Village, has increased significantly (from 906 to 2,523 cases). Factors such as low health literacy, non-adherence to medication, and limited access to healthcare services constitute major barriers to hypertension control. Empowering health cadres through the WhatsApp platform, which is already familiar to the community, was selected as a pragmatic, low-cost, and easily accessible intervention strategy. Theory: This intervention is grounded in Bandura's Social Learning Theory, which posits that learning is more effective when individuals receive repeated information, gain social support, and interact within a learning environment. Objective: To improve community knowledge of hypertension and achieve blood pressure control (systolic <140 mmHg and diastolic <90 mmHg) through continuous education and mentoring by empowered health cadres.
3. What (Materials)	The educational materials used in the intervention included: (1) a cadre empowerment module developed in Phase 1 of the study, containing guidelines on hypertension management (definition, signs and symptoms, risk factors, prevention, treatment, and control); (2) educational videos on hypertension management, low-salt diet, physical activity, medication adherence, stress management, and smoking/alcohol restriction; and (3) digital brochures and posters containing concise information on hypertension and healthy lifestyles. All materials were delivered via the WhatsApp application in group format. Participants could access the materials repeatedly at any time (anytime accessibility) through their respective smartphones.
4. What (Procedures)	The intervention was conducted through a WhatsApp group as a medium for education and mentoring. The procedures included: (1) Structured education: Cadres delivered hypertension management materials gradually over 3 months in the form of text, images, videos, and brochures; (2) Periodic message reinforcement: Regular reminders regarding medication adherence, blood pressure monitoring, and healthy lifestyle behaviors were provided periodically; (3) Active mentoring: Cadres provided mentoring to community members twice weekly via WhatsApp, comprising question-and-answer sessions, discussions, and motivational support; (4) Social support (peer support): Interaction among group members was facilitated to enable experience sharing and support for therapeutic adherence; (5) Blood pressure monitoring: Respondents were motivated to undergo regular blood pressure checks and report the results to the cadres.
5. Who Provided	The intervention was delivered by health cadres who had been empowered in the previous study. The health cadres were community members who had received hypertension management training during the preceding intervention period (1 month). The training encompassed enhancing the cadres' knowledge and skills in health education, early screening, community mentoring, and the use of WhatsApp as a communication medium. The cadres were supported and supervised by health officers from the Tateli Primary Health Center to ensure the accuracy of the information conveyed.
6. How	The intervention was delivered digitally via the WhatsApp application using a virtual group mechanism. The material delivery combined: (1) one-way communication, in which cadres sent educational materials (videos, brochures, posters) to all group members; and (2) two-way communication, in which respondents could ask questions, discuss, and consult with cadres and fellow group members. The intervention was provided in a group setting (WhatsApp group) utilizing a participatory approach that enabled continuous learning.
7. Where	The intervention took place in a rural community, specifically Kalasey 2 Village, within the working area of the Tateli Primary Health Center. The implementation did not require specific physical infrastructure, as all activities were conducted virtually through each respondent's smartphone. Respondents could access materials and interact from their homes or any location, provided they had an internet connection.
8. When and How Much	The intervention was conducted over 3 months (follow-up period). Frequency: Twice-weekly mentoring sessions by cadres via WhatsApp (total of approximately 24

TIDieR Item	Brief Description
	mentoring sessions over 3 months). Duration of each session: Varied (15–30 minutes), depending on the interaction and discussions that occurred. Intensity: Educational materials were delivered gradually with periodic message reinforcement. Total intervention duration: 3 months (12 weeks).
9. Tailoring	The intervention was not individually modified (standardized intervention), as all respondents received identical materials and mentoring through the WhatsApp group. However, cadres provided individual responses to specific questions or complaints raised by each respondent via private chat features when necessary. Mentoring was adapted to the comprehension level and needs of each respondent based on interactions within the group.
10. Modifications	No modifications were made to the intervention protocol during the study. All respondents in the experimental group received the same intervention in accordance with the established protocol (WhatsApp-based health education with cadre mentoring twice weekly for 3 months).
11. How Well (Planned)	Fidelity assessment: (1) Monitoring cadre activities: The researcher monitored the frequency and quality of cadre interactions in the WhatsApp group (minimum of two mentoring sessions per week); (2) Monitoring respondent participation: Respondent activeness in the group (reading messages, asking questions, engaging in discussions) was indirectly monitored through responses and interactions within the group; (3) Maintenance strategy: Regular reminders were provided to cadres to ensure the mentoring schedule was adhered to. Cadres also received periodic support and supervision from the researcher.
12. How Well (Actual)	Based on the evaluation over the 3-month intervention period, all cadres (100%) implemented the mentoring according to the established protocol (twice weekly). The level of respondent participation in the WhatsApp group demonstrated active engagement, reflected by improved knowledge (100% of respondents achieved a "Good" category) and significant reductions in blood pressure (systolic $\Delta=14.10$ mmHg; diastolic $\Delta=5.3$ mmHg). All respondents (30 out of 30) experienced a reduction in systolic blood pressure, and 25 out of 30 experienced a reduction in diastolic blood pressure. This indicates that the intervention was implemented as planned and achieved the expected targets.

(Sumber: Hoffmann TC, et al. (2014) doi: <https://doi.org/10.1136/bmj.g1687>)

DISCUSSION

Testing the Effect of Health Cadre Empowerment via WhatsApp on Hypertension Knowledge

The findings demonstrated a significant improvement in knowledge among the experimental group following the WhatsApp-based empowerment intervention. Overall, the intervention was proven to enhance knowledge in both groups. However, the experimental group exhibited superior improvement, achieving 100% good knowledge status, compared to the control group, which only attained 63.3%. This confirms that the health cadre empowerment intervention via WhatsApp for hypertension knowledge and control was more effective in the experimental group than the intervention in the control group in improving the knowledge of study subjects.

The observed increase in knowledge scores indicates that WhatsApp-based health cadre empowerment holds potential as an effective health education instrument for improving hypertension literacy in community populations. The intervention, designed through the delivery of structured and continuous materials, periodic message reinforcement, and optimized social support (peer support) within a virtual group setting, enabled participants to access information repeatedly and flexibly (anytime accessibility), while simultaneously fostering interaction between cadres and respondents through text, image, and video features. This condition significantly facilitated active learning construction, which is pedagogically superior to conventional one-way educational methods. Conversely, the control group, which received only standard information from the primary health center without active WhatsApp-based mentoring, demonstrated substantially lower knowledge capacity gains, thereby reinforcing the superior effectiveness of this digital-based intervention approach.

Knowledge serves as a fundamental determinant influencing individual decision-making capacity and the actualization of preventive health behaviors. At the level of health cadres, comprehensive knowledge enhancement is positively correlated with the strengthening of clinical-social competence, encompassing the effectiveness of educational communication, the accuracy of early screening, and the optimization of community mentoring in hypertension control efforts. Furthermore, adequate knowledge construction plays a central role in improving cadre self-efficacy, thereby reinforcing their position as a critical link mediating professional healthcare services with the dynamic needs of the population within the community.

The research conducted by Kappes et al. (2023), which reported that health education and mentoring programs were capable of improving health literacy among hypertensive patients and enhancing their ability to manage the disease independently. Adequate knowledge enables patients to comprehend the consequences of uncontrolled hypertension, thereby increasing their motivation to adhere to therapy and consistently adopt healthy lifestyle behaviors.

The findings of this study are consistent with the research conducted by Mbuthia et al. (2022), which reported that community-based health cadre interventions were capable of improving knowledge, adherence, and blood pressure control among hypertensive patients in developing countries. The interventions delivered by cadres were proven effective in providing health education, promoting behavioral change, and facilitating community blood pressure monitoring.

The present findings are also supported by the study of Israfil et al. (2022), which concluded that health education delivered via mobile phones and mobile health (mHealth) platforms was effective in enhancing knowledge and hypertension management capacity. The utilization of digital media enables faster, more flexible, and sustained delivery of health information, thereby improving the understanding of both patients and health cadres.

Furthermore, the research conducted by Fitriani et al. (2022) demonstrated that training and mentoring of health cadres could improve cadre knowledge in hypertension management. Following the training, significant increases were observed in the knowledge scores and attitudes of health cadres in serving community members with hypertension. The improvement in knowledge observed in the present study can also be elucidated through Bandura's Social Learning Theory, which posits that the learning process becomes more effective when individuals receive information repeatedly, obtain social support, and engage in interaction with their learning environment. WhatsApp enables two-way communication between researchers and respondents, thereby rendering the learning process participatory and continuous, while concurrently reinforcing the theoretical justification that WhatsApp-based social media is effective as a medium for continuous learning within the context of community health empowerment.

Inferentially, the present findings confirm that the WhatsApp-based health cadre empowerment intervention has been empirically demonstrated to be effective in enhancing respondents' cognitive capacity regarding hypertension, with a statistically significant level of significance. This measurable improvement in health literacy subsequently serves as fundamental intellectual capital in optimizing the outcomes of non-communicable disease (NCD) control programs, particularly within the context of reducing cardiovascular morbidity and mortality attributable to hypertension risk factors at the community level. Thus, the strengthening of this knowledge capital constitutes a strategic pillar for the sustainability of early detection systems and non-pharmacological therapy management that is independently administered by the community.

Testing the Effect of Health Cadre Empowerment via WhatsApp on Hypertension Control

The research findings demonstrated that health cadre empowerment via WhatsApp exerted a significant influence on hypertension control. The mean blood pressure in the experimental group exhibited a substantial reduction and achieved target levels: systolic pressure decreased from 151.17 to 137.07 mmHg ($\Delta = 14.10$) and diastolic pressure decreased from 95.20 to 89.90 mmHg ($\Delta = 5.3$ mmHg). Conversely, the control group only demonstrated smaller reductions in systolic ($\Delta = 8.80$) and diastolic ($\Delta = 3.8$) pressures. The reduction observed in the control group is presumed to have been triggered by urgent complaints that enhanced medication adherence and spontaneous lifestyle modifications, without the repeated reinforcement, social support, and active monitoring present in the experimental group. This disparity in outcomes indicates that the WhatsApp-based intervention provided a substantive additional contribution to the success of hypertension control in the community.

The blood pressure reduction observed in the experimental group was influenced by the WhatsApp based intervention, which systematically improved knowledge, treatment adherence, self-monitoring, social support, and the active role of trained cadres in education and mentoring. The cadres delivered hypertension management materials, including information on low-salt diets, physical activity, medication adherence, stress management, smoking and alcohol restriction, and routine blood pressure monitoring. This continuous WhatsApp-based (m-Health) education ultimately enhanced community awareness and discipline in adopting healthy lifestyle behaviors. The findings of this study are consistent with the research conducted by Thapa et al. (2023), which demonstrated that health cadre-based interventions combined with education, blood pressure monitoring, and health support significantly improved blood pressure control among hypertensive patients. Cadres played a role in providing healthy lifestyle counseling, blood pressure monitoring, and reinforcement of treatment adherence.

A systematic review by Mbuthia et al. (2022) also found that health cadre interventions in low- and middle-income countries yielded positive effects on blood pressure reduction, improved medication adherence, and reduced cardiovascular disease risk factors. Health cadres constitute an essential component in expanding access to healthcare services, particularly in communities with limited resources. The present findings are further supported by the research of Kappes et al. (2023), which demonstrated that telehealth interventions based on health education were capable of reducing blood pressure and improving patient adherence to hypertension therapy. The utilization of digital media facilitates communication between healthcare providers and the community, thereby rendering the monitoring process more effective.

Theoretically, hypertension control is influenced by pharmacological therapy, health literacy, behavioral factors, and social support. WhatsApp serves as a medium for cadres to provide reminders, motivation, education, and continuous mentoring, with social support within the group reinforcing adherence. These findings affirm the strategic role of health cadres in non-communicable disease (NCD) control; digital empowerment enhances their educational capacity and consequently impacts the improvement of community health status. Nevertheless, optimization of health cadre recruitment, the provision of continuous training with up-to-date materials, and improvement of the incentive system are required to enhance and sustain cadre motivation in supporting the success of the program.

Furthermore, Green (2024) explained that health education constitutes one of the most effective promotive and preventive strategies in chronic disease management, as it is able to enhance individual awareness of risk factors and the importance of behavioral change. Increased knowledge encourages patients to pay greater attention to dietary patterns, reduce sodium intake, increase physical activity, maintain ideal body weight, and adhere to prescribed therapeutic regimens. This is supported by the research of (Matsumoto et al., 2024), which demonstrated that interventions based

on education and continuous monitoring contributed to improved treatment adherence and enhanced blood pressure control among hypertensive patients.

From the perspective of nursing practice and public health, the findings of this study confirm that the WhatsApp-based health education intervention facilitated by health cadres represents an approach that is pragmatic, applicable, and potentially low-cost. Although classified as a relatively simple intervention, this method has been proven to contribute meaningfully to improving patient knowledge and enhancing blood pressure control. In line with this evidence, the integration of structured and systematic health education into hypertension management protocols at primary healthcare facilities, the Posbindu PTM (Integrated Non-Communicable Disease Post) program, as well as community based health promotion initiatives, constitutes an imperative recommendation.

Despite providing promising findings, this study is not without several methodological limitations that warrant careful consideration. The relatively small sample size and the geographically limited scope confined to a single location may potentially reduce external validity; therefore, the generalizability of the research findings must be exercised with caution. In addition, this study has not evaluated the sustainability of behavioral changes and the stability of blood pressure control over the long-term post-intervention period. In light of these limitations, future research is recommended to involve larger and more representative sample sizes, adopt a randomized controlled trial (RCT) design to control for confounding factors, and incorporate long-term follow-up phases in order to enable a more holistic and comprehensive assessment of the effectiveness of health education interventions.

CONCLUSION

Statistical analysis showed that the WhatsApp-based cadre empowerment intervention significantly improved knowledge and blood pressure control, with the experimental group achieving greater reductions in systolic and diastolic blood pressure compared to the control group. Although this intervention may address therapeutic barriers such as non-adherence and limited social support, these mediating mechanisms were not directly measured in this study, and the quasi-experimental design employed does not permit strong causal inferences beyond the observed associative relationships. Given that WhatsApp is easily accessible, low-cost, and already widely used by the community, this approach shows potential for adoption as a community-based hypertension control strategy within primary healthcare settings.

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