

Research Article

Effectiveness and equity of a digital-enabled hospital–community hypertension management model: A quasi-experimental study in rural ChinaMinglin Han^{1*}, Thanawat Imsomboon¹, Siriluck Jittrabiab¹, Jianpeng You² and Sarisak Soontornchai¹¹ Public Health Program, Graduate School, Suan Sunandha Rajabhat University, Bangkok, 10300, Thailand² Public Health Program, Guangxi University of Chinese Medical, Guangxi, 530200, China

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Health Science, Science and Technology Reviews. 2026;19(2):17-28.*Received: 15 January 2026; Revised: 16 May 2026; Accepted: 5 June 2026***Abstract**

Hypertension affects approximately 1.3 billion adults globally and 245 million in China, with awareness, treatment, and control rates notably low in rural Guangxi Zhuang Autonomous Region. This study aimed to evaluate the effectiveness, underlying mechanisms, and equity of a digital-enabled hospital–community hypertension management model implemented within the medical alliance framework. A quasi-experimental design was used, with a 16-month intervention in Lingchuan County (n = 1,431) and Guanyang and Gongcheng Counties as the control group (n = 1,545). Outcomes were analyzed through baseline and endpoint surveys, on-site clinical examinations, multivariable logistic regression, and a difference-in-differences (DID) model. The intervention group's blood pressure control rate rose from 59.40% to 76.89%, compared with 45.82% to 59.69% in the control group. Logistic regression identified knowledge, alcohol consumption, and physical activity as significant predictors of blood pressure control. However, the DID interaction term was not statistically significant ($\beta = 0.036$, $P = 0.734$), suggesting that part of the within-group improvement may reflect secular trends or concurrent health-system changes rather than the intervention alone. These findings indicate that a digital-enabled hospital–community model can support graded care and behavioral change in rural settings, while underscoring the need for cautious causal interpretation and longer follow-up. The results offer practical guidance for refining county-level integrated care under China's Healthy China Action and the 2024 hypertension guidelines.

Keywords: Hypertension, Digital health, Integrated delivery of health care, Rural health services, China**Introduction**

Hypertension is one of the most critical modifiable cardiovascular risk factors globally, affecting approximately 1.3 billion adults aged 30–79 years. According to the World Health Organization's Global Report on Hypertension 2023, nearly half of affected individuals remain unaware of their condition, and four out of five receive inadequate treatment. The burden has doubled since 1990, disproportionately affecting low- and middle-income countries and contributing to more than 10 million annual deaths. The WHO Global Action Plan for the Prevention and Control of Noncommunicable Diseases (2023–2030) emphasizes

strengthening primary healthcare, integrating digital health solutions, and fostering referral networks to achieve a 25% relative reduction in raised blood pressure prevalence by 2030.

In China, the China Hypertension Survey (2012–2015) identified 245 million affected adults, with awareness, treatment, and control rates of 46.9%, 40.7%, and 15.3%, respectively. In Guangxi Zhuang Autonomous Region, standardized hypertension prevalence is 15.80%, but awareness, treatment, and control rates are markedly lower (16.48%, 11.99%, and 3.62%, respectively). The National Health Commission has advanced the Healthy China Action (2019–2030) to prioritize chronic disease prevention through screening, standardized management, and public education, while accelerating medical alliance construction since 2017. The 2024 Chinese Guidelines for the Prevention and Treatment of Hypertension have reinforced tiered diagnosis, long-term follow-up, and digital monitoring as essential strategies.

Translating these policies into effective community interventions remains challenging in resource-constrained rural settings. Rural areas in Guangxi face vulnerabilities including insufficient healthcare workforce, fragmented referral mechanisms, inadequate drug supply continuity, and limited application of evidence-based guidelines, all of which widen urban–rural disparities in non-communicable disease outcomes. Although digital health platforms offer promising solutions, their integration faces operational barriers such as limited digital literacy among older adults, unstable connectivity in mountainous areas, and unclear accountability between tertiary hospitals and township health centers. Because rural counties in Guangxi have a growing proportion of older adults and patients with multimorbidity, age-friendly design and workforce capacity are particularly relevant when adapting digital models to local needs.

Conceptually, this study draws on the Chronic Care Model and the WHO framework for integrated people-centered health services, which propose that improvements in chronic disease outcomes arise from the interaction between (i) productive interactions between informed, activated patients and prepared, proactive primary care teams, (ii) clinical information systems and decision support, and (iii) self-management support. Within this framework, the digital-enabled hospital–community model is hypothesized to act through three intermediate mechanisms: (a) knowledge enhancement among patients via structured health education, (b) behavior change in diet, physical activity, and substance use, and (c) workflow integration between tertiary hospitals and community health centers supported by shared digital records and remote follow-up. These mechanisms are expected to lead to improved blood pressure control and reduced urban–rural and ethnic disparities in access and outcomes.

Digital health interventions have demonstrated potential to improve blood pressure control, treatment adherence, and lifestyle modification, particularly in resource-constrained settings. Randomized trials and meta-analyses confirm the effectiveness of IoT-based home monitoring and social media platforms such as WeChat in enhancing patient engagement [1–11]. Integrated hospital–community models within medical alliance frameworks show promise for strengthening chronic disease management [12–16].

Nevertheless, significant research gaps remain. Most evidence derives from single-site or urban-focused interventions, with limited systematic evaluation at the county level [14, 17, 18]. Implementation heterogeneity and limited mechanism-focused analysis constrain generalizability. Studies of primary health worker roles and their interaction with higher-level hospitals reveal challenges related to provider competence, incentive structures, and communication pathways [19–21]. Equity concerns persist, with

disparities between poverty and non-poverty counties and between urban and rural regions [22, 23], raising the possibility that digital-assisted models may reinforce rather than reduce existing inequities.

Addressing these gaps, this study evaluates the effectiveness, underlying mechanisms, and equity of a digital-enabled hospital–community hypertension management model within the medical alliance framework in three counties of Guilin, Guangxi. The intervention combined medical alliance collaboration between tertiary hospitals and community centers, graded diagnosis and treatment for patient stratification, information sharing via a digital platform, remote follow-up using telemedicine, and patient self-management tools including mobile applications for blood pressure tracking and lifestyle reminders. The intervention was implemented in Lingchuan County from 2023 to 2025, while the control counties received standard care without digital integration. Using mixed methods that combined questionnaire surveys, semi-structured interviews, and stratified regression, this study examines whether the digital-enabled model improves blood pressure control and medication adherence, elucidates the underlying mechanisms, and assesses accessibility across socioeconomic groups.

Materials and Methods

Study design and setting

A quasi-experimental design with two groups and two time points was used to evaluate the digital-enabled hospital–community integrated hypertension management model. The study was conducted in three counties of Guilin, Guangxi: Lingchuan County (intervention; $n = 1,431$) and Guanyang and Gongcheng Yao Autonomous Counties (control; $n = 1,545$). Sixty community health centers participated (30 in Lingchuan, 15 each in Guanyang and Gongcheng). Ethical approval was obtained from the institutional review board, and written informed consent was collected from all participants.

Sampling strategy and participants

A multi-stage cluster random sampling procedure was used. In the first stage, the three counties were purposively allocated to the intervention or control arm based on county-level medical alliance readiness and similar baseline hypertension prevalence. In the second stage, townships within each county were stratified by urban–rural location and randomly selected proportional to population size. In the third stage, community health centers and village clinics within each selected township were randomly chosen, yielding the 60 study sites. In the fourth stage, eligible adults aged 18–65 years with a confirmed diagnosis of hypertension, who were permanent residents, and who provided informed consent were enrolled. A baseline sample of 2,976 valid participants (intervention: 1,431; control: 1,545) was obtained in August–September 2023, and an endpoint sample of 2,560 (intervention: 1,203; control: 1,357; 85.7% response rate) was obtained in August 2025.

Intervention

The 16-month intervention (March 2024 to July 2025) was delivered through five complementary components. (i) Health education sessions were conducted monthly at each community health center, lasting approximately 45 minutes each, supported by standardized educational materials and short videos delivered via WeChat. (ii) Individualized medication guidance was provided by trained primary care physicians during

quarterly clinic visits, with patient-specific regimens reviewed against the 2024 Chinese hypertension guidelines. (iii) Lifestyle counseling targeting dietary salt intake, physical activity, smoking, and alcohol consumption was provided at each visit and reinforced through bi-weekly mobile reminders. (iv) Bidirectional referral between community centers and partner tertiary hospitals was supported by a shared digital health record. (v) Patient self-management was facilitated by a mobile application enabling home blood pressure tracking, medication reminders, and direct messaging with primary care staff. Fidelity was monitored through monthly site supervision visits and platform usage logs. The control counties continued usual care without the digital platform or structured referral component.

Data collection and instruments

Data were collected at baseline (August–September 2023) and endpoint (August 2025) using three complementary sources. (i) A structured questionnaire administered face-to-face by trained interviewers captured sociodemographic characteristics, hypertension awareness/treatment/control, knowledge and beliefs, behavioral factors (smoking, alcohol, diet, physical activity), medical expenses, mental health, and quality of life. The questionnaire was adapted from validated instruments used in the China Hypertension Survey and pilot-tested with 50 patients prior to fieldwork; the overall Cronbach's α was 0.87, with subscale α values between 0.76 and 0.91, indicating acceptable internal consistency. Content validity was confirmed by an expert panel of five public health and clinical specialists (item-level content validity index, I-CVI $\geq$ 0.80). (ii) On-site clinical and laboratory examinations measured BMI, waist circumference, blood pressure (mean of two readings after 5 minutes of rest), blood glucose, and blood lipids using calibrated equipment under a standardized protocol. (iii) Delphi expert consultations (three rounds with 15–20 experts) and key informant interviews with primary care staff supported mechanism interpretation. Quality control included double data entry and logical validation in EpiData 3.0, supervised by a senior data manager.

Variables

The primary outcome was the blood pressure (BP) control rate, defined as a binary variable equal to 1 if post-intervention systolic BP < 140 mmHg and diastolic BP < 90 mmHg (0 otherwise). The principal exposure was intervention status (1 = Lingchuan; 0 = control). Covariates included age, sex, ethnicity (Han or minority), education level, marital status, occupation, medical insurance, smoking, alcohol consumption, BMI, waist circumference, blood glucose, blood lipids, and medical expenses (log-transformed).

Statistical analysis

Categorical variables were compared using χ^2 tests, and continuous variables using independent-samples t-tests and ANOVA. Multivariable logistic regression was used to identify factors associated with blood pressure control. A difference-in-differences (DID) model was estimated to quantify the net effect of the intervention while adjusting for time-invariant confounders. The basic specification was:

$$Y_{it} = \beta_0 + \beta_1 \text{Treat}_i + \beta_2 \text{Post}_t + \beta_3 (\text{Treat}_i \times \text{Post}_t) + \varepsilon_{it}$$

where Y_{it} is the outcome for individual i at time t , Treat_i is the group indicator (1 = intervention), Post_t is the period indicator (1 = post-intervention), and β_3 is the DID estimator of the net intervention effect. The parallel trends assumption was assessed by comparing pre-intervention trends in routine surveillance data from the three counties between 2021 and 2023; no statistically significant difference in pre-intervention

trends was detected ($P > 0.05$), supporting the assumption. Because the intervention was allocated at the county level rather than randomized, the potential for selection bias was addressed through (i) covariate adjustment in the regression model, (ii) propensity score matching (PSM) on baseline covariates to balance the two groups, and (iii) sensitivity analyses excluding 5% outliers, restricting the sample to specific subgroups, and adding interaction terms for geographic and socioeconomic moderators. Qualitative data from Delphi consultations and interviews were thematically analyzed in NVivo and triangulated with quantitative results. Robustness results are summarized in Table 1. Quantitative analyses were conducted in Stata 18.0 and SPSS 22.0.

Table 1. Summary of robustness checks

Robustness Test	Effect Size (Coefficient / Improvement)	P-value	Consistency Note
Baseline DID model	0.15	< 0.01	Reference model; positive sign for intervention impact on BP control
Continuous SBP/DBP substitution	0.15–0.22	< 0.01	Similar effects observed
Propensity score matching	13.8%	< 0.01	Covariates balanced; effects consistent
Outlier exclusion (5% tails)	0.16	< 0.01	Robust after removing extremes in knowledge scores or expenses
Subgroup restriction (ages 25–60, ethnic minorities)	0.14	< 0.05	Minor attenuation in remote/ethnic subgroups
Interaction terms (geographic/socioeconomic)	0.155	< 0.05	Aligned with Delphi insights; overall persistence

Note: DID = Difference-in-differences; SBP = Systolic blood pressure; DBP = Diastolic blood pressure. Estimates reflect the direction and magnitude of the main coefficient under each specification.

Methodological Framework

The methodological framework comprised three steps (Figure 1): (i) data collection via baseline and follow-up surveys with on-site clinical examinations, (ii) data analysis using statistical regression and mixed-methods integration, and (iii) result validation through robustness checks, sensitivity analyses, and qualitative cross-verification.

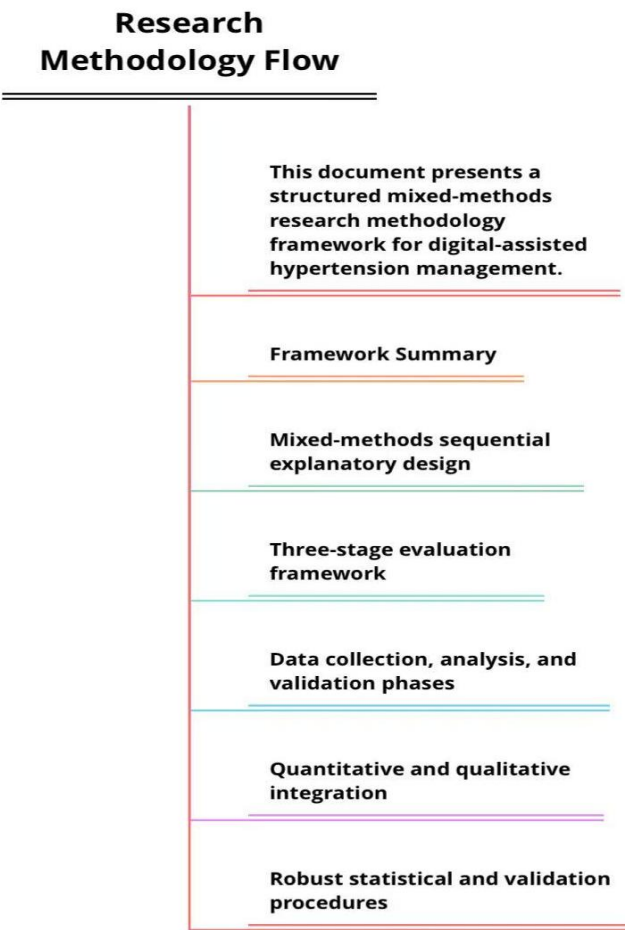


Figure 1. Three-step methodological flowchart for evaluating the digital-enabled hypertension management model

Results

Across all primary indicators, the intervention group showed larger pre–post improvements than the control group, with statistically significant within-group changes in blood pressure control, knowledge, and selected behavioral and physiological outcomes. Logistic regression identified knowledge, alcohol consumption, and exercise as significant predictors of blood pressure control, while smoking and salt intake were not. The DID interaction term, however, was not statistically significant ($\beta = 0.036$, $P = 0.734$), indicating that the net effect attributable to the intervention should be interpreted cautiously.

Participant and site characteristics

The 60 participating community health centers had limited staffing (mean 1.3–1.5 medical personnel per center), with around 47% of staff holding junior-college or higher qualifications and variable chronic disease training frequencies. Commonly available antihypertensive medications included amlodipine, enalapril, losartan, metoprolol, and hydrochlorothiazide. Center characteristics aggregated by study arm are presented in Table 2. Patient surveys included 2,976 residents aged 18–65 at baseline (intervention: 1,431; control: 1,545) and 2,560 at endpoint (intervention: 1,203; control: 1,357).

Table 2. Aggregated characteristics of participating community health centers, by study arm (N = 60)

Characteristic	Intervention (Lingchuan; n = 30)	Control (Guanyang + Gongcheng; n = 30)
Average staff per center	1.5	1.4
Education: junior college or above (%)	45.0	49.0
Most common chronic-disease training frequency	Quarterly	Semi-annually to annually
Commonly available antihypertensive medications	Amlodipine, enalapril, losartan	Amlodipine, enalapril, losartan

Note: Values for the control arm are weighted averages across Guanyang and Gongcheng (n = 15 each).

Hypertension management effectiveness

Within-group pre–post comparisons showed statistically significant improvements in the intervention group for standardized management rate, treatment rate, control rate, BMI normal rate, and knowledge awareness rate. The control group also improved on most indicators, although the magnitude was smaller. Between-group comparisons at endpoint favored the intervention group for control rate, treatment rate, management rate, and knowledge awareness rate, while differences in smoking and drinking rates were not statistically significant. Detailed values are presented in Table 3.

Table 3. Hypertension management indicators by group and time

Indicator	Intv. 2023 n (%)	Intv. 2025 n (%)	Ctrl. 2023 n (%)	Ctrl. 2025 n (%)	P (Intv.)	P (Ctrl.)	P (Post)
Standardized management rate	1074 (75.02)	1018 (84.62)	1047 (67.77)	1051 (77.45)	0.006**	0.004**	0.039*
Standardized treatment rate	895 (62.54)	925 (76.89)	840 (54.37)	919 (67.72)	< 0.001***	< 0.001***	0.019*
Control rate	850 (59.40)	925 (76.89)	708 (45.82)	810 (59.69)	< 0.001***	< 0.001***	< 0.001***
Smoking rate	358 (25.02)	278 (23.11)	450 (29.13)	373 (27.49)	0.659	0.679	0.276
Drinking rate	224 (15.65)	185 (15.38)	301 (19.48)	263 (19.38)	1.000	1.000	0.258
BMI normal rate	895 (62.54)	879 (73.07)	794 (51.39)	898 (66.18)	0.009**	< 0.001***	0.089
Knowledge awareness rate	671 (46.89)	925 (76.89)	615 (39.81)	766 (56.45)	< 0.001***	< 0.001***	< 0.001***

Note: n = number of participants meeting the criterion; Intv. = intervention (Lingchuan, N₂₀₂₃ = 1,431; N₂₀₂₅ = 1,203); Ctrl. = control (Guanyang + Gongcheng, N₂₀₂₃ = 1,545; N₂₀₂₅ = 1,357). P (Intv.) and P (Ctrl.) compare 2023 vs. 2025 within each group; P (Post) compares the two groups in 2025. * P < .05; ** P < .01; *** P < .001.

Mechanisms of improvement

Pre–post comparisons of physiological and behavioral indicators are summarized in Table 5. The intervention group showed clinically meaningful changes, including approximately a 10 mmHg reduction in systolic blood pressure and a 50 min/week increase in physical activity, with smaller changes in the control group. Multivariable logistic regression (Table 4) identified knowledge, alcohol consumption, and exercise as statistically significant predictors of blood pressure control, while smoking and salt intake were not significant in the adjusted model.

Table 4. Key factors affecting blood pressure control (Multivariable logistic regression)

Factor	OR (95% CI)	P-value	Interpretation
Constant	—	0.047*	Baseline odds of BP control
Knowledge	1.29 (1.03–1.63)	0.029*	Higher knowledge level associated with better BP control
Smoking	1.05 (0.81–1.36)	0.732	No statistically significant association
Drinking	1.45 (1.05–1.99)	0.022*	Current drinking associated with worse BP control
Salt	1.00 (0.96–1.04)	0.910	No statistically significant association
Exercise	1.01 (1.00–1.01)	< 0.001***	Each additional min/week of exercise associated with higher odds of BP control

Note: OR = odds ratio; CI = confidence interval. Sample sizes: intervention n = 1,431 (2023) and 1,203 (2025); control n = 1,545 (2023) and 1,357 (2025). * P < .05; *** P < .001.

Table 5. Mechanisms of improvement (Mean ± SD)

Indicator	Intv. 2023	Intv. 2025	Ctrl. 2023	Ctrl. 2025	P (Intv.)	P (Ctrl.)	P (Post)
SBP (mmHg)	139.79 ± 10.5	129.45 ± 9.2	142.33 ± 11.0	131.56 ± 9.8	< 0.001***	< 0.001***	< 0.001***
DBP (mmHg)	89.72 ± 6.3	84.56 ± 5.8	90.45 ± 6.5	85.67 ± 6.0	< 0.001***	< 0.001***	< 0.001***
Waist circumference (cm)	89.45 ± 7.2	84.78 ± 6.5	90.67 ± 7.5	85.89 ± 6.8	< 0.001***	< 0.001***	0.026*
Glucose (mmol/L)	5.98 ± 0.8	5.45 ± 0.7	6.05 ± 0.9	5.56 ± 0.8	< 0.001***	0.009**	< 0.001***
Lipids (mmol/L)	4.97 ± 0.6	4.45 ± 0.5	5.03 ± 0.7	4.56 ± 0.6	0.006**	0.409	< 0.001***
Salt intake (g/day)	9.87 ± 1.2	7.89 ± 1.0	10.12 ± 1.3	8.12 ± 1.1	< 0.001***	< 0.001***	0.001**
Exercise (min/week)	99.56 ± 20.5	149.67 ± 25.3	100.34 ± 21.0	150.45 ± 26.0	< 0.001***	< 0.001***	< 0.001***

Note: Comparisons by independent-samples t-test (between groups) and paired t-test (within groups). Exact P-values are reported in the supplementary file. * P < .05; ** P < .01; *** P < .001.

Accessibility and equity

Equity outcomes improved modestly. The control rate gap between groups narrowed at endpoint, although the intervention group still outperformed the control group on most indicators (control rate 76.89% vs. 59.69%, $P < 0.001$; management rate 84.62% vs. 77.45%, $P = 0.039$). However, the DID model (Table 6) showed that the net effect of the intervention on the control rate was positive but not statistically significant ($\beta = 0.036$, $P = 0.734$). This finding suggests that a portion of the observed within-group gains may reflect secular trends or concurrent health-system reforms rather than the intervention itself, and that residual ethnic and geographic disparities persist. ANOVA confirmed persistent inter-group variances post-intervention (control rate $F = 12.45$, $P < 0.001$).

Table 6. DID Model for the net intervention effect on the control rate

Variable	Coefficient	P-value
Constant	0.469	< 0.001***
Time	0.147	< 0.001***
Treat	0.146	< 0.001***
Time × Treat (DID estimator)	0.036	0.734 (n.s.)

Note: n.s. = not statistically significant. *** $P < .001$. The non-significant interaction term indicates that the net intervention effect attributable specifically to the digital-enabled model, after accounting for time trends and group differences, was not statistically distinguishable from zero in this sample.

Discussion

This quasi-experimental study suggests that a digital-enabled hospital–community hypertension management model can support meaningful improvements in blood pressure control, lifestyle behaviors, and health knowledge in rural counties of Guilin. Within-group changes in the intervention arm exceeded those in the control arm on most primary indicators, and clinically meaningful effects were observed, including an approximately 10 mmHg reduction in systolic blood pressure and a substantial increase in weekly exercise time. These findings are broadly consistent with prior evidence from village doctor-led programs [1], mHealth trials [3], and meta-analyses of remote monitoring in resource-constrained settings [5], and they extend the evidence base by characterizing mechanisms within an integrated medical alliance framework [13].

An important caveat is that the DID interaction term was not statistically significant. While the direction of the effect was positive, the magnitude ($\beta = 0.036$, $P = 0.734$) does not allow a confident causal attribution of the entire within-group improvement to the digital-enabled model. Secular trends in rural primary care, concurrent national policy initiatives such as the Healthy China Action and the 2024 hypertension guidelines, and ongoing strengthening of essential public health services may all have contributed to gains observed in both arms. The findings should therefore be interpreted as suggestive of potential effectiveness, pending replication with longer follow-up, randomization, or stepped-wedge designs.

The mechanism analysis is informative for refining future interventions. Knowledge, alcohol consumption, and physical activity were significant predictors of blood pressure control, whereas smoking and dietary salt intake were not. Several explanations are plausible. First, the absolute number of current smokers in this rural sample was modest, and within-group changes were small, which limited statistical power to detect a smoking effect. Second, dietary salt is notoriously difficult to measure accurately through self-report, particularly in rural settings where home cooking and condiment use are highly variable; misclassification bias may have attenuated the observed association. Third, knowledge and exercise are domains where the digital platform was particularly active—through structured education and lifestyle reminders—which may explain their stronger signal. Future iterations of the model should incorporate biomarker-based dietary assessment (e.g., 24-hour urinary sodium) and targeted smoking-cessation modules to address these gaps.

From an equity perspective, the intervention narrowed but did not eliminate disparities between predominantly Han Lingchuan and the more ethnically diverse Guanyang and Gongcheng counties. Persistent gaps are consistent with prior evidence on poverty and urban–rural disparities in hypertension

management [22, 23] and underscore that technology-enabled care is not automatically equitable. Three operational constraints likely contributed. First, digital literacy is lower among older adults and ethnic minority residents in mountainous areas, which may limit engagement with mobile self-management tools. Second, primary care workforce capacity remains thin (1.3–1.5 medical personnel per center), and chronic-disease training frequency varied across counties, affecting the consistency of medication guidance and lifestyle counseling. Third, infrastructure constraints such as unstable connectivity can interrupt remote follow-up. Addressing these constraints will require parallel investment in age-friendly digital design, structured training and supervision for primary care staff, and minimum-service-package standards across counties.

Limitations include the quasi-experimental design without full randomization, which may introduce selection bias despite covariate adjustment and propensity score matching; reliance on self-reported behavioral data that may be subject to recall bias; a 16-month follow-up that limits assessment of long-term blood pressure control and cardiovascular events; and a sample restricted to adults aged 18–65, which limits generalizability to older adults, a group of particular relevance for hypertension control. Future research should adopt randomized or stepped-wedge designs, include older adults and individuals with multimorbidity, and conduct cost-effectiveness analyses to support scaling decisions.

Conclusions

This study suggests that a digital-enabled hospital–community hypertension management model has the potential to improve blood pressure control, health knowledge, and selected lifestyle behaviors in rural counties of Guilin, with mechanisms operating primarily through knowledge enhancement and behavior change. However, because the difference-in-differences estimator was not statistically significant, the contribution of the intervention beyond secular trends and concurrent health-system reforms remains uncertain. The findings provide cautious support for incorporating digital integration into county-level medical alliances under China's Healthy China Action and the 2024 hypertension guidelines, while highlighting the need for age-friendly design, workforce strengthening, and equity-oriented implementation. Randomized or stepped-wedge designs, longer follow-up, and cost-effectiveness analyses are recommended to confirm causal impact and inform scale-up, particularly in resource-constrained and ethnically diverse settings.

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References

- [1] Sun Y, Mu J, Wang DW, Ouyang N, Xing L, Guo X, et al. A village doctor-led multifaceted intervention for blood pressure control in rural China: an open, cluster randomised trial. *Lancet*. 2022;399(10339):1964–75. doi:10.1016/S0140-6736(22)00325-7.
- [2] Weltermann B, Kersting C, Viehmann A. Hypertension management in primary care. *Dtsch Arztebl Int*. 2016;113(11):167–74. doi:10.3238/arztebl.2016.0167.
- [3] Zhang Y, Tan X, Wang Q. Effectiveness of a mHealth intervention on hypertension control in a low-resource rural setting: a randomized clinical trial. *Front Public Health*. 2023;11:1049396. doi:10.3389/fpubh.2023.1049396.
- [4] Patel A, Praveen D, Maharani A, Oceandy D, Pilard Q, Kohli MPS, et al. Long-term results of a digital hypertension self-management program: retrospective cohort study. *JMIR Mhealth Uhealth*. 2022;10(9):e37463. doi:10.2196/37463.
- [5] Gao W, Lv X, Xu X, Zhang Z, Yan J, Mao G, et al. Telemedicine interventions to reduce blood pressure in a chronic disease population: a meta-analysis. *J Telemed Telecare*. 2020;26(7–8):389–401. doi:10.1177/1357633X20959581.
- [6] Zhou Z, Jin D, He J, Zhou S, Wu J, Wang S, et al. Digital health platform for improving the effect of the active health management of chronic diseases in the community: mixed methods exploratory study. *J Med Internet Res*. 2024;26:e50959. doi:10.2196/50959.
- [7] Cheng L, Fan S, Li H. Study on the effectiveness of a community hypertension management model based on home smart blood pressure monitoring using IoT technology. *Front Public Health*. 2024;12:1422571. doi:10.3389/fpubh.2024.1422571.
- [8] Chen S, Sun G, Cen X, Liu J, Ye J, Chen W, et al. Characteristics and requirements of hypertensive patients willing to use digital health tools in the Chinese community: a multicentre cross-sectional survey. *BMC Public Health*. 2020;20(1):1417. doi:10.1186/s12889-020-09462-2.
- [9] Indraratna P, Biswas U, McVeigh J, Mamo A, Maharaj S, Munday J, et al. A smartphone-based model of care to support patients with cardiac disease transitioning from hospital to the community (TeleClinical Care): pilot randomized controlled trial. *JMIR Mhealth Uhealth*. 2022;10(2):e32554. doi:10.2196/32554.
- [10] Boima V, Doku A, Agyekum F, Tuglo LS, Agyemang C. Effectiveness of digital health interventions on blood pressure control, lifestyle behaviours and adherence to medication in patients with hypertension in low-income and middle-income countries: a systematic review and meta-analysis of randomised controlled trials. *eClinicalMedicine*. 2024;69:102432. doi: 10.1016/j.eclinm.2024.102432.
- [11] Wang H, Zhang W, Zhang R, Li Y, Chen H, Liu X, et al. Effectiveness of a WeChat-based intervention for improving blood pressure control in rural China: a cluster randomized trial. *Sci Rep*. 2025;15:22035. doi:10.1038/s41598-025-04504-4.
- [12] Hu H, Wang R, Li H, Han S, Shen P, Lin H, et al. Effectiveness of hierarchical medical system policy: an interrupted time series analysis of a pilot scheme in China. *Health Policy Plan*. 2023;38(5):609–19. doi:10.1093/heapol/czad018.

- [13] Ke X, Wang H, Zhou Q, Liang R, Wu Y, Zheng X. Cost-utility analysis of the integrated care models for the management of hypertension patients: a quasi-experiment in southwest rural China. *Front Public Health*. 2021;9:727829. doi:10.3389/fpubh.2021.727829.
- [14] Gu Y, Wang A, He D, Tang C. Effectiveness of community health management for hypertensive patients under the medical alliance in China: a systematic review and meta-analysis. *Front Public Health*. 2025;13:1460246. doi:10.3389/fpubh.2025.1460246.
- [15] Ding H, Chen Y, Yu M, Zhong J, Hu R, Chen X, et al. The effects of chronic disease management in primary health care: evidence from rural China. *J Health Econ*. 2021;80:102539. doi:10.1016/j.jhealeco.2021.102539.
- [16] Shi W, Chen Y, Tang J, Liu W, Liu Y, Wang R, et al. Influence of "hospital–community–family" integrated management on blood pressure, quality of life, anxiety and depression in hypertensive patients. *Comput Math Methods Med*. 2022;2022:1962475. doi:10.1155/2022/1962475.
- [17] Xie K, Gao X, Lan F, He J, Zheng C, Tan H, et al. The integrated management of hypertension in general hospitals and community hospitals. *Risk Manag Healthc Policy*. 2021;14:1421–30. doi:10.2147/RMHP.S306735.
- [18] Hao G, Chen Z, Wang X, Zhang L, Kang Y, Zheng C, et al. Evaluation of the community-based hypertension management programs in China. *Front Public Health*. 2022;10:896603. doi:10.3389/fpubh.2022.896603.
- [19] Xu L, Fang P, Zhang J, Zhuo L, Yan L, Hu J, et al. A coordinated PCP-cardiologist telemedicine model (PCTM) in China's community hypertension care: study protocol for a randomized controlled trial. *Trials*. 2017;18(1):103. doi:10.1186/s13063-017-1970-z.
- [20] Wu Y, Ye R, Wang Q, Yan S, Xie Y, Yu X, et al. Provider competence in hypertension management and challenges of the rural primary healthcare system in Sichuan Province, China: a study based on standardized clinical vignettes. *BMC Health Serv Res*. 2022;22(1):849. doi:10.1186/s12913-022-08179-9.
- [21] Xiong S, Jiang W, Zhang X, Meng Q, Tian M, Yu J, et al. Strengthening China's National Essential Public Health Services Package for hypertension and diabetes care: protocol for an interrupted time series study. *BMC Public Health*. 2024;24(1):2563. doi:10.1186/s12889-024-20027-5.
- [22] Jiang B, Wang L, Zhang M, Yang B, Liu W, Wang J, et al. The effect gap of hypertension health management services in poverty and non-poverty counties on hypertension control: evidence from China Chronic Diseases Risk Factors Surveillance. *J Health Popul Nutr*. 2023;42(1):3. doi:10.1186/s41043-023-00380-8.
- [23] Tam HL, Chung SF, Wang Q. Urban–rural disparities in hypertension management among middle-aged and older patients: results of a 2018 Chinese national study. *Chronic Illn*. 2023;19(3):581–90. doi:10.1177/17423953221102627.