

ORIGINAL ARTICLE

Blood Pressure Trends and Their Association with Cardiovascular Risk Factors in a Tertiary Care Population

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**ABSTRACT**

Background: Cardiovascular disease is a major global problem due to hypertension, and this is especially true in low and middle-income countries. This is important as it helps identify its association with modifiable risk factors so that early interventions and prevention are possible.

Objective: In order to assess blood pressure trends and their relation with cardiovascular risk factors in a tertiary care population in Pakistan.

Methods: This was a cross-sectional study conducted at the University of Lahore Teaching Hospital during July 2023 to July 2024. Sixty adult patients were enrolled. AHA 2017 guidelines were followed for categorization of blood pressure. Demographics, BMI, diabetes status, lipid profile, smoking, and family history of CVD were collected. SPSS v25 was used for statistical analysis, including multivariate logistic regression.

Results: Hypertension was present in 60% of 60 subjects (mean age 51.3 ± 12.6 years). Hypertension was significantly associated with obesity ($p=0.011$), diabetes ($p=0.042$), smoking ($p=0.045$), and elevated LDL ($p=0.004$). Obesity ($OR=2.74$, $p=0.024$) and diabetes ($OR=2.58$, $p=0.048$) were found to be independent predictors by multivariate analysis.

Conclusion: Obesity and diabetes are closely associated with the high burden of hypertension in this population. Reduction of long-term morbidity is dependent on early identification and integrated cardiovascular risk management. The tertiary care and community health settings should prioritize a preventive strategy based on lifestyle modification.

Keywords: Hypertension, Obesity, Diabetes Mellitus, Cardiovascular Risk, Tertiary Care, Pakistan.

INTRODUCTION

Elevated blood pressure or hypertension is a silent but powerful contributor to the global disease of CVD. Over 1.28 billion adults are affected by the disease; two-thirds of these individuals live in low and middle-income countries (LMICs), including Pakistan¹. Hypertension is not only a disease, but also an important risk factor for a wide variety of cardiovascular events (ischemic heart disease, cerebrovascular accident, congestive heart failure, and chronic kidney disease), and, in most cases, the disease is often undetected until the complications are serious.

Preventive medicine focuses on its insidious progression and a strong association with modifiable risk factors².

Over the past few decades, the prevalence of hypertension has escalated in Pakistan as a result of rapid urbanization, sedentary lifestyle, poor dietary habits, increasing rates of obesity, and rising burden of type 2 diabetes mellitus^{3, 4}. Repeatedly, national health surveys and regional studies have documented that a sizeable percentage of hypertensive people remain undiagnosed, untreated, and/or inadequately managed. These trends are even more frightening in tertiary care settings in which patients frequently present with multiple comorbidities and advanced disease profiles⁵.

Evaluation of the interplay between blood pressure and established cardiovascular risk factors (obesity, diabetes mellitus, dyslipidemia, smoking, and family history) is essential for designing effective screening programs and individualized intervention strategies. However, existing global and regional studies have demonstrated that these factors independently affect cardiovascular risk stratification, but little data exists regarding the current burden and correlation patterns of these variables in hospital-based populations in Pakistan⁶. However, given the clinical complexity of tertiary care centers' patient population, there is a critical need to reevaluate blood pressure trends and their relation to cardiovascular risk indicators, particularly in these centers⁷.

The purpose of this study was to fill this gap by investigating the distribution of blood pressure levels among adult patients attending a tertiary care hospital and their relation to the major cardiovascular risk factors. The study aimed to provide empirical evidence of the relationship between these two variables and to use it to inform both clinical decision-making and health policy on cardiovascular prevention and management in the context of Pakistan⁸.

MATERIALS AND METHODS

Study Design and Setting

This was a cross-sectional and observational study done at the University of Lahore Teaching Hospital, a tertiary care academic medical centre in Lahore, providing services to a variety of patients from urban and peri-urban areas of Lahore. The hospital itself serves as a good setting to examine how cardiovascular risk patterns exist in Pakistan. The duration of the study lasted for one year from July 2023 to July 2024.

Sample Size and Sampling Technique

The study includes a total of 60 adult patients. The sample was defined based on feasibility and the need to conduct a more detailed pilot of blood pressure patterns regarding cardiovascular risk factors. Both outpatient clinics and general medical wards of the hospital were used for recruiting participants as a nonprobability consecutive sample.

Inclusion and Exclusion Criteria

Male and female patients of 18 years and above were included in the study and were willing to participate. Only those patients who were clinically stable and came for routine medical evaluation or treatment for a non-cardiac condition were considered eligible. They excluded patients with known secondary causes of hypertension, chronic

kidney disease, malignancy, or pregnancy. Furthermore, patients who had incomplete clinical records and laboratory data were not enrolled in the final analysis.

Data Collection Procedure

A structured, pre-validated questionnaire was administered by trained medical staff for the collection of demographic and clinical data. The information contained included age, sex, residence (urban/rural), smoking status, family history of cardiovascular disease, and medical history of diabetes mellitus or dyslipidemia. Using standardized procedures, blood pressure measurements were obtained by means of a calibrated mercury sphygmomanometer. The right arm was rested in each participant for 10 minutes, and two readings were taken, five minutes apart taken from it; the mean of these two readings was analyzed.

Blood Pressure Classification

They categorized blood pressure levels according to the American Heart Association (AHA) 2017 guidelines. Normotensive individuals were those who had systolic blood pressure below 120 mmHg as well as diastolic blood pressure below 80 mmHg. Systolic BP 120–129 mmHg and diastolic <80 mmHg were considered elevated BP readings. Systolic 130 to 139 mm Hg or diastolic 80 to 89 mm Hg was considered stage 1 hypertension, and values \geq 140/90 mm Hg were stage 2 hypertension.

Anthropometric and Biochemical Assessment

As per standard protocol, body weight and height were measured, and BMI was calculated as the weight in kilograms (kg) divided by height in meters squared (kg/m^2). BMI $\geq 30 \text{ kg/m}^2$ was used as the definition of obesity. Fasting blood sugar and lipid profiles were determined in the morning by fasting venous blood samples. The lipid parameters measured were total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and triglycerides. Automated enzymatic techniques were used in all laboratory tests performed at the University of Lahore's central diagnostic laboratory.

Ethical Considerations

This study was approved by the Ethical Review Committee of the University College of Medicine and Dentistry (UCMD). Ethical standards of human research were adhered to in all procedures as per the Declaration of Helsinki. Each participant was asked to provide informed consent after being informed of the purpose, procedure, risks, and benefits of the study. Confidentiality and anonymity were strictly maintained in the course of the study period.

Statistical Analysis

Statistical analysis was done on all the data collected and entered in SPSS version 25. Continuous and categorical variables were calculated using descriptive statistics like mean, standard deviation, and frequencies. The chi-square tests were used for categorical variables, and independent t tests for continuous variables to evaluate the relationship between blood pressure and the cardiovascular risk factors, such as obesity, diabetes, smoking, and dyslipidemia. The independent predictors of elevated blood pressure were identified using a multivariate logistic regression model. All analyses had a p-value less than 0.05, considered statistically significant.

RESULTS

Demographic and Clinical Characteristics

Adult patients with a mean age of 51.3 ± 12.6 years ($n = 60$) were included in the study population. There were 33 males (55%) and 27 females (45%). Most of the patients (71.6%) were living in urban localities, and 28.4% in rural localities. There were 23 participants (38.4%) with primary or no formal education, and 22 (36.6%) with secondary education, while 15 (25%) were graduates or above. Occupationally, 21 (35%) were office workers or professionals, 14 (23.3%) laborers or daily wage earners, 18 (30%) homemakers, 7 (11.7%) retired or unemployed. Socioeconomic classification found 26 (43.3%) in the lower income group (<40,000 PKR/month), 24 (40%) in the middle-income group (40,000–80,000 PKR/month), and 10 (16.7%) in the high income group (>80,000 PKR/month) as shown in table 1.

Blood Pressure Categories

According to the AHA 2017 guidelines, blood pressure was categorized. Of the 60 participants, 13 (21.7%) had normal

BP, 11 (18.3%) had elevated BP, 19 (31.7%) had stage 1 hypertension, and 17 (28.3%) had stage 2 hypertension. Therefore, 60 percent (36) had blood pressure readings in the hypertensive range as shown in table 2.

This shows that the majority of patients had some degree of elevated blood pressure, with a notable portion falling in the stage 1 and 2 hypertension categories.

Association with Cardiovascular Risk Factors

Several cardiovascular risk factors were strongly associated with elevated blood pressure. As compared to 5 of 24 normotensives (20.8%), 19 of 36 hypertensive individuals (52.7%) were obese ($\text{BMI} \geq 30$), and this was statistically significant ($p = 0.011$). The hypertensive group had more diabetes mellitus patients (15 of 36, 41.6%) compared to the normotensive group (5 of 24, 20.8%) ($p = 0.042$). Also, hypertensive participants (16/36, 44.4%) were significantly more likely to smoke compared to normotensives (6/24, 25%) ($p = 0.045$). Hypertensives (139.6 ± 23.1 mg/dl) had higher mean LDL cholesterol than normotensives (118.4 ± 20.7 mg/dl) ($p = 0.004$). Although there was no significance, the amount of HDL cholesterol in hypertensives (42.5 ± 7.4 mg/dL) was less than that of normotensives (47.3 ± 6.9 mg/dL) as shown in table 3.

Multivariate Logistic Regression Analysis

Multivariate logistic regression analysis was carried out to determine the independent predictors of elevated blood pressure. The model showed that obesity ($\text{OR} = 2.74$, 95% CI: 1.14–6.55, $p = 0.024$) and diabetes mellitus ($\text{OR} = 2.58$, 95% CI: 1.01–6.58, $p = 0.048$) were statistically significant independent predictors of hypertension. There was a trend toward significance for smoking ($\text{OR} = 2.21$, 95% CI: 0.93–5.29, $p = 0.067$) as well as for LDL > 130 mg/dL ($\text{OR} = 1.89$, 95% CI: 0.88–4.12, $p = 0.089$) as shown in table 4.

Table 1: Demographic Profile of Study Participants

Variable	Category	Frequency (n)	Percentage (%)
Age	Mean \pm SD	—	51.3 ± 12.6
Gender	Male	33	55.0%
	Female	27	45.0%
Residence	Urban	43	71.6%
	Rural	17	28.4%
Education Level	No formal / Primary	23	38.4%
	Secondary	22	36.6%
	Graduate or above	15	25.0%
Occupation	Office worker / Professional	21	35.0%
	Laborer / Daily wage worker	14	23.3%
	Homemaker	18	30.0%
	Retired / Unemployed	7	11.7%
Income Level	Low (<40,000 PKR)	26	43.3%
	Middle (40,000–80,000 PKR)	24	40.0%
	High (>80,000 PKR)	10	16.7%

Table 2: Blood Pressure Categories Among Participants

Blood Pressure Category	Frequency (n)	Percentage (%)
Normal (<120/80 mmHg)	13	21.7%
Elevated (120–129/<80)	11	18.3%
Stage 1 Hypertension	19	31.7%
Stage 2 Hypertension	17	28.3%

Table 3: Association of BP with Cardiovascular Risk Factors

Risk Factor	Hypertensive (n=36)	Normotensive (n=24)	p-value
Obesity (BMI ≥30)	19 (52.7%)	5 (20.8%)	0.011
Diabetes Mellitus	15 (41.6%)	5 (20.8%)	0.042
Smoking	16 (44.4%)	6 (25%)	0.045
LDL (mg/dL)	139.6 ± 23.1	118.4 ± 20.7	0.004
HDL (mg/dL)	42.5 ± 7.4	47.3 ± 6.9	0.071

Table 4: Multivariate Logistic Regression for Predictors of Elevated Blood Pressure

Variable	Odds Ratio (OR)	95% Confidence Interval	p-value
Obesity (BMI ≥30)	2.74	1.14–6.55	0.024
Diabetes Mellitus	2.58	1.01–6.58	0.048
Smoking	2.21	0.93–5.29	0.067
LDL >130 mg/dL	1.89	0.88–4.12	0.089

The results show that obesity and diabetes independently contribute to higher blood pressure, statistically, and emphasize the significance of early identification and treatment. In addition to smoking and high LDL, these did not reach significance, probably due to the small sample size.

DISCUSSION

In this study, the blood pressure trends were evaluated and correlated with common cardiovascular risk factors in the tertiary care population of the University of Lahore Teaching Hospital. As revealed in the findings, 60 percent of the participants fall into the hypertensive range according to the AHA 2017 guidelines⁹. This is consistent with previous studies from Pakistan, which have consistently reported an increasing burden of hypertension in the community and clinical settings, due to urbanization, shifts in lifestyle, and metabolic disorders¹⁰.

A strong association between elevated blood pressure and modifiable risk factors, namely obesity, diabetes mellitus, smoking, and dyslipidemia, was a key observation. Hypertensive participants were more than twice as likely to be obese as compared to normotensive participants, and obesity was an independent significant predictor¹¹. This is in agreement with the global literature that highlights the mechanistic role of excess adiposity in the promotion of insulin resistance, sympathetic nervous system activation, and renal sodium retention (all of which contribute to the development of hypertension)¹².

The blood pressure also had a statistically significant association with diabetes mellitus. Chronic hyperglycemia is well known to cause endothelial dysfunction, arterial stiffness, and activation of the renin-angiotensin-aldosterone system, which increases vascular resistance and blood pressure in concert. Hypertension and diabetes have a bidirectional relationship, which underlines the need for integrated screening and management protocols in populations at risk^{13, 14}.

Consistent with evidence that smoking increases vascular inflammation, oxidative stress, and atherosclerosis, the hypertensive group was significantly more prevalent and more severe than the normotensive group. Although smoking did not perform independently, it is a large contributor to overall cardiovascular risk¹⁵.

When controlling for BP, those who were hypertensive had a significantly higher LDL cholesterol, but this remained statistically significant only. It could be due to a small sample size, or confounders such as statin use, or dietary variation¹⁶.

This study points out that hypertension typically occurs in the absence of any other metabolic risk factors but in the presence of several, forming a cluster of cardiovascular risk factors. Finally, a multivariate logistic regression model confirmed that obesity and diabetes are the strongest predictors for elevated blood pressure in this population, while smoking and high LDL levels are important, but not statistically significant, in this small cohort¹⁷.

These findings support screening for comprehensive cardiovascular risk in patients presenting to tertiary care

settings, particularly those who are obese or diabetic. Additionally, there is an urgent need to develop lifestyle modification programs aimed at reducing physical inactivity, dietary habits, and smoking cessation, especially among urban populations where the risk factors are prevalent¹⁸.

This also makes future research possible. Establishing causality between hypertension and its associated risk factors requires longitudinal studies with larger sample sizes. Future studies should follow up patients to see how blood pressure progresses over time and to ascertain the effects of interventions such as weight reduction, glycemic control, and smoking cessation¹⁹. Research into genetic predisposition, dietary patterns, and the involvement of physical inactivity in local populations could help identify region-specific contributors to cardiovascular risk. Wearable health technology, mobile-based monitoring tools, and community-level interventions can also be integrated to improve early detection and sustained blood pressure control, particularly in low-resource settings²⁰.

CONCLUSION

This study shows that hypertension is prevalent among adults attending a tertiary care hospital, and its prevalence is significantly associated with modifiable cardiovascular risk factors such as obesity, diabetes mellitus, and smoking. A strong, independent relationship between obesity and diabetes, and hypertension was demonstrated. The findings emphasize the requirement for integrated screening programs and preventive health plans targeted at the Pakistani population. More public health initiatives aimed at weight control, glycemic management, and tobacco cessation are critical to minimize the increasing impact of hypertension and its complications. These findings warrant further large-scale, prospective studies to validate these findings and develop region-specific intervention frameworks.

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Conflict of Interest:

The authors declare that they have no conflicts of interest.

Data Availability Statement:

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Authors contribution:

AF: Conceptualization, Study Design

FG: Literature Review, Data Collection

HA: Statistical Analysis, Data Interpretation

KA: Manuscript Drafting, Formatting

HBV: References Management, Final Editing and Review

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