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Characterizing Prehypertension and Lifestyle Determinants Among College Students: A Cross-Sectional Study

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ABSTRACT

Background: Prehypertension, defined as blood pressure levels that are elevated but not yet in the hypertensive range, is increasingly recognized as a critical public health concern. It is a significant predictor of future hypertension and cardiovascular morbidity. College students are particularly vulnerable due to lifestyle behaviours that may contribute to elevated blood pressure, such as poor dietary habits, inadequate sleep, sedentary behaviour, and psychological stress. This study aimed to determine the prevalence of prehypertension among college students aged 18 to 24 years and to examine its association with modifiable lifestyle factors including diet, sleep quality, perceived stress, and physical activity.
Methods: A cross-sectional study was conducted involving 500 college students within the specified age range. Individuals with known endocrine or metabolic disorders were excluded. Blood pressure was measured using a standardized manual sphygmomanometer and stethoscope. Lifestyle variables were assessed using a structured questionnaire. The prevalence of prehypertension and its contributing factors were calculated to better understand the risk profile of the study population Ordinal regression analysis was performed to evaluate associations between lifestyle determinants and blood pressure categories.
Results: A considerable proportion of students were found to have prehypertensive readings. Ordinal regression analysis revealed statistically significant associations between elevated blood pressure and poor dietary habits, insufficient sleep, increased perceived stress, and low levels of physical activity *($P < 0.05$)*. These associations remained significant after adjusting for potential confounding variables.
Conclusion: Prehypertension is prevalent among college students and is significantly influenced by modifiable lifestyle factors. Early identification and targeted health promotion strategies are warranted to prevent the progression to hypertension and reduce long-term cardiovascular risk in this population.
Keywords: Prehypertension, Blood pressure, Lifestyle determinants, young adults, Cardiovascular risk

INTRODUCTION

The lifestyle of contemporary college students is influenced by a multitude of factors that significantly impact their overall well-being. Within the academic environment, students often face substantial pressure due to demanding schedules, frequent examinations, and high academic expectations. The fear of underperforming or failing to meet these expectations can

adversely affect their mental health, frequently resulting in heightened levels of stress. This stress response activates the body's fight-or-flight mechanism, leading to the release of specific hormones that elevate heart rate and contribute to physiological and emotional strain. Due to time constraints and food cravings, students often rely on fast food and processed snacks. Skipping breakfast, common due to early college schedules, is linked to increased risks of high blood pressure and elevated lipid levels. Excessive screen time and academic stress contribute to physical inactivity and reduced cardiovascular health. In response to stress, many students resort to emotional eating, typically consuming high calorie sugary foods to cope with negative emotions [1,2,3]

Blood pressure is a critical physiological parameter defined as the force exerted by circulating blood on the walls of arteries. It is measured by two values: systolic pressure, recorded during heartbeats, and diastolic pressure, measured between heartbeats at the heart's lowest point [4]. Blood pressure is classified into several categories: normal (systolic <120 mmHg, diastolic <80 mmHg), prehypertension (systolic 120–139 mmHg, diastolic <80 mmHg), stage 1 hypertension (systolic 140–159 mmHg, diastolic 90–99 mmHg), and stage 2 hypertension (systolic ≥160 mmHg, diastolic ≥100 mmHg) [5]. Prehypertension, although often asymptomatic, can manifest with symptoms such as fatigue, dizziness, headache, and irregular heart rhythms. It is considered a significant risk factor for the development of hypertension and increases the likelihood of severe health complications, including stroke, coronary heart disease, heart failure, and kidney disorders [6]. The early identification and management of blood pressure abnormalities are essential for reducing the incidence of these cardiovascular and renal conditions.

Obesity is a significant risk factor for cardiovascular complications in young individuals, particularly students, who face higher risks than older adults [7]. Due to academic and social pressures, students often skip meals and rely on caffeine, exacerbating health issues. Stress, a leading precursor to hypertension, arises from academic, career, social, and family pressures, as well as the influence of social media on self-esteem [8]. A sedentary lifestyle, driven by prolonged screen time and sitting during studies, contributes to weight gain, poor cardiovascular health, and elevated blood pressure [9]. Stress hormones trigger blood vessel constriction, further increasing hypertension risks [10]. Additionally, alcohol consumption, often influenced by peer pressure and stress, causes acute changes in heart rate and circulatory function, contributing to cardiovascular risks [11,12].

The lifestyle factors of college students, including poor dietary habits, stress, and physical inactivity, are strongly linked to prehypertension. Many students remain unaware of their blood pressure status, making early identification crucial. Therefore, it is essential to document the prevalence of prehypertension in this population and examine the contributing lifestyle factors to prevent its progression to hypertension. This period of life offers a unique opportunity to influence health behaviors, and this study aims to assess the specific behaviors associated with hypertension risk in college students. While most research on hypertension focuses on middle-aged and older adults, this study will provide valuable insights into how lifestyle choices in young adult's impact long-term health. Prehypertension is an emerging public health concern, particularly among young adults, due to its potential to progress into full-blown hypertension and increase long-term cardiovascular risk. Despite its significance, limited data are available on the prevalence and contributing lifestyle factors of prehypertension in the college-going population. Therefore, the objective of this study was to assess the prevalence of prehypertension among college students aged 18 to 24 years and to evaluate its

association with modifiable lifestyle factors, including diet, sleep patterns, perceived stress, and physical activity levels. This study aims to generate evidence that can guide early interventions and promote cardiovascular health in this vulnerable age group

MATERIALS & METHODS

This cross-sectional observational study was conducted with a sample population of college students aged 18-24 years, of both genders. Convenient sampling was employed to select a total of 500 participants. Written informed consent was obtained from all participants prior to their inclusion in the study, ensuring they were fully informed about the study's purpose, procedures, and their right to withdraw at any time without consequence. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki, ensuring the protection of participants' rights, safety, and well-being throughout the research process. Inclusion criteria included college students within the specified age range who were willing to participate. Exclusion criteria encompassed individuals with a known history of diabetes mellitus, hyperthyroidism, hypothyroidism, or polycystic ovarian syndrome. Blood pressure measurements were taken using a sphygmomanometer and stethoscope. A self-made questionnaire was administered to gather relevant data on lifestyle factors. The primary outcome measure was blood pressure, assessed through the use of a blood pressure apparatus. To reduce potential bias, the researcher responsible for statistical analysis was blinded to participant identities and questionnaire responses during data processing. Neutral and non-suggestive language was used during participant recruitment and throughout the study to minimize bias and avoid influencing participants' expectations of the intervention. Since this was a cross-sectional study conducted at a single time point, there was no follow-up phase. There were no missing data for any of the variables of interest, ensuring a complete dataset for analysis and minimizing the risk of bias due to data incompleteness.

The study was approved by the Institutional Ethical Committee and the study was registered with the Clinical Trial Registry-India was done with the number (REF/2024/11/094595). College students aged 18–24 years were selected using convenient sampling, with a total sample size of 500. According to the study done by Qaiser S et al. Prevalence and risk factors of prehypertension in university students in Sabah, Borneo Island of East Malaysia, The SD of Blood pressure in university students comes out to be 7.0. Taking acceptable difference as 2.5 and confidence interval 95%, the required sample size comes out to be 497, considering 10% dropout rate, total sample size comes to 500 [13]. Participants were instructed to avoid caffeine and strenuous activity 30 minutes prior to blood pressure measurement. They were seated comfortably, with back supported, feet flat, legs uncrossed, and bladder emptied.

Outcome Variable

Blood pressure was measured using a sphygmomanometer and stethoscope, with the arm supported at heart level. The cuff was placed on the bare upper arm, one inch above the elbow crease, and inflated 20–30 mmHg above the estimated systolic pressure. Systolic and diastolic pressures were determined using Korotkoff sounds. Three readings were taken at two-minute intervals, and the average was recorded. Blood pressure was classified according to the guidelines set forth by the American College of Cardiology (ACC) as follows [14]:

- **Normal Blood Pressure:** Systolic BP < 120 mmHg and Diastolic BP < 80 mmHg
- **Prehypertension:** Systolic BP between 120–139 mmHg and/or Diastolic BP between 80–89 mmHg
- **Hypertension Stage 1:** Systolic BP between 140–159 mmHg and/or Diastolic BP between 90–99 mmHg

Hypertension Stage 2: Systolic BP ≥ 160 mmHg and/or Diastolic BP ≥ 100 mmHg

For this study, participants with blood pressure readings falling within the prehypertension range (systolic 120–139 mmHg and/or diastolic 80–89 mmHg) were classified as prehypertensive. This classification served as the primary outcome variable for the analysis of the prevalence of prehypertension and its association with various lifestyle factors. A self-made questionnaire was administered to prehypertensive participants to assess lifestyle factors including family history of hypertension, dietary habits, stress, sleep patterns, physical activity, and overall lifestyle.

Data Collection Instrument

A structured, self-administered questionnaire was utilized as the primary data collection instrument to assess lifestyle factors associated with prehypertension among college students. The questionnaire consisted of sections capturing demographic details including name, age, gender, contact information, weight, height, and calculated body mass index (BMI). Additional items assessed family history of hypertension and dietary preferences. The core of the questionnaire was divided into five domains: dietary patterns, sleep patterns, stress, physical activity, and general lifestyle. Each domain included six items scored on a four-point Likert scale: Never (0), Sometimes (1), Often (2), and Always (3). The cumulative score for each domain was calculated, with the highest scoring domain identified as the most significant contributing factor to prehypertension in the individual.

This self-developed questionnaire served as a comprehensive and practical tool for capturing modifiable behavioral risk factors and provided valuable insight into the lifestyle habits influencing blood pressure in young adults. Its use supported early identification and informed preventive strategies for reducing the risk of progression from prehypertension to hypertension.

To ensure content validity, the questionnaire was reviewed and validated by five cardiologists from the Department of Cardiology. The final version was administered only to participants whose blood pressure readings fell within the prehypertensive range, defined as systolic blood pressure between 120–139 mmHg and/or diastolic pressure between 80–89 mmHg. This targeted approach ensured the assessment of lifestyle-related risk factors was relevant to the population at risk, supporting early identification and preventive health strategies.

STATISTICAL ANALYSIS

Statistical analysis was performed using IBM SPSS Statistics version 26.0. Descriptive statistics were used to analyses demographic data, and the prevalence of prehypertension was calculated. Ordinal regression analysis was conducted to evaluate the association between various contributing factors and blood pressure levels. No formal sensitivity analyses were conducted; however, the robustness of findings was supported by consistent results across multiple analytic approaches.

RESULT

Table 1-Demographic Data

Determinants	Mean and standard deviation
Age	20.9±1.95
Gender	Male (32%) Female (68%)

Inference: Mean and standard deviation of demographic data

Table 2-Prevalence of Prehypertensive Students

Type of hypertension	Total	Percentage
Non-prehypertensive	306	61.2%
Prehypertensive	194	38.8%
Total	500	100

Inference: Among 500 participants the prevalence of prehypertension was 38.8% which was found within 194 participants whereas 306 participants were categorized as non -prehypertensive which was 61.2%.

Graph 1- Prevalence of Prehypertensive Students

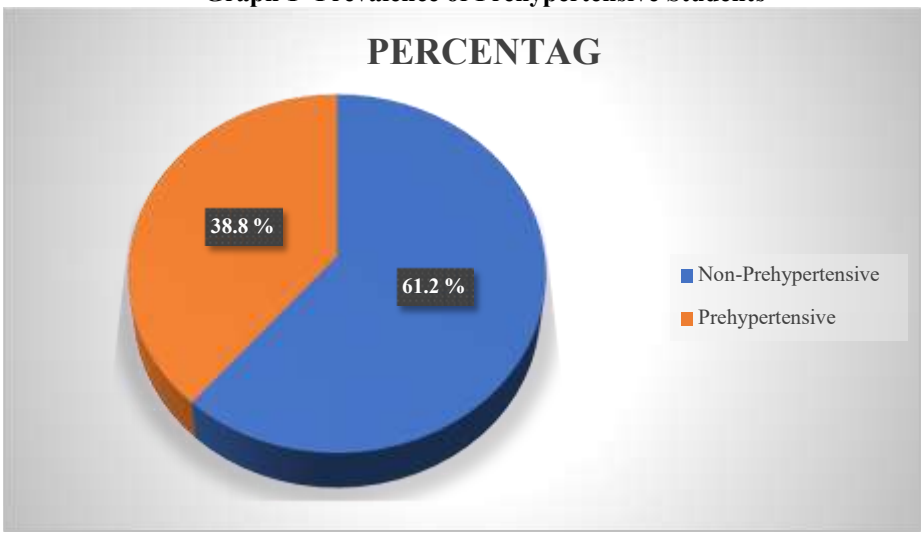

Table 3-Contributing causes For Prehypertension

Components	Percentage
Diet	28.10%
Sleep	29.40%
Stress	31.30%
Physical Activity	28.14%
Lifestyle	30.45%

Inference: The cause for prehypertension was influenced by various factors, with stress as leading cause as 31.30% other contributors included lifestyle choices which was 30.45% sleep habits, 29.40% diet and physical activity were key factors where diet contributing as 28.10% and physical activity impacting as 28.14%. The most leading precursor was stress for prehypertension among students.

Graph 2- Contributing causes For Prehypertension

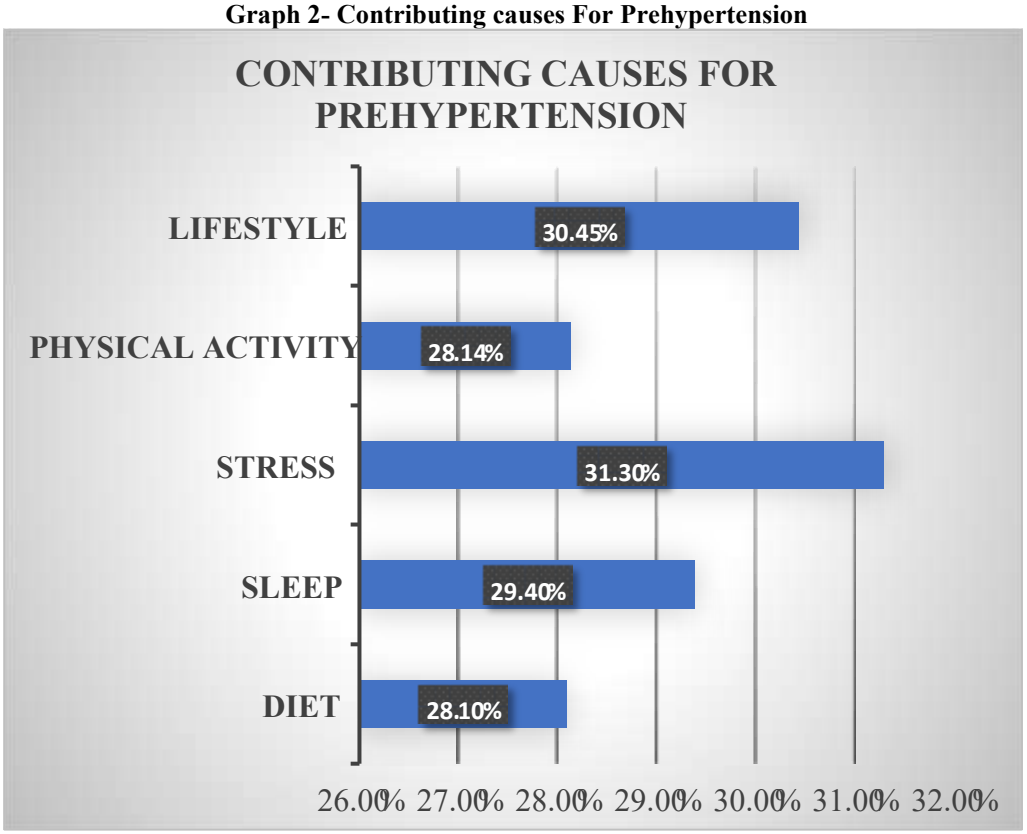

TABLE 4- Ordinal Regression Model

Model	Deviance	AIC	R^2_{McF}
1	663	667	0.0302

Predictor	Estimate	Lower	Upper	SE	Z	P value
DIET	-0.0811	-0.15669	-0.00667	0.0382	-2.12	0.034
Sleep	-0.0763	-0.14751	-0.00615	0.0360	-2.12	0.034
Stress	0.0684	0.00337	0.13453	0.0334	2.05	0.040
Physical activity	-0.0804	-0.15648	-0.00579	0.0384	-2.10	0.036
Lifestyle	0.0765	6.73e-4	0.15346	0.0389	1.97	0.049

Graph 3: Association Between Blood pressure and its contributing factors

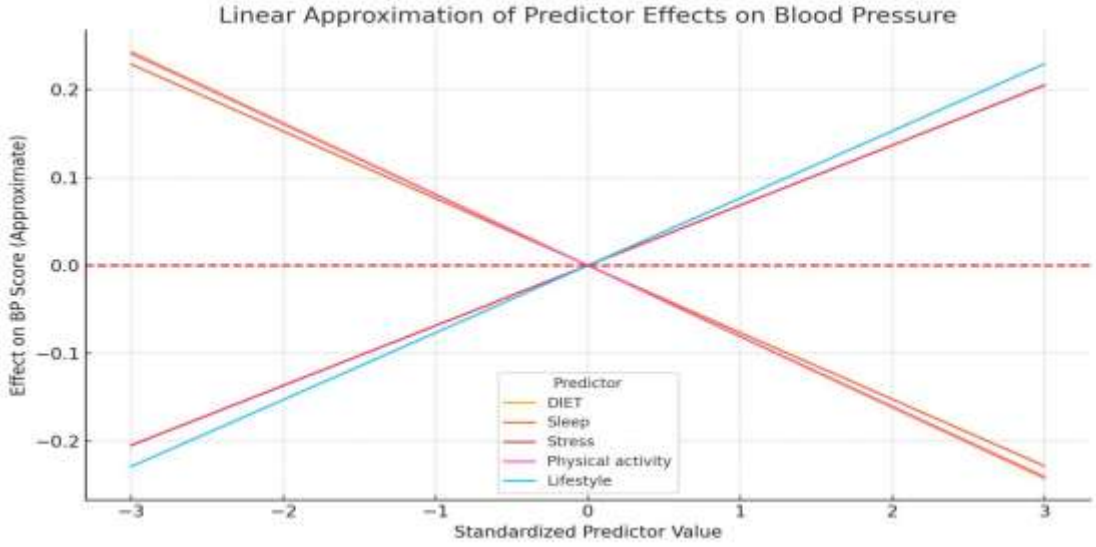

Table 1 summarizes the demographic characteristics of the participants. The mean age was 20.9 ± 1.95 years, with 32% males and 68% females.

As shown in Table 2, the prevalence of prehypertension among the 500 participants was 38.8% (n = 194), while 61.2% (n = 306) were normotensive. Graph 1 illustrates this distribution.

Table 3 presents the reported lifestyle factors contributing to prehypertension. Stress (31.3%) was the most frequently identified factor, followed by lifestyle (30.45%), sleep disturbances (29.4%), physical inactivity (28.14%), and poor dietary habits (28.1%). These findings are depicted in Graph 2.

Ordinal regression analysis (Table 4) demonstrated statistically significant associations between blood pressure status and all assessed lifestyle factors. Diet (*P = 0.034*), sleep (*P = 0.034),* and physical activity *(P = 0.036)* were negatively associated with prehypertension, indicating a protective effect. Conversely, stress *(P = 0.040)* and lifestyle *(P = 0.049)* showed positive associations. The model yielded a McFadden R^2 of 0.0302, suggesting a modest explanatory power. Associations are illustrated in Graph 3.

DISCUSSION

This study found that the prevalence of prehypertension among college students was 38.8%, identified in 194 participants. This finding is comparatively higher than a study conducted in Bahrain, which reported a prevalence of 30% among a similar population [15]. The observed rise in prehypertension may be attributed to the growing influence of unhealthy lifestyle habits among young adults. This is consistent with findings by Bansal et al., who reported that the prevalence of prehypertension in university students was significantly associated with poor dietary patterns, physical inactivity, and parental history of hypertension [16].

This study highlights the significant role of lifestyle factors in the prevalence of prehypertension among college students. Among these, dietary habits contributed to 28.1%, with frequent consumption of oily fried snacks, sugary foods, and high caffeine intake (more than 2–3 cups per day) emerging as prominent risk factors. This aligns with findings by Abad-Hashemi et al., who reported that excessive caffeine consumption being a known pressor agent elevates blood pressure levels [17]. High dietary salt intake, especially from processed foods, was also noted to contribute to elevated blood pressure by promoting water retention and increased blood volume, as supported by Chen et al. [18]. Additionally, inadequate intake of fruits and vegetables was observed among participants, contributing further to poor cardiovascular outcomes.

Sleep disturbances accounted for 29.4% of the contributing factors. Poor sleep quality, commonly associated with academic stress and excessive screen time, was prevalent among the participants. Studies by Makarem et al. and Jain et al. have shown that short or disrupted sleep impairs autonomic regulation, promotes metabolic dysfunction, and disrupts circadian rhythms that collectively contribute to elevated blood pressure [19,20].

Stress emerged as the most significant contributing factor, accounting for 31.4%. Academic pressure, peer relationships, and lifestyle disruptions such as irregular routines and prolonged screen time were identified as primary stressors. Chronic stress activates the sympathetic nervous system, triggering the release of adrenaline and cortisol, which increase heart rate and cause vasoconstriction leading to elevated blood pressure. Psychological stress activates the sympathetic nervous system, triggering the release of stress hormones such as adrenaline and cortisol. This response increases heart rate and induces vasoconstriction, ultimately leading to elevated blood pressure [21].

Physical inactivity emerged as a significant factor, accounting for 28.14% of prehypertension cases in this study. Prolonged sedentary behavior, including extended periods of sitting and excessive mobile phone use, reduces physical activity levels, thereby increasing the risk of prehypertension. Evidence suggests that regular leisure-time physical activity can effectively lower blood pressure [22]. Inactivity contributes to weight gain and obesity, both established risk factors for prehypertension, and can provoke insulin resistance [23]. Moreover, physical activity supports vascular elasticity and healthy blood circulation, whereas inactivity leads to vascular stiffness and impaired endothelial function, resulting in decreased nitric oxide production and increased vascular resistance [24]. These changes, along with a shift in autonomic balance towards increased sympathetic and reduced parasympathetic activity, elevate heart rate and promote vasoconstriction [25].

This study has certain limitations. Self-reported data may be affected by recall or social desirability bias, potentially influencing the accuracy of associations. Blood pressure was measured at a single time point, which may not fully capture long-term variability. Although missing data were minimal, their presence could still introduce bias if not random. The results of this study may be generalizable to college student populations in similar urban academic institutions, particularly within regions sharing comparable sociodemographic and environmental contexts. Future studies should adopt longitudinal designs to better assess causal relationships and track blood pressure trends over time. Incorporating objective measures for lifestyle factors and using repeated blood pressure readings would improve data accuracy. Additionally, interventional research focusing on health education, stress management, and physical activity could help evaluate strategies for preventing the progression of prehypertension in young adults.

This study highlights a substantial prevalence of prehypertension among college students aged 18 to 24 years and underscores the significant role of modifiable lifestyle factors in its development. Stress, inadequate sleep, poor dietary habits, low physical activity, and unhealthy lifestyle behaviors were all found to be significantly associated with elevated blood pressure. These findings emphasize the need for early identification, targeted health education, and lifestyle interventions to prevent the progression to hypertension and reduce future cardiovascular risk in this young adult population.

CONCLUSION

A notable proportion of college-aged individuals exhibit elevated blood pressure levels that fall within the prehypertensive range. This condition appears closely associated with lifestyle-related behaviors that are amenable to intervention. Therefore, timely detection combined with the implementation of focused preventive and health-promotion initiatives is imperative to mitigate the transition to clinical hypertension and to lower the risk of future cardiovascular morbidity within this demographic.

Declaration by Authors

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