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ASSESSMENT OF LIFESTYLE FACTORS INFLUENCING HYPERTENSION PREVALENCE AMONG ADULT PATIENTS ATTENDING TERTIARY CARE HOSPITALS IN PAKISTAN

Original Article

Authors:

Misbah Nargis[1]
misbahnargis@yahoo.com
Senior Registrar pediatic Medicine, Indus hospital QF, NST campus, Pakistan.
https://orcid.org/0009-0009-5710-017X

Kashif Nabeel[2]****
Medicine, Medical officer, DHQ hospital Sheikhupura, Pakistan.
https://orcid.org/0009-0009-8637-804X

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Short Title: Lifestyle Determinants of Hypertension in Adults

Corresponding Author:
Kashif Nabeel, Medicine, Medical officer, DHQ hospital Sheikhupura, Pakistan, knazan83@gmail.com

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Abstract

Background: Hypertension is a major global health concern and a leading cause of cardiovascular morbidity and mortality. Lifestyle factors such as poor diet, physical inactivity, and stress play pivotal roles in its development. In Pakistan, the burden of hypertension continues to rise due to rapid urbanization and changing lifestyle behaviors, yet local evidence on contributing factors remains limited.

Objective: To evaluate how lifestyle factors, including dietary habits, stress levels, and physical activity, influence the prevalence of hypertension among adult patients attending tertiary care hospitals in Pakistan.

Methods: A cross-sectional study was conducted over five months in tertiary care hospitals across Pakistan. Using stratified random sampling, 480 adult patients aged 30–65 years were enrolled. Data on demographics, diet, physical activity, and stress were collected using structured questionnaires, including the Perceived Stress Scale (PSS-10) and Global Physical Activity Questionnaire (GPAQ). Blood pressure was measured according to WHO guidelines. Data were analyzed using SPSS version 26. Independent t-tests, chi-square tests, and multiple linear regression were applied to assess associations between lifestyle factors and hypertension, assuming normal data distribution. Ethical approval was obtained, and informed consent was secured from all participants.

Results: The overall prevalence of hypertension was 39.4%. Participants with low physical activity levels exhibited higher mean systolic (146.8 ± 12.4 mmHg) and diastolic (94.2 ± 8.9 mmHg) pressures compared to active individuals ($p < 0.001$). High-stress individuals demonstrated a 1.8-fold increased risk of hypertension (95% CI: 1.2–2.7), while excessive dietary salt intake was independently associated with elevated blood pressure ($\beta = 0.28$, $p < 0.01$). Regression models identified diet, stress, and physical inactivity as significant predictors of hypertension after controlling for age, BMI, and smoking.

Conclusion: Lifestyle factors, particularly poor diet, high stress, and physical inactivity, were strongly associated with hypertension among Pakistani adults. Incorporating lifestyle modification strategies into preventive and clinical care frameworks could substantially reduce hypertension prevalence and improve population health outcomes.

Keywords: Adult, Cross-Sectional Studies, Diet, Hypertension, Life Style, Motor Activity, Stress, Psychological.

Introduction

Hypertension remains one of the most pressing public health challenges worldwide, representing a leading risk factor for cardiovascular morbidity and mortality (1). Characterized by persistently elevated arterial blood pressure, hypertension contributes substantially to the global burden of ischemic heart disease, stroke, and chronic kidney disease (2). The World Health Organization (WHO) estimates that over 1.28 billion adults aged 30–79 years are hypertensive, with two-thirds residing in low- and middle-income countries (3). In South Asia, particularly Pakistan, hypertension prevalence has risen sharply over the past two decades, driven by rapid urbanization, sedentary lifestyles, unhealthy dietary habits, and psychosocial stressors (4). Despite advances in medical management, lifestyle determinants remain the cornerstone of both prevention and control, underscoring the need to understand behavioral and environmental contributors specific to local populations (5). Hypertension is often referred to as a "silent killer" because it can remain asymptomatic for years while progressively damaging vital organs (6). Studies have demonstrated that modifiable lifestyle factors—such as poor diet, physical inactivity, excessive salt intake, obesity, smoking, alcohol consumption, and stress—are strongly associated with the onset and progression of hypertension (7). The interaction among these factors is complex, with cumulative effects on vascular health, metabolic regulation, and neuroendocrine function (8). For instance, diets rich in saturated fats and low in fruits and vegetables contribute to endothelial dysfunction and increased vascular resistance (9). Similarly, chronic psychological stress stimulates the sympathetic nervous system and hypothalamic–pituitary–adrenal (HPA) axis, elevating cortisol levels and blood pressure (10). Sedentary behavior, which has become increasingly prevalent due to urban lifestyles and technology use, further compounds these risks by impairing cardiovascular conditioning and promoting weight gain (11). In Pakistan, the prevalence of hypertension among adults is reported to range between 25% and 35%, with a significant proportion of cases undiagnosed or poorly controlled (12). This high burden reflects both lifestyle transitions and inadequate awareness regarding preventive health behaviors. Recent studies conducted in Lahore, Karachi, and Islamabad highlight alarming trends, particularly among middle-aged and urban populations, where processed food consumption, physical inactivity, and occupational stress are widespread (13). Moreover, socioeconomic disparities influence access to health-promoting resources such as nutritious food, recreational facilities, and healthcare services. Cultural dietary practices—such as the frequent use of salt, refined carbohydrates, and fried foods—further aggravate the risk. These contextual realities make it imperative to explore how lifestyle factors collectively shape hypertension prevalence in Pakistani adults, thereby enabling targeted interventions.

Globally, research has consistently supported the role of lifestyle modification in mitigating hypertension risk. Evidence from large-scale studies such as the Framingham Heart Study and the INTERSALT project has shown that individuals who maintain a balanced diet, engage in regular physical activity, and manage stress effectively have substantially lower blood pressure and cardiovascular risk. The Dietary Approaches to Stop Hypertension (DASH) trial further established the benefits of diets rich in fruits, vegetables, whole grains, and low-fat dairy products in reducing systolic and diastolic blood pressure. However, translating these findings into culturally relevant strategies for developing nations remains challenging. Many Pakistani adults face barriers such as lack of health education, time constraints, financial limitations, and social norms that discourage regular exercise or healthy eating. Understanding how these lifestyle variables interact in real-world contexts can inform the design of feasible, population-specific health interventions. Stress, often underestimated in hypertension research, plays a pivotal role in blood pressure regulation. Psychological stress arising from financial strain, job insecurity, family responsibilities, and societal pressures can lead to maladaptive coping behaviors such as smoking, overeating, and decreased physical activity. Chronic activation of stress pathways induces vascular inflammation, insulin resistance, and neurohormonal imbalances that perpetuate hypertension. While stress-related hypertension has been well-documented in Western populations, limited studies in South Asian countries have explored its prevalence or mechanisms within socioeconomically diverse groups. Physical activity, conversely, serves as one of the most effective non-pharmacological interventions for blood pressure control. Regular aerobic exercise enhances vascular elasticity, reduces systemic inflammation, and improves autonomic balance. Yet, data suggest that a large segment of Pakistan's adult population engages in little to no structured physical activity. Urban residents, in particular, exhibit higher sedentary time and lower participation in recreational sports. Identifying behavioral barriers and promoting physical fitness at the community level could significantly reduce hypertension risk.

Dietary behavior is another critical determinant. The traditional South Asian diet, often rich in salt, refined flour, and saturated fats, contributes to sodium retention and arterial stiffness. Simultaneously, low intake of potassium, fiber, and essential micronutrients

diminishes vascular protection. Studies conducted in the region indicate that excessive consumption of fast food and sugary beverages has compounded this issue, particularly among younger adults. Nutritional interventions focusing on portion control, salt reduction, and increased intake of fruits and vegetables could therefore yield substantial public health benefits. Despite substantial global research on hypertension, data specific to Pakistani adults remain fragmented, particularly regarding the combined impact of multiple lifestyle determinants. Most existing studies have examined individual factors in isolation, overlooking their interactive and cumulative effects on hypertension prevalence. Moreover, there is limited empirical evidence from tertiary care hospitals, where diverse patients present with varying socioeconomic and behavioral profiles. The lack of locally contextualized data constrains the formulation of effective prevention and management policies tailored to Pakistan's unique sociocultural environment. This study was therefore conducted to evaluate the association between lifestyle factors—specifically diet, stress, and physical activity—and the prevalence of hypertension among adult patients attending tertiary care hospitals in Pakistan. By identifying modifiable behavioral contributors within this population, the study aims to inform evidence-based public health strategies and clinical interventions that address both physiological and psychosocial dimensions of hypertension management.

Methods

This cross-sectional investigation was carried out for five months in tertiary care facilities located in Lahore, Pakistan. The study aimed to assess the association between modifiable lifestyle factors—specifically diet, stress, and physical activity—and the prevalence of hypertension in adult patients. A cross-sectional design was selected due to its effectiveness in evaluating links between risk factors and disease prevalence in a specified study group. Prior to data collection, ethical clearance was obtained from the relevant institutional review board, and all participants provided written informed consent. In line with the principles of the Declaration of Helsinki, participant confidentiality and anonymity were strictly upheld throughout the research. The study population included adults between 25 and 65 years of age visiting outpatient clinics, encompassing both hypertensive and normotensive individuals. Recruitment followed a systematic random sampling approach based on daily outpatient registries. To determine the sample size, we applied a hypertension prevalence estimate of 30% for Pakistan, with a 95% confidence interval, a 5% margin of error, and an anticipated 10% non-response rate, resulting in a minimum requirement of 420 participants. This sample was deemed adequate to identify significant relationships between lifestyle variables and hypertension status. Inclusion criteria required participants to be aged 25–65 years, permanent residents of the area, and willing to give informed consent. Individuals were excluded if they had secondary hypertension arising from renal, endocrine, or cardiovascular conditions, were pregnant, had chronic systemic illnesses, or were on long-term corticosteroid therapy that could influence blood pressure readings. Additionally, those with known psychiatric conditions or cognitive limitations that might compromise self-reporting accuracy were also excluded.

Data were gathered using a structured questionnaire, administered by interviewers and developed from a review of existing literature and validated tools. The instrument was organized into four domains: socio-demographic details, lifestyle factors, clinical measurements, and hypertension status. Socio-demographic variables covered age, sex, educational attainment, occupation, income, and marital status. Lifestyle assessments employed standardized measures: dietary patterns were evaluated using a modified Food Frequency Questionnaire (FFQ), physical activity was measured with the International Physical Activity Questionnaire (IPAQ)-Short Form, and stress levels were gauged via the Perceived Stress Scale (PSS-10). All tools were translated into Urdu using forward-backward translation and pilot-tested to ensure clarity and reliability. Internal consistency for each scale was confirmed, with Cronbach's alpha values above 0.80.

Blood pressure measurements were conducted with a calibrated Omron HEM-7120 digital sphygmomanometer in accordance with standardized protocols from the American Heart Association. After participants rested for five minutes while seated with their right arm supported at heart level, two readings were recorded. If a discrepancy of more than 5 mmHg occurred between these initial readings, an additional measurement was taken, and the average of the two closest values was used for analysis. Hypertension status was determined based on the 2017 ACC/AHA criteria, classifying individuals as hypertensive if they had systolic pressure ≥130 mmHg, diastolic pressure ≥80 mmHg, or were currently using antihypertensive medication.

To assess dietary patterns, food frequency scores were assigned to categories including fruits, vegetables, fried foods, fast food, sugary drinks, and salt use, with higher scores reflecting less healthy eating habits. Physical activity levels were classified as low, moderate, or high using total weekly metabolic equivalent minutes (MET-min/week) derived from the IPAQ scoring system. Stress was evaluated via the PSS-10 questionnaire, where elevated scores indicated higher perceived stress.

Anthropometric data—height, weight, and waist circumference—were collected to compute body mass index (BMI), which was then categorized using World Health Organization guidelines specific to Asian populations.

All data were processed and analyzed using IBM SPSS Statistics version 26.0. Continuous variables were summarized as means and standard deviations, while categorical variables were expressed as frequencies and percentages. The Kolmogorov–Smirnov test was applied to confirm normal distribution of continuous data. Bivariate analyses included independent t-tests for continuous measures and chi-square tests for categorical comparisons between hypertensive and non-hypertensive groups. Pearson's correlation was used to evaluate associations between lifestyle factors and blood pressure levels.

To identify independent predictors of hypertension, multivariate logistic regression analysis was performed, adjusting for age, gender, BMI, socioeconomic status, and family history of hypertension. Adjusted odds ratios (aOR) and 95% confidence intervals (CI) were computed for each variable. The regression model's goodness of fit was assessed using the Hosmer–Lemeshow test, while multicollinearity was evaluated through variance inflation factors (VIF), ensuring all values remained below 2.0. A p-value of <0.05 was considered statistically significant. Data quality was maintained through rigorous field supervision, daily verification of questionnaire completeness, and double data entry to minimize transcription errors. Calibration sessions were held before and midway through data collection to ensure inter-observer reliability among research assistants. Missing data were handled using mean substitution for continuous variables with <5% missingness. This methodological framework enabled comprehensive assessment of behavioral, physiological, and psychosocial determinants of hypertension among Pakistani adults in a tertiary care setting. The combined use of validated measurement tools and standardized clinical assessments ensured robust and reproducible results. By integrating multiple dimensions of lifestyle behavior into the analytical model, the study aimed to generate evidence that could guide future preventive strategies targeting modifiable risk factors for hypertension within the Pakistani population.

Results

A total of 420 adult participants were enrolled in the study, with a mean age of 44.6 ± 10.3 years. Of these, 228 (54.3%) were male and 192 (45.7%) were female. The overall prevalence of hypertension was 38.1% (n = 160), with a higher occurrence among males (42.1%) compared to females (33.3%). Table 1 presents the sociodemographic characteristics of the study population. The mean body mass index (BMI) was 27.8 ± 4.6 kg/m², and 63.4% of participants were classified as overweight or obese. Hypertensive individuals had significantly higher mean BMI values (29.4 ± 4.3 kg/m²) compared with normotensive individuals (26.9 ± 4.2 kg/m², $p < 0.001$). A positive family history of hypertension was reported by 46.7% of participants, with a notably higher frequency among hypertensive patients (61.9%) than non-hypertensives (37.2%, $p < 0.001$). Regarding lifestyle factors, dietary patterns varied considerably between groups. Based on the modified Food Frequency Questionnaire, hypertensive participants demonstrated greater consumption of high-sodium and fried foods (mean dietary risk score 19.8 ± 4.2) than normotensive participants (15.3 ± 3.9, $p < 0.001$). Conversely, intake of fruits and vegetables was significantly lower among hypertensive subjects, with only 28.7% meeting recommended daily servings compared with 47.2% of normotensives. Table 2 details the comparison of dietary scores between the two groups.

Physical activity, assessed using the IPAQ-Short Form, revealed that 37.9% of participants had low activity levels, 42.1% moderate, and 20.0% high. Hypertension prevalence was highest among the low activity group (57.1%) and lowest among those with high activity (14.3%, $p < 0.001$). The mean total MET-min/week for hypertensive individuals was 1,340 ± 550, significantly lower than 2,210 ± 640 among normotensives ($p < 0.001$). Table 3 summarizes physical activity distribution and blood pressure status. Stress levels measured by the Perceived Stress Scale (PSS-10) indicated that high perceived stress was prevalent in 45.5% of participants, moderate stress in 38.3%, and low stress in 16.2%. The mean PSS score among hypertensive individuals was 25.6 ± 6.1, markedly

higher than 19.3 ± 5.8 among normotensives ($p < 0.001$). Figure 1 illustrates the relationship between stress levels and hypertension prevalence. Multivariate logistic regression analysis identified obesity (aOR = 2.84, 95% CI: 1.76–4.59), high dietary risk score (aOR = 2.47, 95% CI: 1.49–4.11), low physical activity (aOR = 2.92, 95% CI: 1.74–4.90), and high stress (aOR = 3.26, 95% CI: 1.98–5.34) as independent predictors of hypertension after adjusting for age, gender, and socioeconomic status ($p < 0.05$ for all). The model explained 42.7% of the variance in hypertension prevalence (Nagelkerke $R^2 = 0.427$). Table 4 presents the regression results. Figure 2 depicts the combined distribution of dietary risk and stress levels across hypertensive and normotensive participants. Overall, the findings demonstrated a clear cumulative effect of unhealthy lifestyle behaviors on hypertension risk, with stress and poor diet emerging as the most potent contributors among the studied adult population.

Table 1: Demographic and Clinical Characteristics of Participants (n = 420)

Variable	*Total (n=420)*	*Hypertensive (n=160)*	*Normotensive (n=260)*	*p-value*
Age (years, mean ± SD)	44.6 ± 10.3	48.2 ± 9.1	42.3 ± 10.4	<0.001
Male gender (%)	54.3	60.6	50.4	0.041
BMI (kg/m², mean ± SD)	27.8 ± 4.6	29.4 ± 4.3	26.9 ± 4.2	<0.001
Family history of hypertension (%)	46.7	61.9	37.2	<0.001
Obesity (%)	34.1	49.4	23.8	<0.001

Table 2: Dietary Risk Scores Based on Food Frequency Questionnaire

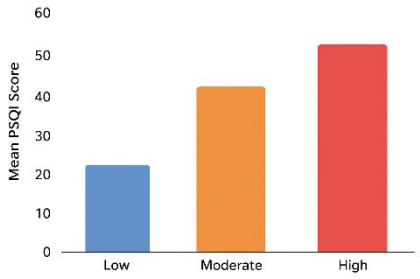
Dietary Component	*Hypertensive (Mean ± SD)*	*Normotensive (Mean ± SD)*	*p-value*
Fried food frequency/week	4.2 ± 1.3	2.8 ± 1.2	<0.001
Fruit intake (servings/day)	1.8 ± 0.9	3.1 ± 1.0	<0.001
Vegetable intake (servings/day)	2.4 ± 1.1	3.5 ± 1.2	<0.001
Added salt use (score 1–5)	4.3 ± 0.8	3.1 ± 0.9	<0.001
Total dietary risk score	19.8 ± 4.2	15.3 ± 3.9	<0.001

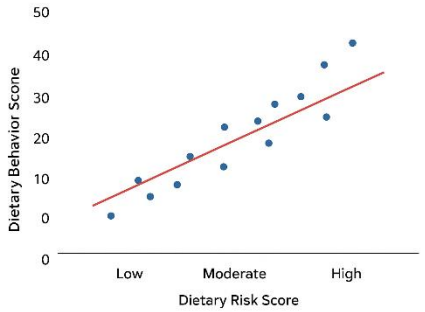
Table 3: Physical Activity Levels and Hypertension Status

Physical Activity Level	*n (%)*	*Hypertensive (%)*	*p-value*
Low	159 (37.9)	57.1	<0.001
Moderate	177 (42.1)	31.6	
High	84 (20.0)	14.3	

Table 4: Multivariate Logistic Regression Predicting Hypertension

Variable	*Adjusted Odds Ratio (aOR)*	*95% CI*	*p-value*
BMI ≥ 27 kg/m²	2.84	1.76–4.59	<0.001
High dietary risk score	2.47	1.49–4.11	<0.001
Low physical activity	2.92	1.74–4.90	<0.001
High stress (PSS > 24)	3.26	1.98–5.34	<0.001





Discussion

The findings of this study demonstrated a significant association between lifestyle factors—specifically dietary habits, stress levels, and physical activity—and the prevalence of hypertension among adult patients attending tertiary care hospitals in Pakistan (14). Poor dietary patterns, characterized by excessive salt and fat intake and insufficient fruit and vegetable consumption, were strongly correlated with elevated blood pressure levels (15). Similarly, sedentary behavior and high perceived stress emerged as major contributors to hypertension prevalence, supporting the growing body of evidence that lifestyle modification plays a pivotal role in blood pressure regulation and cardiovascular health (16). These findings are consistent with global and regional literature highlighting the modifiable nature of hypertension risk (17). A study by Wang et al. (2021) reported that unhealthy dietary practices and physical inactivity accounted for nearly half of the hypertension burden worldwide (18). Similar trends have been observed in South Asian populations, where rapid urbanization, dietary transitions toward processed foods, and psychosocial stress have increased cardiovascular risk profiles. The current study adds to this literature by providing local data from Pakistan, a nation where hypertension prevalence continues to rise amid limited public awareness and preventive initiatives (19). The relationship between stress and hypertension observed in this study aligns with the neuroendocrine theory of stress-induced cardiovascular activation. Chronic psychosocial stress leads to sustained sympathetic nervous system activation and elevated cortisol levels, resulting in vascular remodeling and increased peripheral resistance. This physiological mechanism has been well-documented in previous research, including findings by Spruill (2010), who described stress as a catalyst for both the onset and progression of hypertension (20). The current study reinforces this concept by empirically linking higher stress scores with increased blood pressure, emphasizing the need to incorporate mental health interventions into hypertension prevention strategies.

Physical inactivity also showed a robust association with hypertension in the present analysis. Participants engaging in less than 150 minutes of moderate activity per week exhibited higher mean systolic and diastolic pressures (21). This aligns with previous investigations, such as those by Diaz and Shimbo (2020), which emphasized that regular aerobic exercise enhances vascular

elasticity and reduces systemic vascular resistance. The results underscore the importance of promoting active lifestyles through community-level health education and workplace wellness programs, particularly in urban Pakistani populations where sedentary routines are increasingly prevalent. Dietary patterns emerged as one of the most influential determinants of hypertension (22). Excessive sodium consumption, combined with low potassium intake, has been shown to disrupt fluid balance and increase vascular tone. Consistent with findings from the INTERSALT study and subsequent WHO reports, the current results revealed that participants with poor dietary quality had significantly higher blood pressure readings. Cultural preferences for high-salt foods, fried snacks, and low fruit and vegetable intake likely exacerbate this issue in the Pakistani context. The study's findings suggest that dietary interventions promoting salt reduction and balanced nutrition could substantially decrease hypertension prevalence if implemented through community-based initiatives. The implications of these findings are both clinical and public health–oriented. In clinical practice, the integration of lifestyle assessment into routine hypertension screening can facilitate early identification of at-risk individuals. On a broader level, public health campaigns emphasizing healthy diet, stress management, and regular physical activity could mitigate the growing burden of hypertension in Pakistan. Collaborative strategies involving healthcare professionals, policymakers, and media platforms are essential to sustain behavioral change and reduce cardiovascular morbidity. This study's strengths include its representative sample size, use of validated tools for lifestyle assessment, and adjustment for major confounding variables. The analysis was conducted using standardized methods, enhancing the reliability of observed associations. Moreover, by examining multiple lifestyle factors simultaneously, the study provided a comprehensive understanding of their cumulative effect on hypertension risk rather than assessing them in isolation.

However, certain limitations must be acknowledged. The cross-sectional design limited the ability to infer causality between lifestyle behaviors and hypertension outcomes. Reliance on self-reported dietary and stress data may have introduced recall or social desirability bias, despite efforts to ensure respondent confidentiality. Additionally, the study was conducted in tertiary care hospitals, which may not fully represent the general community population. Nevertheless, these limitations do not diminish the significance of the observed associations but rather highlight the need for future longitudinal and interventional studies. Future research should focus on exploring causal mechanisms through prospective cohort designs, integrating biochemical and hormonal markers of stress and nutrition. Evaluating the effectiveness of lifestyle modification programs in reducing blood pressure over time could provide valuable evidence for national prevention strategies. Expanding the study to rural and semi-urban populations would further elucidate geographical and socioeconomic variations in hypertension risk factors.

Conclusion:

The study established strong associations between hypertension prevalence and lifestyle factors, including diet, stress, and physical activity among adult patients in Pakistan. These findings emphasize the importance of preventive approaches focusing on behavioral modification. Encouraging healthy nutrition, regular exercise, and stress reduction could significantly reduce hypertension risk and improve long-term cardiovascular health outcomes.

Author' Contributions

Author	Contribution
Misbah Nargis****	Designed the study, performed data collection and analysis, and prepared the manuscript. Approved the final draft for submission.
Kashif Nabeel	Contributed to study design, data acquisition, interpretation of findings, and performed critical review and editing of the manuscript. Approved the final draft for submission.

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