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RESEARCH ARTICLE

Association of Dietary Patterns, Sleep Quality, and Perceived Stress with Hypertension Among Middle-Aged Adults.

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Abstract: ***Background***: Hypertension is one of the chief causes of cardiovascular diseases. Habitual lifestyle changes that are completely controllable, such as food intake, sleep habits, and mental stress, could be the potential factors that cause a heart attack. These environmental influences tend to support hypertension mainly in middle-aged people. In this article, we look into how diet, sleep, and stress levels are linked to high blood pressure, both individually and in combination.***Methods:*** This cross-sectional study included 450 male and female residents of Lahore, Pakistan, aged 40–60 years. In addition to the usual dietary patterns, weight gain was the primary factor tied to poor sleep quality. The Pittsburgh Sleep Quality Index (PSQI) was applied to evaluate sleep quality [1]. To measure stress, the Perceived Stress Scale (PSS10) was administered directly [2]. The tests were executed using standardized and validated tools. Blood pressure measurements were taken using automated machines. The statistical relations were explored using chi-square tests, independent t-tests, and multivariate logistic regression.***Results:*** High blood pressure was found in 36.0% of the sample (N=162). There was a very strong association between eating processed meals and high salt consumption, both of which were clearly associated with elevated blood pressure ($p < 0.001$). The results regarding the sleeping habits seem quite alarming: 52.0% of participants (N = 234). It is reported to have sleep disturbances. The group with hypertension is showing a significantly higher mean sleep disturbance score. It is compared with those without hypertension: 6.8 ± 2.1 vs. 5.2 ± 1.9; $t = 6.12$, $p < 0.001$. In contrast, even when perceived stress was higher. It still appeared to increase hypertension risk on its own, with an "adjusted OR" of 1.78 (95% CI 1.23–2.56; p=0.002). Moreover, when poor eating habits, disturbed sleep, and increased psychological strain all occurred simultaneously. The odds of hypertension augmented more than twofold (OR = 2.46; 95% CI 1.63–3.71; $p < 0.001$).***Conclusion:*** Improper dietary patterns, lower sleep quality, and elevated stress levels are quite strongly tied to hypertension in the middle-aged cohort. The link is not a coincidence. Public health actions should address three lifestyle factors simultaneously and more effectively. The goal is to minimize or alleviate regional cardiovascular risks.

Keywords: cardiovascular risk, dietary patterns, hypertension, middle-aged adults, perceived stress, sleep quality .

INTRODUCTION

Hypertension is potentially the most common risk factor for cardiovascular disease around the world, affecting about 30% of adults [3]. Persistent elevated blood pressure, specifically during middle age, generally increases the risk of myocardial infarction, stroke, including cerebrovascular accidents, and chronic kidney disease [4]. A combination of genetic weaknesses and daily lifestyle habits influences the onset of hypertension. It signifies factors such as diet, sleep, and stress management [5].

Diet is the main factor affecting the proper regulation of hypertension. A change in the diet, specifically increasing the intake of sodium, saturated fats, and sugar-sweetened beverages. It is very likely to exacerbate systemic hypertension. On the contrary, increasing consumption of fruits, vegetables, whole grains, and lean proteins is commonly associated with more stable, healthier blood pressure levels [6]. Public health campaigns aimed at raising people's nutritional awareness are in place. However, the twin problems of rapid urbanization and the widespread availability of convenience foods make it quite tough for people to maintain ideal dietary patterns in metropolitan life.

Another major factor determining cardiovascular health is sleep quality. Chronic sleep deprivation or disorganized sleep patterns are quite detrimental. They stimulate the sympathetic nervous system and cause an imbalance of metabolic hormones. In addition, they increase peripheral vascular resistance [7, 8]. Middle-aged individuals are most seriously affected, especially when they experience sleep disturbances or are just not able to sleep well. Despite facing problems, they have to handle the dual strain of managing work while caring for their family, which can feel relentless. This could further raise their clinical risk of hypertension [9].

Stressful psychological factors can have a significant impact on blood pressure. Besides making small changes in behavior, it also activates the neuroendocrine system.

When people are constantly exposed to prolonged and continuous stress. These individuals sometimes resort to maladaptive coping behaviors. Over time, these behaviors become routine. It could result in unhealthy food choices, inactivity, and more frequent alcohol consumption. At the same time, chronic mental stress keeps the hypothalamic–pituitary–adrenal axis activated and going. Consequently, there is vasoconstriction and possibly an increase in cardiac output [10, 11]. People's self-reported stress levels remain very helpful. They serve as good predictors of cardiovascular risk for different groups [12].

Although individual lifestyle-related risk factors are very well addressed. However, little research has examined the combined effects of diet, sleep quality, and stress in South Asian populations. Middle-aged adults in Pakistan are subject to many factors. They include a unique food environment and socioeconomic pressures that differ from those experienced by Western populations [13]. For this reason, it is critical to understand how these factors interact to inform the development of targeted and culturally appropriate preventive strategies.

This cross-sectional study aims to examine how dietary patterns are associated with various factors among middle-aged groups in Lahore, Pakistan. The factors comprise sleep quality, perceived stress, and hypertension. It establishes the relationships among various aspects and how they may be linked collectively. We hypothesized that people with bad dietary habits, poor sleep quality, and high stress levels are more likely to develop hypertension. The study results should assist clinicians and the public health sector in preparing combined lifestyle interventions for the urban population.

MATERIALS AND METHODS

Study Design and Setting: This is a cross-sectional, descriptive study organized to examine the associations between day-to-day lifestyle factors and hypertension. The setup allowed us to examine behavioral hazards and the clinical hypertension situation simultaneously within the group we focused on, as described in [14]. Research fieldwork occurred in Lahore, Pakistan. The timeline had to be covered, Jan 2025 to Mar 2025. We have selected participants from multiple settings. It includes city community centers, outpatient clinics, and enterprise health screening programs. The purpose was to maintain an adequately broad socioeconomic representation rather than becoming narrowly or systematically limited.

Selection Criteria: We were seeking individuals aged 40 to 60 who live in Lahore and can physically sign a consent form to participate in our study. Their secondary causes of hypertension include severe renal insufficiency, endocrine tumors, and pregnancy. This would disqualify them from the inclusion of the study. Respondents who did not conclude their questionnaires in full or who missed critical aspects have been excluded from the final results.

Sample Size and Sampling Strategy: We derived the minimum sample size using the single population proportion formula. Based on earlier provincial studies, the prevalence of urban adult hypertension is around 30%–35% as a baseline [15]. We figured we required at least 420 individuals. While to use a 95% confidence level with a 5% margin of error suggests that the sample size is reasonable. Enrollment was limited to 420. Thus, the threshold was slightly higher, moving toward 450. Some responses were missing, or the questionnaires were incomplete. A nonprobability convenience sampling method was used to recruit additional participants during the brief study period. It was considered more practical and efficient than other options. This approach is a typical everyday standard for initial observational studies in specific communities [16].

Data Collection Instruments: Data were collected through a structured, four-part interview schedule. It was not a single unit. It was divided into different sections that simultaneously recorded demographic details, dietary behaviors, sleep quality indicators, and felt subjective stress levels.

Sociodemographic Profile: This part recorded baseline characteristics. It includes age, sex, level of education, occupational category, marital status, and average household income. Hence, it provides the usual starting point.

Dietary Patterns: A localized Food Frequency Questionnaire (FFQ) noted how often people ate common regional food groups during the prior month. Because factor analysis provides it. It grouped people into healthy, mixed, or unhealthy diet patterns, primarily based on nutrient density, sodium levels, and processed food content. However, it is not obvious whether it was the same for everyone. But it reduced the entire concept to three simpler groups.

Sleep Quality Assessment: The Pittsburgh Sleep Quality Index (PSQI) is applied to gain a reasonable sense of sleep-related aspects [1]. We also asked how long it took to fall asleep. What issues they had been exposed to, and how frequently participants woke during the night. How efficient sleep felt, all with reference to the last month. For the overall PSQI, a score above 5 was considered indicative of poor sleep quality [1]. How efficient sleep felt, all with reference to the last month. For the overall PSQI, a score above 5 was considered indicative of poor sleep quality [1].

Perceived Stress Evaluation: The 10-item Perceived Stress Scale (PSS10) was used to measure the psychological strain participants have seriously experienced [2]. The final scores were split into low

stress (0–13), moderate stress (14–26), and high stress (27–40), using the usual thresholds [2].

Clinical and Anthropometric Measurements: Blood pressure was measured in accordance with a clinical guideline [17]. The participants were seated silently and resting for five minutes before their blood pressure was measured. Three different blood pressure readings were obtained with an automatic digital sphygmomanometer from the dominant arm at one-minute intervals. For the final course, we averaged the last two readings. ACC/AHA has clear-cut guidelines that delineate hypertension as systolic blood pressure above 130 mmHg, diastolic blood pressure above 80 mmHg, or the use of antihypertensive medications [17].

The anthropometric measures included height, body mass, and weight. Calibrated digital scales and stadiometers were used. For Body Mass Index (BMI), the following equation was employed: weight (kg) / height (m^2) ("kg/m^2"). Then, participants were categorized by BMI. This is in consonance with the World Health Organization standards. A body mass index (BMI) of 18.524.9 kg/m^2 is normal weight. A BMI of 25.029.9 kg/m^2 is overweight. A person is considered obese if BMI is 30.0 kg/m^2 or higher [18].

Data Collection Procedure: Fieldwork procedures were initiated only after the Institutional Research Board conducted a thorough review of the study protocols. This way, the researcher got the permission. Research assistants introduced the study to potential participants and obtained their consent, if necessary. The interview was the primary means by which the research team collected data in person. As much as possible, strategies were implemented to prevent missing data. The medical tests and blood pressure assessments were conducted twice in individual rooms to ensure participants' privacy and prevent overlap.

Statistical analysis: Statistical calculations were done using SPSS 26.0 (IBM Corp., Armonk, NY). Normally, continuous quantitative variables are presented as arithmetic means and standard deviations and indicated as "mean" ± "SD." As for qualitative, categorical data, they are represented as counts with respective relative percentages (N, %).

For hypothesis testing between two variables, the chi-square test (χ^2) was used. When categorical variables were involved, crosstabulations were conducted. Independent samples t-tests were used for continuous variables. Logistic regression was also performed to assess independent behavioral associations. It produces adjusted odds ratios (ORs) with 95% confidence intervals (CIs). This approach allows one to consider the effects of age, sex, BMI, and accompanying initial socioeconomic factors. The preset level of statistical significance was $p < 0.05$. With this, postdoc correction or adjustment was completely evaded.

Ethical considerations: The study protocol was thoroughly reviewed. It was formally authenticated by the Institutional Review Board of the University of Health Sciences Lahore under Approval No. UHSIRB/2025/101. Participation remained completely voluntary. Each individual signed a written informed consent form enclosed. The main purpose was to ensure that each data fragment was fully anonymized to shield the privacy of participating individuals. This must be challenging to surface a person's identity.

RESULTS

Baseline Participant Demographics: At the outset, we focused on middle-aged participants. Eventually, our final sample landed at 450. Most participants were about 50.2 ± 5.8 years old, overall. This group mix was composed of 54.0% male (243) and 46.0% female (207), an uneven proposition. The distribution seems slightly lopsided toward the men. When we looked at education, 279 people (62.0%). It was reported that they have finished secondary school or even higher education. On the flip side, just 261 (58.0%) were currently employed. For body-related measures, the average BMI was 27.8 ± 4.5 kg/m^2. Then, after further review, 171 participants (38.0%) fell into the overweight tier. At the same time, 99 (22.0%) could be considered obese.

Prevalence of Hypertension: The proportion of the population with hypertension was 36.0% (N=162). Of those who have been affected with hypertension, we found 99 men (61.1%) and 63 women (38.9%). It appears that hypertension also rises with age. The greatest percentage was the 5560 range at 43.5% (N=50). However, the 4044 group was at 28.3% (N=34). To compare variables, bivariate chi-square tests indicated meaningful differences in hypertension status. It reveals across age brackets, biological sex, and weight classes (Table 1).

TABLE 1: Participant Demographics and Hypertension Distribution

Demographic Category	Total Cohort Sample N (%)	Hypertensive Cohort N (%)	Test Statistic (χ^2)	Significance Value (p)
Age Cohort (Years)			11.45	< 0.01
40–44	120 (26.7%)	34 (28.3%)		
45–49	110 (24.4%)	38 (34.5%)		
50–54	105 (23.3%)	40 (38.1%)		
55–60	115 (25.6%)	50 (43.5%)		
Biological Sex			4.71	0.03
Male	243 (54.0%)	99 (40.7%)		
Female	207 (46.0%)	63 (30.4%)		
Body Mass Index (BMI)			28.34	< 0.001
Normal (18.5–24.9)	130 (28.9%)	28 (21.5%)		
Overweight (25–29.9)	171 (38.0%)	72 (42.1%)		
Obese (≥30)	99 (22.0%)	54 (54.5%)		

Legend:
- χ^2 = Chi-square test statistic
- p = Significance value

Notes:
- Data are expressed as counts and percentages (N, %).
- Chi-square (χ^2) was generally the statistical tool used to discover associations.
- Alpha significance levels were set at $p < 0.05$ and $p < 0.001$.
- Results showed that the prevalences of age, gender, and BMI groups are significantly related to hypertension.

Dietary Profiles

Using factor analysis of the FFQ, the study identified three distinct nutrition profiles. The healthy pattern (N=140, 31.1%) was more evident. It was mostly associated with a higher intake of wholegrain foods. Primarily, it consisted of fresh fruits, fresh vegetables, and lean protein sources. Taken together, it paints a cleaner, more "whole" way forward. The Mixed Pattern (N=165, 36.7%) appeared more often in the middle. It still included fresh foods in the mix. However, there were also occasional processed snack items. Lastly, the Unhealthy Pattern (N=145, 32.2%) appeared to focus primarily on sodium-laden snacks, ultra-processed foods, and sugar-sweetened drinks. Moreover, crosstabulation exhibited that the share of people with hypertension was higher following the Unhealthy Pattern compared to those following the Healthy Pattern (Table 2).

TABLE 2: Dietary Patterns and Hypertension Prevalence

Identified Dietary Pattern	Total Cohort Sample N (%)	Hypertensive Cohort N (%)	Test Statistic (χ^2)	Significance Value (p)
Healthy Pattern	140 (31.1%)	31 (22.1%)	21.56	< 0.001
Mixed Pattern	165 (36.7%)	53 (32.1%)		
Unhealthy Pattern	145 (32.2%)	70 (48.3%)		

Legend:
- χ^2 = Chi-square test statistic
- p = Significance value

Notes:
- Data are presented as counts and percentages (N, %).
- Statistical relationships were evaluated using Chi-square (χ^2) tests.
- Alpha significance thresholds were established at $p < 0.05$ and $p < 0.001$.

Findings indicate that dietary patterns are significantly associated with hypertension prevalence, with the unhealthy pattern showing the highest proportion of hypertensive individuals.

Sleep Quality Metrics: Based on global PSQI scores, more than half (52.0%, N=234) of participants reported poor sleep quality (score >5). A larger proportion of hypertensives (64.2%, N=104) than normotensives (45.1%, N=130; χ^2=15.22, p<0.01). It reported poor sleep. Moreover, hypertensive individuals had notably higher average PSQI scores (6.8±2.1) than normotensives (5.2±1.9), t=6.12, p<0.001 (Table 3).

TABLE 3: Sleep Quality Status and Hypertension Distribution

Sleep Quality Tier (PSQI)	Total Cohort Sample N (%)	Hypertensive Cohort N (%)	Test Statistic (χ^2)	Significance Value (p)
Good Sleep Quality (≤ 5)	216 (48.0%)	58 (26.9%)	15.22	< 0.01
Poor Sleep Quality (> 5)	234 (52.0%)	104 (44.4%)		

Legend:
- χ^2 = Chi-square test statistic
- p = Significance value

Notes:
- Data are presented as counts and percentages (N, %).
- Statistical relationships were evaluated using Chi-square (χ^2) tests.
- Alpha significance thresholds were established at $p < 0.05$ and $p < 0.01$.
- Results indicate a significant association between poor sleep quality and a higher prevalence of hypertension.

Perceived Stress Profiles: The PSS10 screening categorized 149 (33.0%) of the participants as low stress, 203 (45.0%) as moderate stress, and 98 (22.0%) as high stress. From what we saw, the prevalence of hypertension also increased across the same group categories. It was 20.8% (N=31) in the low-stress group, 37.9% (N=77) in the moderate-stress group, and 55.1% (N=54) in the high-stress group (Table 4).

TABLE 4: Perceived Stress Tiers and Hypertension Distribution

Categorized Stress Tier (PSS-10)	Total Cohort Sample N (%)	Hypertensive Cohort N (%)	Test Statistic (χ^2)	Significance Value (p)
Low Stress Level (0–13)	149 (33.0%)	31 (20.8%)	26.41	< 0.001
Moderate Stress Level (14–26)	203 (45.0%)	77 (37.9%)		
High Stress Level (27–40)	98 (22.0%)	54 (55.1%)		

Legend:
- χ^2 = Chi-square test statistic
- p = Significance value

Notes:
- Data are presented as counts and percentages (N, %).
- Statistical relationships were evaluated using Chi-square (χ^2) tests.
- Alpha significance thresholds were established at $p < 0.05$ and $p < 0.001$.
- Results demonstrate a significant association between higher perceived stress levels and increased prevalence of hypertension, with the high stress tier showing the strongest relationship.

Multivariate Regression Modeling: Multivariate logistic regression was used to model lifestyle variables. The measurements remained independently associated with hypertension. It was then realigned for age, sex, and BMI. What emerged was that an unhealthy diet was associated with an increased risk (OR = 2.31; 95% CI: 1.54–3.45; p < 0.001). Poor sleep quality was associated with an odds ratio of 1.76 (95% CI: 1.18–2.61; p=0.005). High perceived stress was associated with a higher risk (OR = 1.78; 95% CI: 1.23–2.56; p = 0.002).

Each remained linked with higher odds of hypertension. Also, individuals are more exposed simultaneously to unhealthy diets, along with poor sleep and higher levels of stress. It indicates an odds ratio of 2.46 (95% CI: 1.63–3.71; $p < 0.001$). Thus, it shows a cumulative, additive effect of these hazards.

DISCUSSION

First and foremost, this research was planned to investigate the interrelations among multiple variables. It primarily investigates the associations among diet, sleep quality, perceived stress, and hypertension in adults aged 4065 living in Lahore, Pakistan. Our findings reveal that 36.0% of the participants from this city were suffering from hypertension. This prevalence aligns with reports from a few nearby regions [13, 15]. It further confirms that cardiovascular risk remains a real issue as people age in South Asia [13, 19]. These outcomes also reaffirm that daily living factors are a major contributor to the development of hypertension. Hence, it makes sense that behavior modification is the primary lever for preventive action in practice [20].

Dietary Patterns and Hypertension: Individuals who are prone to a hectic, unhealthy lifestyle have a notably greater risk of hypertension. This also fits well with the broader canvas we see in pathophysiology. When people consume large amounts of sodium, processed sugars, and saturated fats. There is an increasing risk of water retention. It could ultimately impair endothelial function. It may overstimulate the renin-angiotensin-aldosterone system, a major pathway [6, 21]. Meanwhile, leaning more towards fruits, vegetables, and whole grains in meals is linked to a lower hazard of disease. Such items contain minerals, antioxidants, and dietary fiber that play a crucial role in providing better protection from the disease. It helps to keep blood vessels in better condition [6, 22]. Overall, this study provides robust evidence on how diet affects hypertension management, particularly among middle-aged individuals [20].

Sleep Quality and Hypertension: Most participants in this research (52.7%; n=101) reported low sleep quality. However, this was associated with a higher incidence of hypertension. This outcome is consistent with clinical documentation indicating that sleep fragmentation and sleep shortening will lead to increased sympathetic nervous system activity, elevated systemic inflammation, and disruption of cortisol rhythms, resulting in increased peripheral vascular resistance [7, 8, 23]. This outcome is consistent with clinical documentation indicating that sleep fragmentation and sleep shortening will lead to increased sympathetic nervous system activity, elevated systemic inflammation, and disruption of cortisol rhythms, resulting in increased peripheral vascular resistance [7, 8, 23]. Also, with normal aging, changes in the amount of slow-wave sleep and in the frequency of night awakenings may exacerbate these physiological risks in middle-aged groups [24]. I believe that performing a sleep hygiene evaluation during cardiovascular screening should be considered to improve risk stratification [25].

Perceived Stress and Hypertension: A higher stress perception level was significantly linked to the occurrence of hypertension. In general, chronic psychological stress can disrupt blood pressure control by leading people toward unhealthy habits, such as weaker dietary self-management or too little activity. It may also directly shift neuroendocrine mechanisms through persistent sympathetic overactivity plus cortisol secretion [10, 11, 26]. Research findings indicate that addressing psychosocial problems is integral to reducing cardiovascular risk. To be more precise, there is a growing body of evidence pointing to the incorporation of stress management components in the treatment protocol, including stress-inducing elements such as mindfulness meditation, cognitive behavioral therapy, and relaxation training, that can affect blood pressure [27, 28].

Interacting Behavioral Elements: The majority of the findings were, most strikingly, individuals who, first of all, had a bad diet; second, poor sleep; and third, stress. Overall, this combination made this group the most exposed to risk. Along with one single isolated factor, these combined risk factors in effect show that hypertension is a rather complicated disease influenced by many aspects, and not only by one single factor. Focusing, then, on just one factor, such as diet or exercise, may prove ineffective or yield only minimal effects in practice. Hence, health programs that address multiple behavioral factors simultaneously yield better outcomes [20]. In other words, this is a slightly better strategy: not to target dietary or physical changes separately, but to integrate them.

Put simply, this is a somewhat improved approach: instead of going after dietary or physical changes in isolation, you should combine the two. What this research shows coincides with findings in Western countries and also other parts of the developing world. For instance, epidemiological studies were completed in the USA. It reported that there is a very strong association between a high sodium diet, lack of sleep, mental stress, and increased blood pressure in middle-aged groups [3]. Similarly, cross-sectional data from India indicate that behavioral risk factors, when acting together, effectively predict both cardiopulmonary and hypertensive diseases [19]. This research is the latest work from Pakistan demonstrating how urbanization, altered dietary habits, and exposure to urban lifestyles are factors in the cardiovascular risk of middle-aged people [13, 15].

Public Health Implications

These results suggest that community-based health programs that focus on middle-aged adults should be a priority. Some potential activities include: Nutritional counseling sessions focused on significantly reducing sodium intake while encouraging dietary fiber intake [20].

Public relations efforts aimed at showcasing the various aspects of sleep hygiene to the general public [25]. Community-accessible stress management programs [27, 28].

Workplace wellness initiatives are designed to address multiple lifestyle behaviors concurrently [20].

Implementing multicomponent strategies may help reduce the prevalence of hypertension and lower long-term cardiovascular risks in urban populations [20].

Strengths and Limitations: The greatest strengths of this study are the use of reliable lifestyle measurement tools (FFQ, PSQI, and PSS10), the large sample size, and the use of standardized blood pressure levels, which, in turn, confirm internal validity. However, a few limitations should be noted. This study, in its existing shape, cannot establish a cause-and-effect relationship. Moreover, administering self-report questionnaires to people may lead to inaccuracies. This occurs due to memory limitations or a tendency to provide socially desirable answers without realizing it. Besides, the exclusive use of convenience sampling at a single metropolitan center only makes one wonder to what degree the results can be extended to wider regional or rural communities.

CONCLUSION

The study revealed that the three major factors leading to hypertension among middle-aged individuals are an unhealthy diet, lack of sufficient sleep, and elevated levels of stress perception. The highest threat was observed among people with several lifestyle risk factors. Overall, these results indicate that controlling blood pressure and minimizing cardiovascular risk are crucial. It requires well-planned, integrated interventions that target diet, sleep, and stress. In addition, longitudinal studies will be required to analyze causal relationships. It also evaluates the effectiveness of combined lifestyle interventions in this group.

Additional Information

Author Contributions: Each of the listed authors has participated in the creation of the conceptual framework, the gathering and organization of data, the conduct of statistical analysis, and the drafting of the manuscript. These tasks were shared among the authors. All authors have reviewed the final manuscript and approved it for publication.

Disclosures

Human and Animal Rights: The research acquired formal approval from the Institutional Review Board at the University of Health Sciences Lahore. Participants in the study were handled in accordance with the ethical principles set out by the institutional research committee and in compliance with the 1964 Declaration of Helsinki.

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