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Evaluating the Influence of Lifestyle Interventions on Hypertension Control: A Longitudinal Perspective

[1]Dr. Taj Muhammad Khan, [2]Dr Ayesha Jabeen, [3]Dr Rizwan akhtar, [4]Dr. Sohail Nasir, [5]Dr. Nasir Jamil, [6]Dr.Muhammad Aslam

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[1]Professor of Medicine, Department of Medicine, College of Medicine and Dentistry At Hills Abbottabad
[2]Medical specialist consultant physician FCPS Gen Medicine PAEC general hospital H11 Islamabad
[3]Senior Demonstrator pathology Ibn-e-Siena Hospital & MMDC Multan
[4]Associate Professor (medicine) Lahore Medical and Dental college Lahore
[5]MBBS, M.Sc(Physiology), M.Phil(Physiology), M.Sc(Diabetes & Endocrinology)Assistant Professor Liaquat College of Medicine and Dentistry, Darul Sehat Hospital, Karachi,Pakistan.
[6]Assistant Professor Department of Community & Family Medicine, Akhtar Saeed Medical college, Rawalpindi

Abstract

Background:

Hypertension is a leading global risk factor for cardiovascular disease and mortality. Despite the availability of effective pharmacological treatments, blood pressure control rates remain suboptimal, especially in low- and middle-income countries. Lifestyle interventions—targeting diet, physical activity, alcohol use, stress, and weight management—are increasingly recommended as first-line strategies, but their long-term effectiveness in real-world populations remains underexplored (1–3).

Aim:

To evaluate the longitudinal impact of lifestyle interventions on blood pressure control among adults with hypertension, using both secondary data from recent studies and a local observational cohort.

Methods:

This study synthesizes findings from 15 high-quality clinical trials and meta-analyses published between 2018 and 2024 assessing lifestyle-based blood pressure interventions. Additionally, a 12-month observational cohort from a regional tertiary care hospital (n = 200) and a cross-sectional community survey (n = 100) were analyzed to assess real-world adherence and outcomes. Primary outcomes included mean changes in systolic and diastolic blood pressure, and the proportion achieving target BP control (<140/90 mmHg).

Results

Across published studies, dietary approaches (e.g., DASH, sodium reduction) achieved

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systolic BP reductions of 4–11 mmHg and diastolic reductions of 2–6 mmHg (4–7). Physical activity interventions yielded reductions averaging 5/3 mmHg (3,5), while weight loss and stress management showed moderate but sustained benefits (2,10,11). In the hospital cohort, 67% of patients adhering to ≥3 lifestyle domains achieved BP control at 12 months, compared to 38% among non-adherents. Survey results indicated significant associations between adherence scores and BP change ($p < 0.05$).

Conclusion:

Lifestyle interventions are effective, scalable, and sustainable tools for hypertension control. When applied consistently, they can yield clinically meaningful improvements in blood pressure, especially when tailored to local contexts. Ongoing integration into primary care and public health strategies is essential (14,15).

Keywords:

Hypertension, Lifestyle modification, Blood pressure control, Longitudinal study, DASH diet, Exercise, Adherence, Community health.

Introduction:

Hypertension affects over 1.28 billion adults worldwide and remains the single most important modifiable risk factor for cardiovascular disease, stroke, kidney failure, and premature mortality (1). Despite advances in pharmacological therapies, global hypertension control rates remain dismally low, with less than 20% of hypertensive adults achieving adequate blood pressure (BP) control in low- and middle-income countries (2). This treatment gap is driven not only by access and adherence challenges to medications, but also by underutilization of non-pharmacological approaches that could reduce disease burden at scale (3).

In response, international guidelines such as those by the American College of Cardiology and American Heart Association (ACC/AHA) have placed increasing emphasis on lifestyle modifications as foundational to hypertension management (1). These interventions—primarily dietary changes, physical activity, alcohol moderation, stress reduction, and weight loss—are not merely adjuncts to drug therapy but are often capable of producing BP-lowering effects comparable to first-line antihypertensive medications (4,5). However, most existing studies are short-term and conducted under controlled environments, with limited understanding of how these interventions perform longitudinally in real-world populations.

The Dietary Approaches to Stop Hypertension (DASH) diet, sodium reduction, aerobic exercise, and mindfulness-based stress reduction have all shown evidence-based BP reductions ranging between 4–11 mmHg systolic and 2–6 mmHg diastolic across various populations (4–7). Yet, questions remain about their sustainability, adherence, and combined effects when applied in community or clinical practice. Furthermore, the interaction of lifestyle changes with socio-demographic factors, local habits, and health system infrastructure has not been adequately characterized—particularly in South Asian and other underserved populations where cardiovascular risk profiles are complex and evolving (12,13).

Recent observational and randomized studies have begun to address this gap, examining how lifestyle modification programs implemented at the community level or in primary care settings impact long-term BP control (8,14,15). These studies emphasize the importance of behavior change support, local cultural tailoring, and consistent follow-up. Still, generalizability remains a challenge, and the evidence base requires contextual expansion through mixed-methods approaches that combine controlled data with real-world surveillance.

This study aims to evaluate the longitudinal influence of lifestyle interventions on hypertension control by integrating evidence from high-quality published research with secondary analysis of a local hospital cohort and a small-scale community survey. Specifically, it seeks to (i) quantify the average BP changes associated with key lifestyle domains (diet, exercise, alcohol, stress, weight), (ii) explore adherence patterns and their influence on control rates in a real-world clinical setting, and (iii) identify barriers and facilitators to sustained behavior change based on community survey responses.

By grounding the analysis in both empirical research and contextual data, this paper contributes to a more nuanced understanding of how lifestyle interventions can be optimized, scaled, and sustained in diverse populations facing rising hypertension prevalence. Ultimately, such insights are essential for shaping effective, patient-centered, and culturally sensitive public health strategies aimed at reducing the global burden of hypertension.

Materials and Methods

Study Design and Setting

This study adopted a mixed-methods longitudinal approach combining three components: (i) a structured review of peer-reviewed literature published between 2018 and 2024; (ii) a retrospective observational analysis of hypertensive patients managed at a tertiary care hospital in Lahore, Pakistan; and (iii) a cross-sectional community survey assessing lifestyle adherence and self-reported blood pressure trends.

Population and Sampling Method

The study population comprised two distinct groups: a hospital-based cohort and a community survey sample. The hospital cohort included 200 adult patients aged 35 to 70 years with a confirmed diagnosis of Stage 1 or 2 hypertension, receiving outpatient care at the National Health Institute Hospital, Lahore, between January 2023 and June 2024. Patients were selected through purposive sampling, based on the availability of complete medical records at three time points: baseline, 6 months, and 12 months. Inclusion criteria were a clinical diagnosis of hypertension (systolic BP ≥140 mmHg or diastolic BP ≥90 mmHg), documented lifestyle counseling during follow-up visits, and absence of secondary hypertension or severe comorbidities such as chronic kidney disease or heart failure. Patients who were lost to follow-up or had incomplete records were excluded. For the community-based component, a convenience sample of

100 adults with self-reported hypertension was recruited from urban neighborhoods surrounding the hospital, using outreach through local clinics and community centers. Eligibility required participants to be 30 years or older, report a history of hypertension or antihypertensive medication use, and consent to complete a structured lifestyle and blood pressure survey. This dual sampling strategy allowed for the evaluation of lifestyle intervention outcomes in both clinical and real-world community settings.

Data Collection Procedures

Data collection was conducted in two parallel streams: retrospective chart review for the hospital cohort and structured interviews for the community survey. For the hospital-based sample, trained research assistants extracted data from electronic health records using a standardized abstraction form. Collected variables included baseline, 6-month, and 12-month blood pressure readings; body mass index (BMI); comorbidities; medication status; and documented lifestyle behavior changes. Lifestyle adherence was scored across five domains—diet, physical activity, alcohol intake, stress management, and weight loss—based on physician notes and patient reports recorded in follow-up visits. Each domain was considered "adherent" if the patient sustained the behavior for at least six months. For the community survey, data were gathered in June 2024 using a structured, pilot-tested questionnaire administered in person or by phone. The questionnaire included items on dietary habits (DASH alignment), physical activity (frequency and duration), alcohol consumption, perceived stress levels (measured using the PSS-4 scale), smoking status, medication adherence (assessed via the 3-item Morisky Medication Adherence Scale), and recent BP values. Where available, self-reported BP readings were cross-validated against recent clinic records (verified in 60% of cases). All data were anonymized at the point of entry, coded, and stored securely in a password-protected database. Instruments used in both arms of the study were reviewed for cultural appropriateness and consistency with global hypertension assessment standards **Variables and Outcome Measures**

The main outcomes we looked at were cardiovascular death, hospitalizations due to heart failure, and changes in left ventricular ejection fraction (LVEF). We also tracked secondary measures like kidney function decline (eGFR), patient-reported quality of life scores (using the Kansas City Cardiomyopathy Questionnaire, KCCQ), and major adverse cardiovascular events (MACE).

Ethical Considerations

Institutional Review Board approval was obtained for use of anonymized hospital data and community survey procedures. Participants in the community survey provided written informed consent. No identifiable personal or medical data were published. The study adhered to the ethical principles of the Declaration of Helsinki.

Statistical Analysis

Data were analyzed using SPSS v26. Descriptive statistics (mean, standard deviation, percentages) were used to summarize cohort characteristics. For the hospital cohort, paired t-tests assessed BP changes from baseline to follow-up within groups. Between-group

differences (high vs. low adherence) were assessed using independent-samples t-tests. For the survey, correlation analysis was conducted between lifestyle adherence scores and BP levels. A p-value of <0.05 was considered statistically significant.

Data Management and Reliability

All data were managed using SPSS version 26 and Microsoft Excel for coding, storage, and statistical analysis. Data from hospital records were double-entered independently by two research assistants to ensure consistency and accuracy, with discrepancies resolved through cross-verification against original charts. Survey responses were anonymized at the point of collection, assigned unique ID codes, and entered into a secure, encrypted database with restricted access. To assess the reliability of data abstraction from hospital records, inter-rater agreement was calculated for key variables, yielding a Cohen's κ score of 0.91, indicating excellent consistency. The lifestyle adherence scoring protocol underwent internal validation through a random review of 20% of the patient files by a senior clinician. Survey instruments were pilot-tested with 10 individuals from a similar demographic to evaluate clarity, cultural relevance, and completion time. Missing data were analyzed using Little's Missing Completely at Random (MCAR) test. For cases with less than 20% missing data, mean substitution (for continuous variables) and mode imputation (for categorical variables) were applied; patients with more than 20% missing data on primary outcome variables were excluded from the final analysis. Blood pressure measurements in the hospital cohort were obtained using calibrated automated sphygmomanometers, in accordance with international guidelines, with patients seated after five minutes of rest and using the average of two readings. These procedures ensured data integrity, internal consistency, and methodological rigor across both study components

Results:

Table 1: Summary of Included Lifestyle Intervention Studies

Study (Author, Year)	Intervention Type	Sample Size	Duration (months)	SBP Reduction (mmHg)	DBP Reduction (mmHg)
Whelton et al., 2018	Guideline-based lifestyle modifications	9000	12	11	6
Neter et al., 2018	Weight loss (diet & exercise)	2000	6	8	5
Cornelissen & Smart, 2018	Aerobic exercise programs	500	3	5	3
Sacks et al., 2020	DASH diet	800	6	7	4
Appel et al., 2022	Community-based coaching	1200	12	6	3
He et al., 2022	Alcohol reduction	1500	6	4	2

Study (Author, Year)	Intervention Type	Sample Size	Duration (months)	SBP Reduction (mmHg)	DBP Reduction (mmHg)
Huang et al., 2023	Stress management (mindfulness)	650	4	4	2
Patel et al., 2024	Primary care lifestyle coaching	1800	12	6	3

Table 2: Hospital Cohort Blood Pressure Outcomes

Group	Baseline SBP (mmHg)	6-Month SBP (mmHg)	12-Month SBP (mmHg)	Baseline DBP (mmHg)	6-Month DBP (mmHg)	12-Month DBP (mmHg)	BP Controlled at 12 Months (%)
High Adherence (n=112)	148.6	137.4	132.8	93.2	86.5	83.9	67
Low Adherence (n=88)	149.2	145.6	144.3	94.1	91.8	91.1	38

Description of Results

Findings from the secondary literature review, hospital cohort analysis, and community survey consistently demonstrated that lifestyle interventions contributed significantly to improved blood pressure (BP) outcomes across diverse populations and settings. In the literature review (Table 1), interventions such as the DASH diet, structured aerobic exercise, weight loss programs, and community-based coaching yielded average systolic BP (SBP) reductions ranging from 4 to 11 mmHg and diastolic BP (DBP) reductions of 2 to 6 mmHg. The greatest reductions were associated with multi-component interventions implemented over 6–12 months, particularly when combined with behavioral support and clinical follow-up (1,3,5,14).

In the hospital cohort of 200 patients, those with high adherence (n=112) to at least three lifestyle domains exhibited a substantial decline in BP over 12 months, with mean SBP decreasing from 148.6 to 132.8 mmHg and DBP from 93.2 to 83.9 mmHg (Table 2). By contrast, low adherence patients (n=88) showed only modest BP reductions (SBP: 149.2 to 144.3 mmHg; DBP: 94.1 to 91.1 mmHg). At the end of follow-up, 67% of high-adherence

patients achieved BP control (<140/90 mmHg), compared to just 38% in the low-adherence group.

Results from the community survey (Table 3) supported these findings. Participants with high lifestyle adherence reported lower mean SBP (133.2 mmHg) and DBP (84.5 mmHg), higher medication adherence (82%), and lower perceived stress scores. In contrast, low adherence participants showed elevated BP values and greater psychological stress. A significant negative correlation was observed between adherence scores and BP levels ($p < 0.05$), suggesting that better adherence was associated with lower BP, independent of pharmacologic treatment.

Collectively, these findings underscore the clinical relevance of sustained lifestyle changes in hypertension management.

Discussion:

This study evaluated the longitudinal influence of lifestyle interventions on hypertension control through a combination of published evidence, clinical cohort analysis, and a community survey. The findings reinforce that non-pharmacologic strategies—particularly those targeting diet, exercise, stress, and weight management—have a significant and measurable impact on blood pressure (BP) reduction.

Evidence from the literature review supports this conclusion. Interventions such as the DASH diet, aerobic exercise, and structured weight loss programs yielded average systolic BP (SBP) reductions of 4 to 11 mmHg, with diastolic BP (DBP) reductions of 2 to 6 mmHg (1–7). These magnitudes of change are consistent with reductions seen with first-line antihypertensive medications, emphasizing that lifestyle modifications are not merely supportive but central to hypertension control (3,5,6).

In the hospital cohort, patients who adhered to three or more lifestyle modifications showed a 15.8 mmHg drop in SBP and a 9.3 mmHg drop in DBP over 12 months. The control rate in this group was 67%, nearly twice that of the low-adherence group (38%). These findings align with Patel et al. (2024) and Appel et al. (2022), who demonstrated the importance of behavioral support and long-term follow-up in driving clinical outcomes (14,7).

The community survey further validated these findings, revealing that high-adherence individuals had lower BP, higher medication compliance, and significantly reduced stress levels. A negative correlation between adherence scores and BP levels ($p < 0.05$) reinforced that improved behaviors are associated with better BP control, even in the absence of clinical supervision. This echoes findings from Huang et al. (2023), who emphasized stress reduction and patient empowerment as key drivers of success (11).

Together, these data highlight the importance of multifaceted, patient-centered approaches that combine education, access, and follow-up. While barriers such as limited resources, health literacy, and lifestyle habits remain, the consistent outcomes across literature, clinic,

and community point to the scalability of such interventions.

However, limitations exist. Retrospective data abstraction may introduce bias, and survey responses relied partly on self-reported BP. Nonetheless, the alignment of findings across three data sources enhances confidence in the results.

In sum, lifestyle interventions are not only effective but essential. When implemented with consistency and cultural relevance, they offer a powerful, sustainable tool for hypertension control.

Conclusion

This study demonstrates that lifestyle interventions—when sustained and personalized—can lead to significant improvements in blood pressure control among individuals with hypertension. Evidence from high-quality published research, a real-world hospital cohort, and a community-based survey all converge on the same conclusion: non-pharmacological strategies such as dietary change, regular physical activity, alcohol moderation, weight loss, and stress reduction are not only effective but also scalable.

Patients who adhered to multiple lifestyle changes over a 12-month period experienced clinically meaningful reductions in both systolic and diastolic blood pressure. In the hospital cohort, high adherence was associated with nearly double the BP control rate compared to low adherence. Survey data further highlighted the relationship between improved behaviors, lower BP, better medication compliance, and reduced stress. These findings underscore the critical role of behavioral and environmental factors in managing hypertension, especially in resource-constrained settings.

Importantly, this study reinforces that success depends not just on recommending lifestyle change, but on enabling it—through structured support, follow-up, and cultural adaptation. Challenges such as low health literacy, limited resources, and competing priorities must be addressed through integrated care models and supportive policy frameworks.

Moving forward, health systems should prioritize the integration of lifestyle modification programs into routine hypertension management. By investing in prevention and empowering patients to adopt healthier behaviors, the burden of hypertension can be significantly reduced—both clinically and economically—on individuals, families, and society

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