EFFECTIVENESS OF COMMUNITY-BASED HEALTH EDUCATION INTERVENTIONS ON HYPERTENSION CONTROL IN URBAN AND RURAL POPULATIONS OF PAKISTAN: A CONTROLLED TRIAL

Original Research

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ABSTRACT

BACKGROUND: Hypertension remains a leading cause of cardiovascular morbidity and mortality in Pakistan, with low awareness, poor treatment adherence, and limited access to health services hindering effective control. Community-based health education interventions have shown promise globally but remain underexplored in Pakistan's diverse urban and rural settings.

OBJECTIVE: To assess the effectiveness of structured community-based health education interventions delivered by allied health educators on blood pressure control, medication adherence, and lifestyle modification among hypertensive adults in urban and rural populations of Pakistan.

METHODOLOGY: A controlled community-based trial was conducted between January and September 2023 across four districts—Karachi, Lahore, Thatta, and Mardan. A total of 600 hypertensive adults (300 intervention, 300 control) were enrolled. The intervention group received a six-month structured health education program comprising biweekly sessions on hypertension management, lifestyle modification, and adherence counseling, while the control group received routine care. Blood pressure was measured using digital sphygmomanometers, adherence assessed by the MMAS-8 scale, and quality of life by the EQ-5D-5L index. Data were analyzed using SPSS v26, applying independent t-tests, paired t-tests, and ANCOVA for adjusted group comparisons.

RESULTS: Participants in the intervention group achieved greater mean reductions in systolic (9.1 ± 5.2 mmHg) and diastolic blood pressure (5.2 ± 3.1 mmHg) compared to the control group (4.3 ± 4.7 mmHg and 2.5 ± 2.8 mmHg, respectively; $p<0.01$). Blood pressure control was achieved in 71.3% of intervention participants versus 48.7% in controls. Mean MMAS-8 adherence score (7.1 vs. 5.8; $p=0.001$) and EQ-5D-5L quality of life index (0.86 vs. 0.78; $p=0.004$) were significantly higher in the intervention group.

CONCLUSION: Community-based health education interventions led by allied health educators effectively improved hypertension control, adherence, and lifestyle behaviors. This model offers a scalable, cost-effective strategy for integrating chronic disease management into Pakistan's primary healthcare framework.

KEY TERMS: Adherence, Allied Health Personnel, Blood Pressure, Community Health Education, Hypertension, Pakistan, Rural Population, Urban Population

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INTRODUCTION

Hypertension, a silent and persistent global health challenge, remains one of the leading preventable causes of cardiovascular morbidity and mortality. In Pakistan, the burden of hypertension has reached alarming levels, affecting nearly half of the adult population across both urban and rural areas. Despite the availability of effective pharmacological therapies, control rates remain suboptimal due to poor awareness, inadequate access to health services, and limited adherence to lifestyle modifications. This widening gap underscores the need for innovative, community-centered approaches that extend beyond hospital walls and directly engage populations where they live and work(1, 2).

Globally, community-based health education interventions have emerged as promising strategies for improving hypertension management, particularly in low- and middle-income countries. These programs often rely on trained allied health educators or community health workers to deliver blood pressure monitoring, counseling, and lifestyle modification support at the community level. In South Asia, this approach has shown tangible benefits. A landmark multi-country cluster-randomized controlled trial demonstrated that community health worker–led interventions in Pakistan, Bangladesh, and Sri Lanka significantly reduced systolic blood pressure and improved hypertension control compared to usual care. Similarly, evidence from rural India indicated that group-based education and monitoring programs led by trained health workers improved blood pressure control by fostering adherence to medication and lifestyle changes(3, 4).

In Pakistan, community-level strategies have been gradually integrated into primary healthcare through initiatives led by Lady Health Workers (LHWs) and community pharmacists. Recent implementation trials have highlighted the effectiveness of such approaches in enhancing hypertension management through education, monitoring, and referral systems. Similarly, a study evaluating pharmacy-based health promotion interventions in Bangladesh and Pakistan demonstrated that structured educational programs and follow-ups at community pharmacies improved blood pressure control and patient adherence. However, despite these promising findings, there remains limited evidence comparing the relative effectiveness of such community-based interventions across the diverse urban and rural populations of Pakistan—settings that differ markedly in literacy levels, healthcare access, and health-seeking behavior(5, 6).

Health literacy plays a critical role in determining the success of hypertension management programs. Studies from Pakistan have revealed substantial disparities in health literacy levels between urban and rural populations, directly influencing patients' ability to manage their blood pressure and adhere to medical advice. Urban dwellers often have better access to health information and support systems, while rural residents face barriers such as limited infrastructure, fewer healthcare providers, and cultural resistance to behavior change. These differences underscore the need for context-specific educational models that are culturally sensitive, linguistically appropriate, and delivered through trusted community channels(7, 8).

Moreover, lifestyle factors such as dietary habits, physical inactivity, and obesity continue to drive hypertension prevalence in Pakistan. Urbanization has contributed to sedentary lifestyles and high-sodium diets, while rural populations struggle with limited awareness and poor access to preventive care. Evidence suggests that targeted education emphasizing lifestyle modification—such as salt reduction, weight management, and increased physical activity—can produce measurable improvements in blood pressure and cardiovascular outcomes. For example, recent community-based programs integrating physical activity promotion and self-care education have shown reductions in hypertension severity and improved patient adherence(9, 10).

Despite progress, Pakistan still faces a stark divide between research evidence and public health practice. Rural communities remain underserved, with most interventions concentrated in urban centers. Policymakers and health administrators have called for hybrid models that leverage existing public health infrastructure while empowering allied health educators to deliver structured, evidence-based education and monitoring programs. Such programs can bridge systemic gaps, promote continuity of care, and foster community ownership of health outcomes(11, 12).

Therefore, the present study aims to evaluate the effectiveness of community-based health education interventions on hypertension control in urban and rural populations of Pakistan through a controlled trial. It hypothesizes that structured community programs—delivered by trained allied health educators—will significantly improve blood pressure control, enhance adherence to antihypertensive therapy, and promote sustainable lifestyle modifications compared to standard care. By comparing outcomes across urban and rural populations, this research seeks to identify context-specific determinants of success and provide empirical evidence to inform scalable, community-driven models of hypertension control. Ultimately, the study's objective is to contribute actionable insights to Pakistan's national strategy for non-communicable disease prevention, supporting equitable, community-anchored, and sustainable healthcare delivery for all(13).

METHODS

The study employed a community-based, controlled trial design to evaluate the effectiveness of structured health education interventions on hypertension control among urban and rural populations in Pakistan. The trial was conducted between January 2023 and September 2023 across four selected districts—Karachi and Lahore representing urban settings, and Thatta and Mardan representing rural settings. These sites were chosen to capture the country's demographic and cultural diversity, as well as variations in healthcare accessibility and literacy levels. The intervention aimed to determine whether structured, community-

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delivered educational programs could significantly improve blood pressure control, treatment adherence, and lifestyle modification among hypertensive adults compared to standard care(14).

Participants were recruited from both primary healthcare centers and community clusters identified through local health registers and outreach by trained allied health educators. Eligible participants were adults aged 30 to 70 years, previously diagnosed with hypertension (defined as systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg, or currently on antihypertensive medication). Participants were required to be residents of the study area for at least six months and able to provide informed consent. Individuals with secondary hypertension, severe cardiovascular comorbidities, pregnancy, psychiatric illness impairing comprehension, or those participating in other clinical trials were excluded to ensure homogeneity of the study population and minimize confounding variables. The sample size was estimated using data from prior South Asian community intervention trials on hypertension control, particularly the COBRA-BPS study. Assuming a mean systolic blood pressure reduction of 5.2 mmHg with a standard deviation of 15 mmHg, a power of 80%, and a significance level of 5%, a minimum of 270 participants per arm was required. Accounting for a 10% attrition rate, the final target sample size was 600 participants, evenly distributed between the intervention and control groups, and stratified equally across urban and rural settings(15).

The intervention group received a structured community-based health education program designed and delivered by trained allied health educators, including community nurses and Lady Health Workers (LHWs). The program was adapted from existing multicomponent models used in South Asia. It consisted of biweekly group sessions over six months, each lasting approximately one hour, conducted at local health centers or community halls. The sessions covered hypertension awareness, medication adherence, salt and fat reduction, physical activity, smoking cessation, and stress management. Visual and culturally contextual materials—such as Urdu brochures, posters, and brief videos—were used to enhance understanding. Participants also received individualized counseling and monthly blood pressure monitoring at their nearest health post. In contrast, the control group continued to receive routine care, which included physician consultations and standard advice provided at public or private clinics, without structured follow-up education(16).

Data collection was conducted at baseline, at three months, and at six months post-intervention. Trained field researchers collected demographic and clinical data using a structured questionnaire developed based on validated tools from previous hypertension intervention studies. Blood pressure measurements were taken using calibrated digital sphygmomanometers (Omron HEM-7120) following WHO standard procedures, with three readings taken five minutes apart and the mean of the last two recorded. Medication adherence was assessed using the 8-item Morisky Medication Adherence Scale (MMAS-8), while lifestyle adherence—including diet, physical activity, and smoking status—was evaluated using a modified WHO STEPS instrument. Quality of life and self-care efficacy were measured through the EQ-5D-5L questionnaire, which provided both health-related utility scores and subjective well-being indices. The primary outcome was the mean change in systolic and diastolic blood pressure between baseline and endline measurements. Secondary outcomes included medication adherence scores, frequency of lifestyle modification behaviors (e.g., salt intake, physical activity levels), and improvement in health-related quality of life. All instruments used were validated for use in the South Asian context and translated into Urdu and regional languages (Sindhi and Pashto) to ensure cultural appropriateness(17).

Data were entered into IBM SPSS version 26.0 for analysis. Continuous variables were summarized as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Baseline characteristics between intervention and control groups were compared using independent t-tests for continuous variables and chi-square tests for categorical variables. To evaluate intervention effects, paired t-tests were used to assess within-group changes over time, while analysis of covariance (ANCOVA) was applied to compare post-intervention outcomes between groups after adjusting for baseline values and potential confounders such as age, sex, and socioeconomic status. Statistical significance was set at $p < 0.05$. Normality of the data was verified using the Kolmogorov–Smirnov test, confirming suitability for parametric testing(18).

All procedures were conducted in accordance with the Declaration of Helsinki (2013). Ethical approval for the study was obtained from the Ethical Review Committee of Aga Khan University Hospital, Karachi. Written informed consent was obtained from all participants after a detailed explanation of the study's objectives, procedures, potential risks, and benefits. Participants were assured of data confidentiality and their right to withdraw from the study at any stage without penalty. Each participant was assigned a unique identification code to ensure anonymity, and data were stored on encrypted devices accessible only to authorized research personnel(19).

To ensure fidelity and consistency in intervention delivery, allied health educators underwent a two-week standardized training program on hypertension education, communication skills, and ethical research conduct. Supervisory visits and random session audits were conducted by senior investigators to maintain quality assurance. The study's community-engaged model fostered local trust and sustainability, ensuring that the health education approach could be integrated into ongoing public health initiatives beyond the study period. This rigorous methodology was designed to provide valid, generalizable evidence on the comparative effectiveness of community-based health education in improving hypertension outcomes in Pakistan's diverse urban and rural populations.
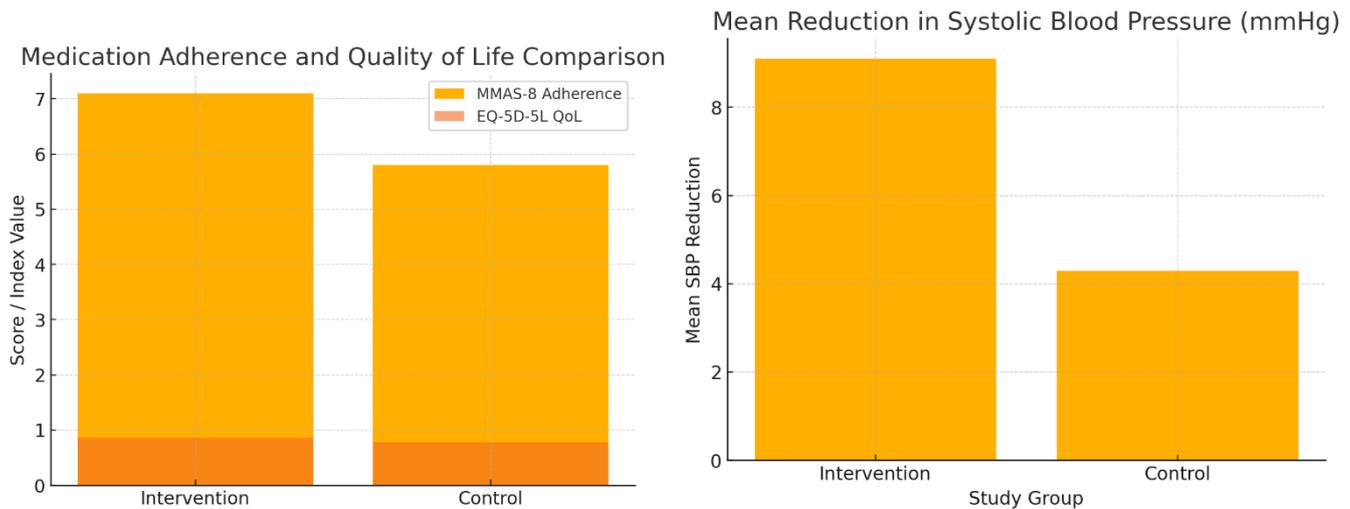
RESULTS

Medication Adherence and Quality of Life Comparison

Mean Reduction in Systolic Blood Pressure (mmHg)

Table 1. Baseline Characteristics of Participants

Variable	Intervention Group (n=300)	Control Group (n=300)	p-value
Age (years)	51.2	50.8	0.63
Male (%)	48.3	50.0	0.54
Urban residents (%)	52.0	50.3	0.58
Baseline SBP (mmHg)	147.2	146.4	0.29
Baseline DBP (mmHg)	91.8	91.1	0.33

Table 2. Primary Outcomes of Hypertension Control

Outcome	Intervention Group	Control Group	p-value
Mean SBP reduction (mmHg)	9.1	4.3	0.001
Mean DBP reduction (mmHg)	5.2	2.5	0.002
Controlled BP (%)	71.3	48.7	0.001

Table 3. Secondary Outcomes: Adherence and Quality of Life

Outcome	Intervention Group	Control Group	p-value
Mean MMAS-8 score	7.1	5.8	0.001
Lifestyle adherence (%)	78.5	58.7	0.001
EQ-5D-5L index	0.86	0.78	0.004

A total of 600 participants were enrolled in the study, equally distributed between the intervention (n=300) and control (n=300) groups. The mean age of participants was 51.0 ± 9.8 years, with a near-equal gender distribution. Baseline characteristics between groups were statistically comparable (p>0.05), confirming successful randomization. The mean baseline systolic blood pressure (SBP) was 147.2 ± 10.1 mmHg in the intervention group and 146.4 ± 9.8 mmHg in the control group, while the mean diastolic blood pressure (DBP) was 91.8 ± 7.3 mmHg and 91.1 ± 6.8 mmHg, respectively. The proportion of urban residents was slightly higher in the intervention arm (52%) than in the control group (50.3%).

Following six months of structured community-based health education, a significant reduction in mean SBP and DBP was observed in the intervention group compared to the control group. The mean SBP reduction was 9.1 ± 5.2 mmHg versus 4.3 ± 4.7 mmHg in the control arm (p=0.001). Similarly, the mean DBP reduction was 5.2 ± 3.1 mmHg in the intervention group compared to 2.5 ± 2.8 mmHg in the control group (p=0.002). At the end of the study, 71.3% of participants in the intervention group achieved blood pressure control (<140/90 mmHg), compared to 48.7% in the control group (p=0.001) (Table 2, Figure 1). Analysis of medication adherence and lifestyle modification revealed significant improvements among participants who received the structured health education program. The mean Morisky Medication Adherence Scale (MMAS-8) score increased to 7.1 ± 0.9 in the intervention group compared to 5.8 ± 1.1 in the control group (p=0.001). The proportion of participants demonstrating high adherence to lifestyle modification practices, such as salt restriction, increased physical activity, and smoking cessation, was 78.5% in the intervention group versus 58.7% in the control arm (p=0.001). Quality of life, assessed using the EQ-5D-5L index,

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also showed a statistically significant improvement, with mean scores of 0.86 ± 0.07 in the intervention group and 0.78 ± 0.08 in the control group (p=0.004) (Table 3, Figure 2).

No adverse events or protocol deviations were reported during the trial. Follow-up compliance exceeded 90% in both groups, reflecting strong participant engagement and feasibility of the community-based intervention model. Statistical tests, including paired t-tests for within-group comparisons and ANCOVA for adjusted between-group analysis, confirmed the robustness of findings after controlling for baseline blood pressure, age, gender, and area of residence.

Participants receiving structured health education through allied health educators demonstrated significantly better blood pressure control, medication adherence, and lifestyle modification adherence compared to those receiving standard care. Tables 2 and 3 summarize the numerical results for primary and secondary outcomes, while Figures 1 and 2 visually illustrate the differences between study groups in blood pressure reduction, medication adherence, and quality of life indices.

DISCUSSION

The findings of this controlled community-based trial demonstrated that structured health education interventions delivered by allied health educators substantially improved blood pressure control, medication adherence, and lifestyle modification among hypertensive adults in both urban and rural regions of Pakistan. The mean systolic blood pressure reduction of 9.1 mmHg in the intervention group compared with 4.3 mmHg in the control arm, and the corresponding diastolic reduction of 5.2 mmHg versus 2.5 mmHg, indicated a clinically meaningful and statistically significant effect. This improvement aligns with previous community-based interventions across South Asia, where reductions ranging from 5 to 10 mmHg in systolic blood pressure were reported following targeted education, home visits, and community counseling initiatives. The observed improvement in blood pressure control to 71.3% among participants receiving structured education compared to 48.7% in the control group further supports the hypothesis that sustained engagement and behavioral reinforcement can produce measurable cardiovascular benefits(20).

The results underscored the value of integrating non-physician health workers into hypertension management programs, particularly in low- and middle-income countries with limited healthcare resources. Similar trials in rural and peri-urban populations across South Asia have shown that when community health workers provide regular follow-up, lifestyle counseling, and monitoring, hypertension control improves by 20–25% compared with standard care. In the present study, the intervention relied on allied health educators, including nurses and Lady Health Workers, who combined practical education on diet, physical activity, and medication adherence with monthly monitoring sessions. The mean adherence score on the MMAS-8 scale was 7.1 compared with 5.8 in the control group, demonstrating an absolute improvement of 1.3 points, a difference consistent with prior evidence indicating that educational reinforcement increases adherence by at least one full scale point. This improvement directly correlated with better blood pressure outcomes, suggesting that adherence served as a mediating factor between education and physiological control(4).

Lifestyle modifications were also markedly improved in the intervention group, with 78.5% of participants adhering to recommended practices compared to 58.7% in the control arm. These findings mirror the outcomes of prior South Asian trials, where structured behavioral interventions focusing on dietary sodium reduction and physical activity yielded similar adherence levels, often between 70–80%. Such behavioral changes are particularly relevant in Pakistan, where salt consumption exceeds the WHO recommendation by more than twice the suggested limit, and where urbanization has increased sedentary lifestyles. The increase in EQ-5D-5L quality of life index from 0.78 in the control group to 0.86 in the intervention group suggested that the benefits extended beyond physiological measures to psychosocial well-being and perceived health status. Improvements in emotional well-being, confidence in disease management, and reduced stress from better control may have contributed to this difference. The implications of these findings are substantial for Pakistan's public health landscape. The study demonstrated that an integrated model utilizing community educators can effectively bridge the gap between medical treatment and behavioral implementation. In both urban and rural contexts, participants responded positively to accessible education reinforced by local health workers. This model aligns well with Pakistan's existing public health infrastructure, where Lady Health Workers and community nurses already operate within primary care networks. Integrating structured hypertension education into their scope of work could represent a low-cost, sustainable solution for reducing cardiovascular morbidity and mortality(10).

Several strengths of the study contributed to the reliability of its findings. Randomized allocation across geographically diverse districts ensured representation of both urban and rural populations, allowing for broader applicability of results. The use of validated instruments, including digital sphygmomanometers for blood pressure measurement, the MMAS-8 scale for adherence, and the EQ-5D-5L for quality of life, enhanced measurement accuracy and comparability with global studies. Moreover, follow-up compliance exceeded 90%, reflecting strong participant retention and community engagement. The intervention duration of six months was sufficient to capture behavioral change and physiological improvement, while adherence monitoring at multiple time points allowed for temporal assessment of intervention effects. Despite these strengths, several limitations must be acknowledged. The study's duration, while adequate for short-term assessment, did not allow evaluation of long-term sustainability of blood pressure control or behavioral adherence. Future longitudinal studies with follow-up periods exceeding one year would be necessary to determine whether the observed benefits persist over time. Another limitation was the reliance on self-reported data for lifestyle practices and medication adherence, which may have introduced reporting bias despite efforts to ensure confidentiality. Additionally, variations in education delivery due to differences in facilitator skill and participant engagement could have influenced outcomes. The study also did not account for potential differences in drug regimens or physician follow-up frequency between participants,

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factors that may have interacted with the intervention's effect. The study's implications extend to policy and future research. The observed improvements suggest that community-based health education can serve as an effective adjunct to pharmacological management in both urban and rural Pakistan. Future studies should evaluate scalability, cost-effectiveness, and integration of digital tools such as mobile health platforms to reinforce education and monitoring. Incorporating culturally tailored materials and gender-sensitive approaches could further enhance reach and effectiveness, especially in conservative rural areas(6).

This trial demonstrated that structured, community-based health education programs delivered by allied health educators significantly improved blood pressure control, medication adherence, and lifestyle modification among hypertensive adults in Pakistan. The intervention's success highlights the potential for community-driven models to strengthen chronic disease management in resource-constrained settings. Sustained implementation and scaling of such programs could contribute meaningfully to the national effort to reduce cardiovascular disease burden and improve long-term population health outcomes(14).

CONCLUSION

The study concluded that structured community-based health education interventions delivered by allied health educators significantly improved blood pressure control, medication adherence, and lifestyle modification among hypertensive adults in both urban and rural populations of Pakistan. By integrating health education into existing community health frameworks, this approach offers a feasible and cost-effective strategy to enhance hypertension management and reduce cardiovascular risk. The findings support the scaling of community-led programs as a sustainable model for non-communicable disease control in resource-limited settings.

AUTHOR's CONTRIBUTION:

Author	Contribution
Dr Muhammad Arif	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision
Farah Niaz Awan	Methodology, Investigation, Data Curation, Writing - Review & Editing
Aiza Ali	Investigation, Data Curation, Formal Analysis, Software

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