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Prevalence and Determinants of Prehypertension Among Adult Patients Visiting a Tertiary Care Hospital in Karachi

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ABSTRACT

Background: A worldwide health concern, hypertension causes many complications, such as cardiovascular disease, stroke, chronic renal disease, and premature heart failure. Prehypertension, a transition condition that lies between normal and raised blood pressure, can lead to sustained hypertension if it remains undiagnosed or untreated. This study was designed to identify the incidence of prehypertension and its contributing factors in adult patients.

Methods: This cross-sectional study was carried out at the Family Medicine department in a tertiary care hospital in Karachi. A total of 384 adult patients between the ages of 18 and 65 were chosen by using non-probability consecutive sampling. A standardized questionnaire addressing dietary, lifestyle, and sociodemographic practices was used to gather data. Anthropometric measurements and blood pressure readings were obtained. It was followed by data analysis via SPSS software version 26.

Results: The prevalence of prehypertension among the 384 participants, who represented a range of ethnic backgrounds, was 49.5% with females accounting for majority (69%), and the median age was 42. Prehypertension was significantly correlated with older age, as the results show that the odds of having prehypertension was higher among participants with age > 40 years as compared to age ≤ 40 years [aOR 1.62 95% CI 1.04-2.54, p-value 0.032]. Similarly, among obese patients, the odds of having prehypertension were higher as compared to underweight patients [aOR 5.88, 95% CI 1.69-20.42]. In addition, the odds of having prehypertension among patients having intermediate level of education were lower as compared to having no formal education [aOR 0.37, 95% CI 0.187-0.74, p-value 0.005].

Conclusion: The possible prevalence of prehypertension among adult patients in Karachi is highlighted by this study. Age, gender, BMI, marital status, and education are important factors. These results demonstrated the necessity of focused treatments and regulations to control prehypertension, stressing the significance of early identification and lifestyle changes to prevent its development and consequences.

Keywords: Prehypertension, Hypertension, Adult patient, Poor dietary lifestyle, Addiction, Sedentary lifestyle, Obesity, Family history, JNC guidelines.

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INTRODUCTION

Hypertension or elevated blood pressure is considered as a modifiable cause of global health problems including cardiovascular and premature mortality worldwide [1]. Prehypertension is a state characterized by raised blood pressure readings that is below the hypertensive range. According to eighth Joint National Committee (JNC 8) recommendations, it is a reversible state characterized by a systolic blood pressure of 120–140 mmHg and diastolic blood pressure of roughly 80–90 mmHg[2]. It can progress to hypertension-a silent killer disease state, if left unaddressed[3]. Based on data from the World Health Organization (WHO), non-communicable diseases are becoming more prevalent in low- and middle-income nations like Pakistan, with hypertension emerging as a significant public health concern[4]

Globally, studies have shown that more than 1.5 billion individuals are estimated to currently live with hypertension[5]. In Pakistan, one in three people suffer from hypertension, which is an alarmingly high frequency[6]. A nationwide diabetes survey in Pakistan conducted between 2016 and 2017 revealed that 46.2% of respondents had hypertension[7]. Despite advancements in medical management, the prevalence of hypertension and its complications continue to rise in Asia, emphasizing the need for early preventive strategies at the prehypertension stage. Prehypertension affects roughly 28.5% of people worldwide[8].

Hypertension, a global health concern, has a major role in cardiovascular morbidity and consequences[9]. Multiple studies performed on hypertension demonstrated various factors that are known to elevate the risk of hypertension, including age, gender, ethnicity, sedentary lifestyle, obesity, family history, high alcohol intake, and low education level[10]. These risk factors collectively contribute to raised blood pressure and exacerbate its progression. Prehypertension has also been linked in numerous studies to coronary artery disease and cardiovascular death[11].

Tan JR et al. found that prehypertension substantially accelerates atherosclerotic changes, particularly among those who suffer from type 2 diabetes[12]. It has been demonstrated that early detection and treatment of prehypertension can successfully stop its development into hypertension and its cardiac complications[13].

Development of health policies to control global burden regarding hypertension prevention and complications requires the data of its preceding factors which need to be identified at its prehypertension state. This study thus aims to bridge the gap between prevalence and its demographic and lifestyle factors among prehypertension individuals visiting a tertiary care hospital. By raising awareness among high-risk individuals, the study's findings will assist policymakers in considering the factors that have a significant influence and developing new strategies to reduce the prevalence of prehypertension and its contributing factors.

METHODS

A prospective cross-sectional study was carried out at the Family Medicine Department of The Indus Hospital and Healthcare Network, including 384 adults aged between 18-65 years. With a prehypertension prevalence rate of 49%, a 95% confidence level and 5% absolute precision, the sample size was determined using the WHO sample size calculator. The study was conducted following approval from the Institutional Review Board (IRB) of The Indus Hospital and the College of Physicians and Surgeons of Pakistan (CPSP) with an IRB reference number: IHHN_IRB_2023_01_026. Participants were selected through a non-probability consecutive sampling technique to ensure the inclusion of all eligible participants visiting the clinics during the study period. All individuals who visited the clinics for medical problems other than hypertension and consented to participate were included. The exclusion criteria were as follows: pregnant women, individuals diagnosed with essential or secondary hypertension, patients taking antihypertensive medications, those with chronic illnesses such as chronic kidney disease, chronic lung disease, or chronic liver disease, malignancies, or cognitive impairments. Additionally, participants who refused to provide consent were excluded from the study.

Informed verbal consent was obtained from all participants after the study was explained to them. Blood pressure was recorded using a digital blood pressure monitor from Omron Automatic. Prior to measurement, participants were seated comfortably for at least five minutes. Using appropriately sized cuffs based on each participant's arm circumference, blood pressure was measured on the upper arm. Three readings were taken at five-minute intervals, and the average of the last two readings was used for analysis. The initial reading was taken in the triage area, while the remaining two were recorded in the clinic. Data collection was followed by a structured questionnaire, which was filled out by the primary investigator (PI).

The proforma consisted of three sections: Section A included sociodemographic and lifestyle details such as age, gender, marital status, occupation, and education level. Section B covered anthropometric measurements and blood pressure readings taken in the clinic (systolic and diastolic BP). Section C contained questions related to lifestyle, dietary habits, physical activity, and its duration.

The Data was analyzed using SPSS version 26. Quantitative variables, including age, height, weight, BMI, sleep duration, systolic blood pressure (SBP), and diastolic blood pressure (DBP), were summarized as mean and standard deviation (mean ± SD). Categorical variables, such as smoking status, were expressed as frequencies and percentages. However, the median (IQR) was used to report non-normally distributed data. Normality data was assessed by using Shapiro Wilk test. Moreover, qualitative characteristics such as gender, ethnicity, comorbid, marital status, education status,

occupation, routine exercise, such as 30 min walk/day, frequent fruit/vegetable intake, family history of hypertension and prehypertension, frequency and percentage were recorded. The factors linked to prehypertension were identified using binary logistic regression. All factors that had a p-value of less than 0.25 in univariate analysis were included in multivariable analysis. In addition, a variable was kept in the multivariable model if it was clinically significant or had a p-value less than 0.1. P-value ≤0.05 was considered significant, and both adjusted and unadjusted odds ratios with 95% CI were reported.

RESULTS

A total of 384 people were enrolled in this study.

The most common reasons for initial visit were body aches (16.9%), followed by Gastroesophageal reflux disease (GERD) 13.5%). The other reasons for presentation in family medicine clinic are shown in Figure 1:

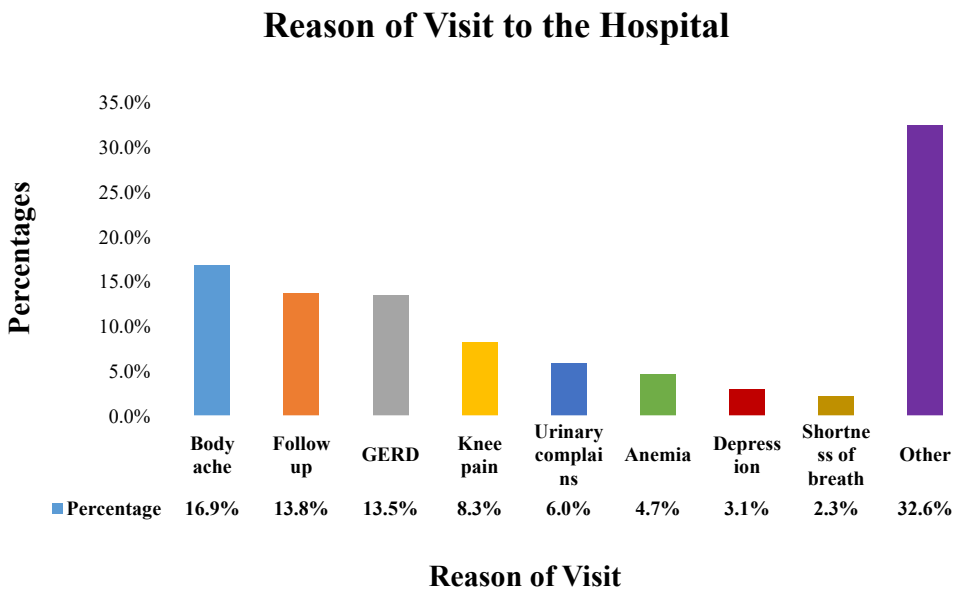

Figure 1: Reasons for visiting the family medicine clinic

The primary aim of this study was to determine the prevalence of prehypertension and explore the relationship of prehypertension with lifestyle, demographic, and comorbid factors.

Figure 2, shows that prehypertension was present in 49.5% of the study population.

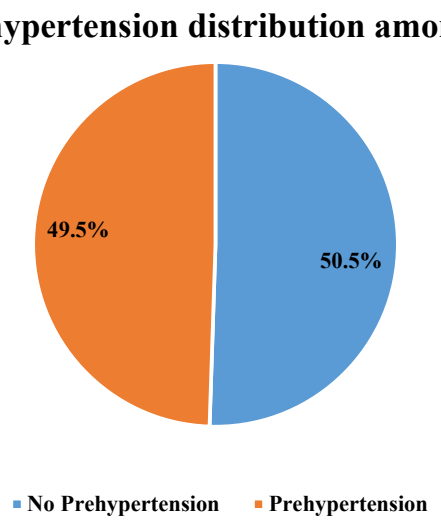

Figure 2: Prevalence of Prehypertension in study population

The median age of participants was 42 (18-79) years. However, median BMI was 27.6 (23.5 – 31.2) kg/m^2. Among 384 participants, 266 (69.27%) were female while 118 (30.7%) were male. Table 1 shows the distribution of ethnicity, marital status, education and occupation.

Table 1: Demographic characteristics of study participants

Variables	n (%)
Ethnicity	
Sindhi	108 (28.1)
Punjabi	75 (19.5)
Pashtoon	44 (11.5)
Urdu	111 (28.9)
Baloch	18 (4.7)
Others	28 (7.3)

Marital status	
Single	38 (9.9)
Married	284 (74)
Separated	14 (3.6)
Widowed	45 (11.7)
Divorced	3 (0.8)
Total	384 (100)
Education status	
No formal education	157 (40.9)
Primary	57 (14.8)
Secondary	64 (16.7)
Matriculation	52 (13.5)
Intermediate	35 (9.1)
Graduate	19 (4.9)
Total	384 (100)
Occupation	
Employed	152 (39.6)
Unemployed	232 (60.4)
Total	384 (100)

This study showed 79 (20.6%) patients had diabetes, 42 (10.9%) had thyroid dysfunction, 20 (5.2%) had asthma, 147 (76.6%) and 188 (49%) had family history of hypertension (Table 2). Among addictions, betel nut addiction was observed to be the highest among 38 participants (9.9%) followed by tobacco use in forms of pan among 32 participants (8.33%) and smoking was reported in 17 participants (4.43%). Details have been shown in Table 2.

Table 2: Distribution of comorbidities, family history of hypertension and addiction

Comorbidities	n (%)
Diabetes	79 (20.6)
Asthma	20 (5.2)
Thyroid disorder	42 (10.9)
Hepatitis	11 (2.9)
Arthritis	18 (4.7)
Dyslipidaemia	5 (1.3)
Family history of hypertension	
Yes	188 (49)
No	196 (51)
Total	384 (100)
Addiction	
Betul nut	38 (9.9)
Tobacco pan	32 (8.33)
Alcohol	2 (0.52)
Ghutka	11 (2.86)
Smoke	22 (5.70)

Lifestyle and dietary habits revealed that 42.4% of individuals spend 3 to 5 hours daily engaged in sedentary activities and 52.9% used sweets, fats, and oils sparingly. Interestingly, a significant portion, i.e., 42.2% did not consume fruit regularly, and 13.8% ate them once a month. Vegetable consumption was more consistent, with 55.2% eating them 3-5 days per week and 27.3% 1-2 days per week. In addition, bread, cereals, and pasta were commonly consumed, with 55.7% eating them 1-2 days per week and 21.1% 3-5 days per week. Details of lifestyle and dietary habits shown in Table 3. Subsequently, 190 patients (49.5%) were diagnosed with prehypertension in our study.

Table 3: Distribution of lifestyle and dietary habits.

Questions	n (%)
What amount of time do you spend using computers, or watching TV/ sedentary activities per week?	
1 to 2 hours/day	109 (28.4)
3 to 5 hours/day	163 (42.4)
over 5 hours/day	38 (9.9)
Don't watch TV or play games	71 (18.5)
Don't Know	3 (0.8)
How much time do you take out for exercise each day?	
At least 30 minutes	55 (14.3)
30 minutes to one hour	9 (2.3)
Don't know	1 (0.3)
What is the intake of sweets/fats/oils per week?	
Use sparingly	203 (52.9)
1-2 days/week	150 (39.1)
3-5 days/week	22 (5.7)
over 5 days/week	1 (0.3)
Don't use	8 (2.1)
How many servings of fruit do you eat per week?	
1-2 days/week	135 (35.2)
3-5 days/week	25 (6.5)
over 5 days/weeks	9 (2.3)
Don't use	162 (42.2)
Use once in a month	53 (13.8)
How many servings of vegetables do you eat per week?	
1-2 days/week	105 (27.3)

3-5 days/week	212 (55.2)
over 5 days/weeks	61(15.9)
Don't use	2(0.5)
Use once in a month	4(1.0)
Intake of slices of bread/cereals/pasta per week?	
1- 2 days/week	214(55.7)
3-5 days/week	81(21.1)
>5 days/week	37(9.6)
Don't use	31(8.1)
Use once in a month	21(5.5)
No. of hours of sleep per day in last week	
Median (IQR)	7 (6-8)
Min-Max	(4-12)

Table 4a. Association of socio-demographic factors with prehypertension (variables with crude and adjusted odds ratios)

Variable	Category	No n (%)	Yes n (%)	COR (95% CI)	aOR (95% CI)
Age (years)	≤40	99 (51.03)	67 (35.26)	Ref	Ref
	>40	95 (48.97)	123 (64.74)	1.91 (1.27–2.88)	1.63 (1.04–2.54)
Education	No formal education	64 (32.99)	93 (48.95)	Ref	Ref
	Primary	30 (15.46)	27 (14.21)	0.61 (0.33–1.13)	0.61 (0.32–1.17)
	Secondary	28 (14.43)	36 (18.95)	0.88 (0.49–1.59)	0.90 (0.48–1.67)
	Matriculation	35 (18.04)	17 (8.95)	0.33 (0.17–0.64)	0.37 (0.18–0.74)
	Intermediate	27 (13.92)	8 (4.21)	0.20 (0.08–0.47)	0.18 (0.07–0.44)
	Graduate	10 (5.15)	9 (4.74)	0.61 (0.23–1.61)	0.64 (0.24–1.73)

Table 4b. Association of socio-demographic factors with prehypertension (variables with crude odds ratios only)

Variable	Category	No n (%)	Yes n (%)	COR (95% CI)
Gender	Male	60 (30.93)	58 (30.53)	Ref
	Female	134 (69.07)	132 (69.47)	1.01 (0.66–1.57)
Ethnicity	Sindhi	53 (27.32)	55 (28.95)	Ref
	Punjabi	37 (19.07)	38 (20.00)	0.99 (0.54–1.78)
	Pashtoon	23 (11.86)	21 (11.05)	0.88 (0.43–1.77)
	Urdu	57 (29.38)	54 (28.42)	0.91 (0.53–1.55)
	Baloch	9 (4.64)	9 (4.74)	0.96 (0.35–2.61)
	Others	15 (7.73)	13 (6.84)	0.83 (0.36–1.92)
Marital status	Single	29 (14.95)	9 (4.74)	Ref
	Married	137 (70.62)	147 (77.37)	3.45 (1.58–7.56)
	Separated	8 (4.12)	6 (3.16)	2.41 (0.66–8.83)
	Widowed	18 (9.28)	27 (14.21)	4.83 (1.85–12.58)
	Divorced	2 (1.03)	1 (0.53)	1.61 (0.13–19.90)
Employment status	Employed	75 (38.66)	77 (40.53)	Ref
	Unemployed	119 (61.34)	113 (59.47)	0.92 (0.61–1.39)

Table 4c. Clinical and lifestyle factors with crude odds ratios only

Variable	Category	No n (%)	Yes n (%)	COR (95% CI)
BMI (kg/m²)	Underweight	11 (5.67)	4 (2.11)	Ref
	Normal weight	69 (35.57)	41 (21.58)	1.63 (0.48–5.46)
	Overweight	68 (35.05)	63 (33.16)	2.54 (0.77–8.41)
	Obese	46 (23.71)	82 (43.16)	4.90 (1.47–16.27)
Diabetes mellitus	No	160 (82.47)	145 (76.32)	Ref
	Yes	34 (17.53)	45 (23.68)	1.46 (0.88–2.40)
Smoking	No	187 (96.39)	175 (92.11)	Ref
	Yes	7 (3.61)	15 (7.89)	2.29 (0.91–5.74)

Duration of sleep	≤6 hours	53 (27.46)	66 (34.74)	Ref
	>6 hours	140 (72.54)	124 (65.26)	0.71 (0.46–1.09)
Diabetes mellitus	No	160 (82.47)	145 (76.32)	Ref
	Yes	34 (17.53)	45 (23.68)	1.46 (0.88–2.40)
Asthma	No	180 (92.78)	184 (96.84)	Ref
	Yes	14 (7.22)	6 (3.16)	0.41 (0.15–1.11)
Thyroid dysfunction	No	171 (88.14)	171 (90.00)	Ref
	Yes	23 (11.86)	19 (10.00)	0.82 (0.43–1.57)
Arthritis	No	183 (94.33)	183 (96.32)	Ref
	Yes	11 (5.67)	7 (3.68)	0.63 (0.24–1.67)
Hepatitis	No	185 (95.36)	188 (98.95)	Ref
	Yes	9 (4.64)	2 (1.05)	0.21 (0.04–1.02)
Dyslipidemia	No	191 (98.45)	188 (98.95)	Ref
	Yes	3 (1.55)	2 (1.05)	0.67 (0.11–4.09)
Betel nut use	No	174 (89.69)	172 (90.53)	Ref
	Yes	20 (10.31)	18 (9.47)	0.91 (0.46–1.78)
Alcohol use	No	192 (98.97)	189 (99.47)	Ref
	Yes	2 (1.03)	1 (0.53)	0.50 (0.04–5.64)
Smoking	No	187 (96.39)	175 (92.11)	Ref
	Yes	7 (3.61)	15 (7.89)	2.29 (0.91–5.74)
Ghutka use	No	188 (96.91)	185 (97.37)	Ref
	Yes	6 (3.09)	5 (2.63)	0.84 (0.25–2.82)
Tobacco pan use	No	182 (93.81)	170 (89.47)	Ref
	Yes	12 (6.19)	20 (10.53)	1.78 (0.84–3.76)
Screen time per day	None	36 (18.56)	35 (18.42)	Ref
	1–2 hours	48 (24.74)	61 (32.11)	1.30 (0.71–2.38)
	3–5 hours	88 (45.36)	75 (39.47)	0.87 (0.50–1.53)

	>5 hours	20 (10.31)	18 (9.47)	0.92 (0.42–2.03)
Daily exercise	None	161 (82.99)	158 (83.16)	Ref
	≥30 minutes	28 (14.43)	27 (14.21)	0.98 (0.55–1.74)
	30–60 minutes	4 (2.06)	5 (2.63)	1.27 (0.33–4.83)
Sweets/fats/oils intake	None	5 (2.58)	3 (1.58)	Ref
	Sparingly	107 (55.15)	96 (50.53)	1.49 (0.34–6.42)
	1–2 days/week	73 (37.63)	77 (40.53)	1.75 (0.40–7.62)
	3–5 days/week	9 (4.64)	13 (6.84)	2.40 (0.45–12.72)
Fruit intake	None	76 (39.18)	86 (45.26)	Ref
	1–2 days/week	76 (39.18)	59 (31.05)	0.68 (0.43–1.08)
	3–5 days/week	14 (7.22)	11 (5.79)	0.69 (0.29–1.62)
	>5 days/week	4 (2.06)	5 (2.63)	1.10 (0.28–4.26)
	Once/month	24 (12.37)	29 (15.26)	1.06 (0.57–1.99)
Bread/cereals/pasta	None	11 (5.67)	20 (10.53)	Ref
	1–2 days/week	111 (57.22)	103 (54.21)	0.51 (0.23–1.11)
	3–5 days/week	40 (20.62)	41 (21.58)	0.56 (0.24–1.32)
	>5 days/week	23 (11.86)	14 (7.37)	0.33 (0.12–0.90)
	Once/month	9 (4.64)	12 (6.32)	0.73 (0.23–2.28)

Abbreviations: COR, crude odds ratio; aOR, adjusted odds ratio; CI, confidence interval.

Notes: Variables included in the multivariable logistic regression model were selected based on a p-value <0.25 in univariable analysis. Reference categories are indicated as “Ref”. Odds ratios were not estimated for categories with insufficient observations.

Table 4a-4c shows the association of prehypertension with baseline characteristics. There is a significant association that was found between age, education level, BMI and prehypertension. Findings of our study showed that the adjusted odds of having prehypertension are higher among patients with age > 40 years as compared to age ≤ 40 years [aOR 1.62 95% CI 1.04-2.54, p-value

0.032]. Similarly, among obese patients, odds of having prehypertension are higher as compared to underweight patients [aOR 5.88, 95% CI 1.69-20.42]. In addition, the adjusted odds of prehypertension among patients having intermediate level of education are lower as compared to no formal education [aOR 0.37, 95% CI 0.187-0.74, p-value 0.005].

DISCUSSION

The result of this study indicate that prehypertension affects almost half of the Karachi population 49.5%, the prevalence is higher among females compared to males in all age categories up to 65 years. The median age of affected females was 42 years, suggesting that middle-aged women are more prone to developing prehypertension. These results are consistent with previous studies, where the prevalence of prehypertension was reported as 33.93% in China, 47.3% in Iran, and 33% in the Korean population based on the Korean National Health and Nutrition Examination Survey[14,15,16].

The study findings indicate that the odds of having prehypertension were 1.91 times higher among patients aged over 40 years compared to those under 40 years, with an adjusted odds ratio of 1.62 and a p value of 0.032. These results, along with findings from previous studies conducted in other populations, support the hypothesis that increasing age is associated with a higher risk of prehypertension, potentially due to age-related vascular stiffness and endothelial dysfunction, as suggested in earlier research[17].

An important finding of our study was the significantly higher BMI observed in participants with prehypertension compared to those with normal blood pressure. Consistent with our findings, previous studies have established a strong relationship between obesity and an increased prevalence of prehypertension and hypertension [18].

In our cohort, diabetes mellitus was more prevalent at 23.7%, which is consistent with findings from previous studies[19]. However, other conditions such as asthma, thyroid disorders, and arthritis did not differ significantly between groups, indicating that they may not be closely associated with prehypertension in this population.

Marital status was also evaluated and showed that being married was associated with higher odds of prehypertension, with a prevalence of 77.4% among participants. Previous research suggests that married individuals, particularly middle-aged couples, may experience elevated blood pressure due to increased stress and responsibilities[20]. Conversely, other studies have shown that marital status

may provide social and emotional support that buffers against hypertension, indicating that the association between marital status and blood pressure may be context-dependent[21].

Our study also found that higher education was associated with an apparent protective effect against prehypertension compared to lower education levels, consistent with previous findings[22]. This protective effect may be attributed to better health literacy, healthier dietary practices, and increased awareness of preventive healthcare.

Ethnic variation was observed in the study population, with Sindhis constituting the largest group, followed by Urdu speakers, Punjabis, and Pashtoons. However, the ethnic distribution did not differ significantly between the normotensive and prehypertensive groups, suggesting that prehypertension may not be strongly influenced by ethnic background within this sample.

Interestingly, our study found no significant association between lifestyle characteristics, including dietary habits, physical activity, sleep duration, and family history of hypertension, and prehypertension, which contrasts with findings from previous studies[23]. Nevertheless, a substantial proportion of participants, 42.4%, reported engaging in sedentary activities for three to five hours per day. Despite this, no association was observed between physical inactivity and prehypertension, contradicting earlier research[24].

Smoking was identified as another potential risk factor for prehypertension. Although the association was not statistically significant, the odds ratio suggested a possible relationship. Smoking is known to increase arterial stiffness and cause endothelial dysfunction, both of which may contribute to the development of prehypertension[25].

A major strength of this study is its potential to serve as a foundation for future research and to assist policymakers in identifying probable risk factors. This information can be utilized to design targeted health policies aimed at preventing the progression of prehypertension to sustained hypertension. The study highlights the urgent need to establish an effective public health framework to address the growing burden of prehypertension and hypertension in Pakistan.

However, despite the significant associations observed between prehypertension and sociodemographic factors such as BMI, diabetes mellitus, and marital status, the study has certain limitations. Its cross-sectional design limits causal interpretation between risk factors and the development of prehypertension or hypertension. Additionally, the data were obtained from a single tertiary care hospital, limiting generalizability to the wider Pakistani population. Furthermore, as

most participants had their blood pressure measured for the first time and readings were taken on a single day, there is a possibility of overdiagnosis, potentially influenced by white-coat hypertension.

CONCLUSION

This study highlights a higher prevalence of prehypertension among the general population, emphasizing the need for early intervention to prevent its progression to hypertension and its complications. Healthcare providers and policymakers should recognize this alarming situation and raise public awareness regarding its prevalence and contributing factors. At the national level, a policy should be created to screen for prehypertension in those who are at higher risk, and necessary actions should be taken to identify and treat the modifiable risk factors in these individuals. More research is needed to identify the overall progression and evaluate the effects of different interventions meant to lower the risk and its prevalence.

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CONFLICT OF INTEREST

None

ETHICAL APPROVAL

This study was approved by Research Ethics Committee of The Indus Hospital and Healthcare Network, Karachi (IHHN_IRB_2023_01_026).

AUTHORS' CONTRIBUTION

KS and **AI** work together both conceptualized the study idea. **AI** helped in establishing the study design, methodology, and supervise the study. **KS** worked on data collection and manuscript writing. All authors reviewed the manuscript.

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