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Hypertension in College Students: Exploring the Prevalence and Risk Factors

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Abstract

Early onset of hypertension (HTN) raises the risk of cardiovascular disease (CVD), the leading cause of death in the U.S. For university students who do not follow healthy diets or lifestyles, high blood pressure (BP) may be markedly prevalent. Researchers utilized a cross-sectional design to assess HTN prevalence and its risk factors among college students (N = 123). Self-administered surveys comprising four validated questionnaires: the Perceived Stress Scale (PSS), Rapid Eating Assessment for Participants-Shortened (REAPS), Dietary Approaches to Stop Hypertension Quality (DASH-Q), and the U.S. Adult Food Security Survey (FSS) were employed. Additionally, physical measurements were conducted, including height, weight, waist circumference (WC), and BP. Results indicated that 71.6% of students had elevated BP, with 24.4% classified as Stage 1 HTN and 23.6% as Stage 2 HTN. Notably, 60% of students reported low adherence to the DASH diet and a mean REAPS score of 26.3 out of 39. Students experiencing marginal food security had higher systolic blood pressure (SBP) 131.7 ± 16.8 mm Hg compared to those with high food security 123.03 ± 11.7 mm Hg ($p = 0.028$). Furthermore, REAPS scores showed a negative correlation with diastolic blood pressure (DBP) ($\beta = -0.201$, $p = 0.03$). Significant predictors for SBP included WC ($\beta = 0.40$, $p < 0.001$), gender ($\beta = -0.33$, $p < 0.001$), and marginal food security ($\beta = 0.16$, $p = 0.046$). The findings highlight the need for BP screenings and nutrition education programs to improve dietary habits among college students, which may help reduce HTN and its associated long-term risks for CVD.

Keywords

Hypertension, College Students, Prevalence, Cardiovascular Disease, Risk Factors

1. Introduction

Hypertension (HTN) is a major risk factor for cardiovascular disease (CVD),

including myocardial infarction (MI), ischemic stroke (IS), hemorrhagic stroke (HS), and heart failure [1]. The prevalence of adult HTN in the United States (U.S.) is 45%, with $219 billion spent annually on treatment [2]. Recent research indicates that the prevalence of elevated blood pressure (BP), Stage 1 HTN, and Stage 2 HTN may reach as high as 46% among university students [3] with males showing higher prevalence rates and elevated diastolic blood pressure (DBP) levels compared to females [4] [5]. College students often engage in lifestyle behaviors that heighten the risk for HTN, such as poor dietary choices, lack of exercise, smoking, and alcohol use. They tend to underestimate the severity of heart disease risk factors and their actual risk for CVD [6]-[8]. This underestimation is concerning, as early onset of HTN raises the likelihood of the development of CVD, the leading cause of death in the U.S. [9] [10]. Identifying elevated BP and HTN in young adults, referring them to a Registered Dietitian for medical nutrition therapy, promoting physical activity (PA), encouraging modifications of unhealthy habits, and managing BP may help prevent serious health issues and reduce the future disease burden of CVD. This research aims to examine the prevalence of high BP and identify risk factors that predict HTN in ethnically diverse students at a rural public university in Texas.

1.1. Risk Factors for Hypertension in College Students

A high-quality diet is associated with a reduced risk for HTN [11] [12]. However, college students often have poor eating habits, which may be exacerbated by the prevalence of food insecurity (FI) on college campuses, estimated to be 40% or higher [13]. Compared to food-secure students, the diet of food-insecure university students is low in nutrient-dense foods, *i.e.*, fruits, vegetables, and whole grains, and excessive in fast foods, added sugars, and sugar-sweetened beverages [14]-[16]. Students with FI are more likely to purchase inexpensive, shelf-stable, ultra-processed foods to cope with food shortages [17]. Consumption of a diet high in energy-dense, nutrient-poor (EDNP) foods may result in excess intake of calories, fat, sodium, and sugar and contribute to the development of obesity, HTN, and chronic diseases [18]-[22]. However, maintaining a healthy diet with increased plant foods, fish, nuts, legumes, and whole grains and less red meat and added sugar as in Dietary Approaches to Stop Hypertension (DASH) or following a low salt diet reduces BP levels and is protective for HTN [11] [12] [23] [24].

Food insecurity may lead to poor diet quality and is associated with higher body mass index (BMI) levels and obesity [25] [26]. Overweight, obesity, and increased central obesity are well-documented risk factors for HTN [27]. In the U.S., one-third of adults aged 20 - 39 years are classified as obese (males, 34.3%; females, 36.8%) with 9.5% of adults in the severely obese category [28]. Also, indicators of obesity, elevated BMI levels and waist circumference (WC) are significant risk factors for HTN in adults with prehypertension. This emphasizes the importance of weight reduction as a preventive intervention for HTN [29] [30]. In college students, elevated WC explained slightly more variance in systolic blood pressure

(SBP) than BMI, suggesting that WC may be a better indicator of the risk for HTN [31].

One coping mechanism that may play a role in food choices made by people with FI is delay discounting [32]-[35]. Delay discounting occurs when a person values instant gratification over later incentives such as disease prevention. For example, a hungry person may choose to consume EDNP foods now instead of nutrient-dense foods that prevent the risk of chronic disease in the future. Epstein and colleagues found that delay discounting moderates the effect of FI in low income mothers [36]. This is important because delay discounting is positively associated with BMI levels [37] [38]. Helping people delay consumption of EDNP foods in favor of healthier foods may be a strategy to reduce obesity in the food-insecure population [39]. Delay discounting has also been studied in obesity and diabetes [40] [41], PA [42], Attention Deficit Hyperactivity Disorder [43], substance use disorders [44] and other health conditions.

Regular participation in PA is associated with a 32% relative risk reduction for HTN [45] [46]; however, students may not be familiar with PA guidelines for Americans [47]. Routine PA lowers BP and reduces the risk for mortality by 33% in adults [48]. In healthy college students, PA is associated with improved quality of life, including physical and mental health, improved social interactions, and increased vitality [49]. However, elevated adiposity is more predictive of the risk for CVD than poor cardiovascular fitness in college students [50], but studies indicate that students lack participation in vigorous PA for comparison [51].

Smoking and exposure to second-hand smoke increase BP levels by inducing vasoconstriction and producing carbon monoxide, which causes structural alterations in the walls of the blood vessels and elevated BP [52] [53]. However, one-fifth of undergraduate students report recent use of tobacco or nicotine delivery products [54]. One gap in the health education of college students is that students who smoke do not perceive HTN to be a serious risk factor for CVD, even though smokers are at higher risk for HTN and CVD than non-smokers [55]. The perception of the seriousness of CVD risk factors also varies by rural or urban geography [56].

Alcoholic beverage consumption at high intake levels and frequency is associated with HTN, and women are more susceptible to the cardiovascular effects of excess alcohol than men [24] [57] [58]. Chronic alcohol intake contributes to HTN by causing endothelial injury and oxidative stress to the blood vessels. [59] Sixty-one percent of undergraduate students report drinking alcohol in the last 3 months, with amounts of social drinking that exceed recommended safe levels of alcohol [54].

High levels of stress, particularly for extended lengths of time, is a modifiable risk factor associated with HTN in adults [60] [61]. In college students, stress is often due to exams, lack of sleep, or overscheduling due to work and school responsibilities. Recent research has not shown an association of stress with HTN in college students [5], but more research is needed to explore this relationship.

As previously mentioned, male college students exhibit higher prevalence rates for HTN and higher DBP levels than females [4] [5] [62]. At age 60 years, male and female rates of HTN converge [1]. Tindall and Stallings suggest that gender-based differences in the risk of CVD may reflect differences in diet patterns and preferences, vasculature, and body composition between men and women [63].

1.2. Diagnostic Criteria for Hypertension

In addition to the high number of risk factors for HTN in college students, criteria for the diagnosis of BP were lowered in 2017. Before this, diagnostic criteria for BP were reported in the *Seventh Report of the Joint National Committee on Prevention Detection, Evaluation, and Treatment of High Blood Pressure* (JNC7). [30] These guidelines included a "prehypertension" category for a SBP of 120 - 139 mm Hg or a DBP of 80 - 89 mm Hg. Hypertension was diagnosed when SBP was 140 - 159 mm Hg or DBP was 90 - 99 mm Hg.

In 2017, the American College of Cardiology/American Heart Association (ACC/AHA) revised HTN diagnostic guidelines to improve patient care through early intervention [64]. The new guidelines eliminated the "prehypertension" category and created a new classification called "elevated blood pressure" for a SBP of 120 - 129 mm Hg and DBP less than 80 mm Hg. Hypertension is now diagnosed when SBP is 130 - 139 mm Hg or DBP pressure is 80 - 89 mm Hg. Thus, the changes to the diagnostic criteria for HTN reduced the limits for non-normal BP levels resulting in higher prevalence rates for elevated BP and HTN in people age 18 and older [65].

1.3. Prevalence of Hypertension and CVD Risk Factors

Several researchers have examined the prevalence of HTN in college students. Crum and colleagues reported elevated BP levels (14.9%), HTN (48.9%), high total cholesterol (23.4%), and low HDL levels (21.3%) in first-semester freshmen [66]. Herlosky and colleagues reported 13.8% of college students with elevated BP, and 29% with HTN [4]. Kessler and Rayman reported the prevalence of elevated SBP and elevated DBP were 50% and 30%, respectively [5]. Curtis found that most college students had normal BP levels; however, 41% exhibited one or more risk factors for metabolic syndrome [67]. Using JNC7 criteria, Gooding and colleagues' reported an overall 25% prevalence rate for HTN in 24 - 32-year-olds [68], and Abshire and colleagues reported the prevalence of HTN as 14% in college students [31].

Researchers investigated the prevalence of CVD risk factors in U.S. college students, including lifestyle, physical, and biochemical risk factors. Bopp and colleagues showed that poor cardiorespiratory fitness and elevated adiposity were associated with multiple CVD risk factors, including BP [50]. Abshire and colleagues researched risk factors for CVD, including physical assessment, PA, fruit and vegetable intake, and smoking [31]. They showed that both anthropometric measures, BMI and WC, were predictors of BP and that WC predicted SBP

independent of BMI. Smoking did not predict BP, but PA predicted SBP [31]. Kessler and Rayman found no associations between BP and reports of stress, alcohol, or caffeine intake, but they reported that males exhibited higher SBP and DBP than females [5].

1.4. Research Gap and Study Aims

Myocardial Infarctions occurred in four percent of the Texas adult population between 2011 - 2018. Of these cases, the highest comorbidities were primarily diet-related conditions, including HTN with 78% prevalence, followed by dyslipidemia (60%), obesity (42%), diabetes (41%), and smoking (32%) [69]. In Texas, the prevalence rate of household food insecurity (2021 - 2023) is 16.9% [70]. Food insecurity increases the likelihood of poor diet quality and obesity, both risk factors for CVD. Recent research indicates an increase in the prevalence of HTN on college campuses, and these numbers have grown with the new guidelines for high BP [64]. Because our student population has an estimated food insecurity prevalence rate of 60%, this research aims to explore how diet quality and FI are related to HTN [71]. Also, there is little research about HTN in college-age populations living in rural geographies. Studies in rural-dwelling adults report decreased cardiovascular health compared to adults in metropolitan areas of the U.S. [72].

While research studies have addressed some aspects of modifiable risk factors in college students, this research aims to investigate relevant health behaviors (smoking, diet, PA, and alcohol intake), physical assessment data (BP, WC, BMI), and validated methods to measure diet quality (REAPS), FI (USDA Adult Food Security Module), stress (PSS) and adherence to the DASH diet (DASH-Q) to predict HTN in college students who may be additionally impacted by FI and rurality. Therefore, this research will be conducted in a rural, public university with a diverse student body located in East Texas, and it aims to establish the prevalence rate of HTN on our campus and to identify relevant modifiable risk factors for HTN to prioritize preventive and treatment resources for college students. This purpose of this research is to describe sociodemographic factors and health behaviors related to risk for HTN; describe the prevalence of normal BP, elevated BP, Stage 1 HTN, and Stage 2 HTN; and examine health, lifestyle, and behavioral predictors for SBP or DBP in college students.

2. Methods

This cross-sectional study recruited a convenience sample of 123 college students between the ages of 18 and 26 years (20.5 ± 2.4 y) from the university recreational center. Eligible participants consented to participate and moved to a private data collection room. To be eligible, participants were required to be enrolled college students aged 18 years or older who were not pregnant and could read and write in English. Data collection included a self-administered questionnaire and anthropometric measures. The survey included four validated questionnaires: demographic questions, the Perceived Stress Scale (PSS), the Rapid Eating Assessment

for Participants - Shortened Version Questionnaire (REAPS), the Dietary Approaches to Stop Hypertension Quality (DASH-Q), and the U.S. Adult Food Security Survey (FSS). Basic demographic information was collected: age, gender, race/ethnicity, education, living situation, relationship status, and health behaviors. It took participants approximately 50 minutes to complete the self-administered survey. After completing the survey, the researchers measured height, weight, waist circumference (WC), and BP. Body mass index was calculated using the standard formula. The study was approved by the University's IRB review board (IRB# IRB-2021-16).

2.1. Measures

2.1.1. Perceived Stress Scale (PSS)

The PSS is a validated measure for college students to assess the individual's stress level during the last month. Participants are asked how often they had specific thoughts or feelings the previous month. Items 4, 5, 7, and 8 were reverse-coded, and all items were summed. A total score can range from 0 to 40, with higher scores indicating higher perceived stress. Total scores can also be categorized as follows: 0 - 13 low stress, 14 - 26 moderate stress, and 27 - 40 would be considered high perceived stress [73].

2.1.2 Rapid Eating Assessment for Participants - Shortened Version Questionnaire (REAPS)

The REAPS is a valid measure to estimate the consumption of fruits, vegetables, milk, and fat sources in the college population [74]. The shortened version roughly estimates fat, cholesterol, fiber, and sugar intake. The total score is a summation of the first 13 questions with the following point values: responses of "usually/often" received 1 point, "sometimes" received 2 points, and "rarely/never or does not apply to me" received 3 points. Scores range from 13 to 39, with a higher score consistent with a higher diet quality [75].

2.1.3. Dietary Approaches to Stop Hypertension Quality (DASH-Q)

The DASH-Q is a validated measure in adults and college-age populations to assess adherence to the DASH diet. The total score is calculated by reverse coding item 4 and then summing all items. The score ranges from 0 to 77 with higher scores considered higher diet quality. The items can be categorized as follows: 0 - 32 low diet quality, 33 - 51 medium diet quality, and scores of 52 or greater should be considered high diet quality or adherent to the DASH diet [76].

2.1.4. U.S. Adult Food Security Survey (FSS)

The U.S. Adult Food Security Survey has the same questions as utilized in the U.S. Household Food Security Survey Module for households with no child present. This is a widely used measure to assess the food security of adults in the U.S. The total score is a summation of all items; responses of "yes", "often", "sometimes", "almost every month", and "some months but not every month" are coded as yes (yes = 1). The scores ranged from 0 - 10, and higher scores were considered very

low food security. The total score can be categorized and assigned to a food security status as follows: 0 = high food security, 1 - 2 = marginal food security, 3 - 5 = low food security, and 6 - 10 = very low food security among adults [77].

2.1.5. Health Behaviors

Student participation in health behaviors was measured using five subscales: PA, smoking, alcohol intake, and currently attempting weight loss. Questions included, "How many of the past 7 days did you engage in PA?", "How many of the past 7 days did you smoke?", "How many of the past 7 days did you drink alcohol?", and "Are you currently attempting to lose weight ?".

2.2. Data Analysis

Data were analyzed using SPSS 29 (IBM Corp., 2023). The participants who completed the survey and anthropometric measures included 123 college students. The remaining missing data were determined to be missing completely at random (MCAR), and participants' data were retained in the analysis [78]. Descriptive statistics were calculated to assess the data distribution, participant demographic data, health behaviors, PSS, FSS, DASH, and REAPS.

Two stepwise multiple regression analyses were conducted to estimate a regression model that best predicts SBP and DBP among college students based on eleven factors: gender, ethnicity, college classification, attempting weight loss, PA, smoking, WC, FSS, PSS, DASH-Q, and REAPS. Before conducting the analysis, descriptive statistics and graphs were generated to examine the test assumptions, including normality of distributions, linear relationships between SBP and DBPs and the factors, normality of residuals, homoscedasticity, and multicollinearity. Measures of skewness and kurtosis, histograms, and Q-Q plots show that the shapes of the distributions of SBP and DBP and factors approach a normal curve. Pearson's correlation coefficients and scatterplots show a linear relationship between SBP and DBP and some factors. In addition, the inspection of histograms and normal probability plots of the residuals confirms that the assumption of homoscedasticity was met for the included factors for each model. The evaluation of the VIF and tolerance values shows no multicollinearity among the included factors for each model factors [79].

To predict Chronic Disease Risk (CDR) a stepwise likelihood ratio (forward LR) logistic regression analysis was conducted to estimate a regression model that correctly predicts the probability of college students' relative chronic disease risk (CDR) (no risk vs. risk). Before conducting the analysis, chi-square and independent t-tests were utilized to examine bivariate relationships between CDR and each factor. The results of the chi-square and independent t-tests showed no significant relationship between CDR and gender, age, ethnicity, mean arterial pressure, DBP, alcohol, smoking, PA, PSS, FSS, DASH, and REAPS; thus, these factors were excluded, and SBP was included in the analysis to predict CDR [78].

A step-wise regression was conducted to explain the relationship between student factors (age, gender, weight, presence of elevated blood pressure, diet quality,

adherence to a dietary pattern (omnivore, vegetarian, vegan, DASH diet), perceived stress, physical activity, currently attempting weight loss, and classification) and WC. Measures of skewness and kurtosis, histograms, and Q-Q plots showed the shape of the WC was positively skewed. Therefore, a log transformation was performed to correct for the skewness and kurtosis of WC. Since there were no relationships between most of the factors and WC, all variables were excluded from the analysis except currently attempting weight loss, FSS, and adherence to DASH.

3. Results

3.1 Participant Characteristics

The study sample (N = 123) reported adherence to an omnivore dietary pattern (97%). The participants were young adults (20.5 ± 2.4 years); 55% of participants identified as male, and 35%, 32%, and 25% of the sample identified as White, Hispanic, and Black, respectively. Half the participants had a BMI ≥ 25.0, considered overweight or obese. A majority of survey respondents (92.7%) were enrolled in a Bachelor's degree program. Table 1 shows the participant demographics.

Dependent variables were normally distributed. Participants reported health-related behaviors, including PA on four or more days per week (54%), smoking (20%), no consumption of alcoholic beverages in the past seven days (56%), and low intake of healthy foods associated with the nutrient composition profile of the DASH diet (60%). The students' mean REAPS score was 26.3 out of 39, which is

Table 1. Participant characteristics in sample of college students (N = 123).

Characteristic	Mean (sd) or %
Age	20.5 (2.4)
18 - 20	52.8%
21 - 24	20.4%
25 or greater	8.2%
Gender	
Male	55%
Female	45%
Race	
White/Caucasian	35%
Hispanic	32%
Black/African American	25%
Asian	4%
Native Hawaiian/Pacific Islander	4%
Living situation	
Off-Campus Apartment	50%
Dorm Room	42%

Continued

Off-Campus with Parents/Significant other	9%
Other	
BMI ≥ 25.0	52%
Enrolled as an undergraduate	92.7%
Diagnosis of high blood pressure	6%
Family history of high blood pressure	56%
Health Behaviors	
Physically active 4 or more days per week	54%
Currently attempting to lose weight	49%
No Alcohol in the past 7 days	56%
Smoking in the past 7 days	20%
Dietary Factors	
DASH	31.1 (12.0)
REAPS	26.3 (4.0)
PSS	16.9 (6.7)
Food Security	1.7 (2.4)

lower than scores from previous studies about dietary quality in young adults [74] [80]. Blood pressure assessments showed that 71.6% of students had BP measurements in the elevated, stage 1, and stage 2 categories of BP (Table 2).

Table 2. Gender and blood pressure levels in college students (N = 123).

Category	Participants		
	Males n(%)	Females n(%)	Total N(%)
Normal	26 (21.1)	9 (7.3)	35 (28.5)
Elevated	12 (9.8)	17 (13.8)	29 (23.6)
Stage 1 HTN	16 (13.0)	14 (11.4)	30 (24.4)
Stage 2 HTN	14 (11.4)	15 (12.2)	29 (23.6)

There was a significant association between gender and BP categories (chi-square (df = 3, N = 123) = 8.002, p = 0.046). The number of males with normal BP (n = 26) was higher than expected (19.3), and the number of females with normal BP (n = 9) was lower than expected (15.7). Cramer's V (C = 0.255) indicates that 6.5% of the variance in the BP category can be explained by gender, a weak correlation. Waist circumference (WC) differed by gender (F (1,121) = 6.043, p = 0.015). Students' scores for REAPS, FSS, DASH-Q, PSS, and risk for chronic disease did not differ by gender. The distribution of the two dependent variables, DBP and SBP scores, was explored; significant relationships are shown in Table 3.

Table 3. ANOVA results table for systolic and diastolic blood pressure on predictor variables in a college sample (N = 123).

Blood Pressure	Results					
	Variable		Mean	SD	F-Statistic	P-value
Systolic Blood pressure	Gender	Males	123.2	13.9	8.83	0.004*
		Females	130.4	12.8		
	Food Security	High FS	123.03	11.7	3.13	0.028*
		Marginal FS	131.17**	16.8		
		Low FS	130.22	14.7		
		Very Low FS	124.17	10.6		
	Smoking	Non-smoker	125.2	13.8	4.18	0.043*
		Smoker	131.5	13.2		
	WC	Elevated WC	135.3	14.7	17.74	0.001*
		Normal WC	123.6	12.4		
	BMI	BMI ≤ 24.9	121.6	13.4	14.84	0.001*
		BMI ≥ 25	130.8	13.1		
Diastolic Blood pressure	Gender	Males	77.9	10.6	4.01	0.05*
		Females	74.0	10.6		
	WC	Elevated WC	82.8	12.7	15.33	0.001*
		Normal WC	74.2	9.4		

Body Mass Index (BMI), Waist Circumference (WC), Food Security (FS). ** Bonferroni post hoc found High FS significantly different (p = 0.05) from Marginal FS.

3.2. Relationships between SBP, DBP, Chronic Disease Risk, and Health Behaviors

Females had a higher SBP than males possibly because WC, a measure of central obesity and a major risk factor for HTN, was significantly higher in females than males in this study. Participants with marginal food security, smoking, WC greater than recommended, or overweight classification had higher SBP than those who did not exhibit these characteristics. Males had a higher DBP than females, and participants with a greater than recommended WC had a higher DBP than those with a normal WC. There was no difference in DBP for food security status, smoking, or BMI. There was no difference between SBP or DBP based on ethnicity, college classification, PSS, DASH-Q, attempting weight loss, alcohol, or PA. REAPS correlated significantly to DBP (−0.201, p = 0.03) but not SBP. Hierarchical linear regression models examined the associations between the predictor variables and each outcome variable.

3.3. Regression Model for SBP

A stepwise multiple regression analysis was conducted to estimate a regression model that best predicted SBP among college students based on four factors: gender,

smoking, WC, and marginal food security. The results of the stepwise multiple regression analysis revealed that three of the four factors emerged as significant predictors of SBP ($F = 13.94$, $p > 0.001$). With a beta of .40 ($p < 0.001$), elevated WC emerged as the strongest predictor of SBP, accounting for 13% of the variance in SBP. The second factor was gender ($\beta = -0.33$, $p < 0.001$), accounting for an additional 11% of the variance in SBP. The third factor, marginal food security ($\beta = 0.16$, $p = 0.046$), accounting for an additional 2.5% of the variance. These results indicate that higher SBP is a function of a larger WC, being female, and marginal food security in a college sample. Overall, the model explains 26% of the variance in SBP, although about 74% is still unaccounted for in this model (Table 4).

Table 4. Results of multiple regression analysis—predictors of SBP.

Factors	Results						
	R	R^2	β	τ	p	F	p
WC	0.36[a]	0.13	0.40	5.02	<0.001	17.74	<0.001
Gender	0.49	0.24	−0.33	−4.11	<0.001	18.41	<0.001
Marginal Food Security	0.51	0.26	0.16	2.02	0.046	13.94	<0.001

[a]All coefficients are rounded to the nearest two decimals. Waist Circumference (WC).

3.4. Regression Model for DBP

A stepwise multiple regression analysis was conducted to estimate a regression model that best predicts DBP among college students based on three factors: gender, waist circumference, and diet quality (REAPS). The stepwise multiple regression analysis results revealed that DBP was predicted by three factors ($F = 10.13$, $p = 0.001$). With a beta of 0.37 ($p < 0.001$), WC emerged as the strongest predictor of DBP, accounting for 10 percent of the variance in DBP. The second strongest factor was gender ($\beta = 0.26$, $p = 0.003$), accounting for an additional 6.4 percent of the variance in DBP. The third strongest factor was diet quality (REAPS) ($\beta = -0.20$, $p = 0.02$); however, it only accounted for 4 percent of the variance in DBP.

These results indicate that higher DBP is a function of higher WC, being male, and having a lower diet quality. Overall, the model explained 20% of the variance in DBP ($R = 0.45$). Conversely, about 80 percent of the variance in DBP is still unaccounted for in this model (Table 5).

Table 5. Results of multiple regression analysis—predictors of DBP.

Factors	Results						
	R	R^2	β	τ	p	F	p
WC	0.36[a]	0.10	0.37	4.46	<0.001	13.35	<0.001
Gender	0.41	0.16	0.255	3.04	0.003	11.76	<0.001
REAPS	0.45	0.20	−0.20	−2.43	0.016	10.13	<0.001

[a]All coefficients are rounded to the nearest two decimals. Rapid Eating Assessment for Participants (REAPS).

3.5. Predicting Chronic Disease Risk with Blood Pressure

A stepwise likelihood ratio (forward LR) logistic regression analysis was conducted to estimate a regression model that correctly predicts the probability of college students' relative chronic disease risk (CDR) (no risk vs. risk) [27]. One factor, SBP, was entered into the analysis. Before the analysis, chi-square and independent t-tests were utilized to examine bivariate relationships between CDR and each factor. The results of the chi-square and independent t-tests showed no significant relationship between gender, age, ethnicity, mean arterial pressure, DBP, alcohol, smoking, PA, PSS, FSS, DASH, and REAPS; thus, they were excluded from the analysis. Finally, the Hosmer and Lemeshow test contingency table shows that only four cells (20%) had expected values less than 5, and no cells had an expected value smaller than 1.

The stepwise likelihood ratio regression results reveal that one factor emerged as a significant predictor of college students' CDR, SBP (Wald (df = 1) = 12.00, $p < 0.001$). The results show that the overall model significantly improves the prediction of the occurrence of increased CDR in students with higher SBP (chi-square (df = 1) = 14.31, $p < 0.001$). This model is a very good fit (−2 log likelihood = 156.00, Hosmer and Lemeshow, X^2 (df = 7) = 10.63, p = 0.15) (Table 6). The results of the Cox and Snell and the Nagelkerke R^2 indicate that SBP accounted for 11.0 to 14.6 percent of the variance in CDR. Finally, the model correctly classified 68% of the "No risk" cases and 72% of the "Elevated Risk" cases. Overall, this model has a success rate of 70%.

Table 6. Results of logistic regression—predictors of chronic disease risk.

Factors	Results						
	β	Wald	df	p	−2LL	R^2	Odds-Ratio
Systolic Blood Pressure	0.054	12.00	1	<0.001	156.00	0.110	1.06
Constant	−6.75	11.71	1	<0.001		−0.146	0.001

Overall model: chi-square (df = 1) = 14.31, $p < 0.001$. Goodness of fit: (−2LL = 156.00, chi-square (df = 7) = 10.63, p = 0.15.

3.6. Predicting Waist Circumference

The results of the stepwise multiple regression analysis revealed that three factors emerged as significant predictors of WC in college students ($F = 9.36$, $p < 0.001$). With a beta of −0.35 ($p < 0.001$), currently, attempting weight loss emerged as the strongest predictor of WC, accounting for 11 percent of the variance of WC. The second strongest factor was adherence to the DASH dietary pattern ($\beta = 0.24$, p = 0.006), accounting for an additional 4.4 percent of the variance in WC. The third strongest factor was food security ($\beta = -0.19$, p = 0.024), and accounted for an additional 3.5 percent of the variance in WC. These results indicate that higher WC is a function of currently attempting to lose weight, adherence to a DASH dietary pattern, and food insecurity. Overall, the model explains 19 percent of the

variance in WC in college students ($R = 0.44$). On the other hand, almost 81 percent of the variance in WC is still unaccounted for in this model.

4. Discussion

Hypertension significantly contributes to CVD, yet previously it was thought that college students faced minimal risk for elevated BP. However, recent research has revealed a higher prevalence of HTN among college students than was previously known [4] [5] [66]. This is partly due to the 2017 updates to BP diagnostic criteria, which lowered the threshold for diagnosing HTN and replaced the "pre-hypertension" category with "elevated blood pressure". Currently, FI is prevalent on college campuses, often manifesting as an inadequate diet high in EDNP foods that frequently contain excess salt, fat, and sugar. Food insecurity is linked to elevated BMI and poor diet quality—both of which may lead to obesity, a chronic condition strongly associated with HTN and the risk of CVD. The early onset of HTN is more likely to result in the development of CVD, not during the college years but surfacing decades later.

Students often overlook the seriousness of smoking, obesity, poor diet quality, and other risk factors related to CVD risk, which may lead to experimentation with smoking and excessive alcohol consumption, increasing the risk for HTN. Frequently, students are too busy with their coursework and extracurricular activities to engage in PA regularly. In the past, unhealthy behaviors and low-quality diets among college students were downplayed as part of the college experience and the cost of earning a degree. Today, modifiable risk factors for chronic diseases, such as HTN, CVD, and diabetes, are increasingly acknowledged as a growing health issue for young people.

Seventy-one percent of college students in this study exhibited either elevated BP (23.6%), Stage 1 HTN (24.4%), or Stage 2 HTN (23.6%). The prevalence of non-normal BP was higher than reported in previous studies of U.S. college students we reviewed for this research [4] [5] [31] [50] [66]-[68]. The participants in this study were quite diverse, with 35%, 32%, and 25% of the sample identifying as White, Hispanic, and Black, respectively. Some studies reported higher percentages of White [4] [31] [68] or Asian [4] students. Except for one study, our research was the only one conducted in a rural environment [31]. Our students also face challenges due to limited public transportation and high rates of FI [71]. These findings suggest that, in addition to health behaviors, social determinants of health may influence the prevalence of HTN in college students. For example, in this research, students with marginal food security had higher SBP and WC, possibly due to the negative impact of poor diet quality on HTN.

Other factors associated with increased SBP included smoking and being overweight or obese. While smoking cessation leads to lower SBP and DBP, it may also result in unintended weight gain [81]. The REAPS, or diet quality, showed an inverse association with DBP. However, adherence to the DASH diet pattern, which is a high-quality diet, has been demonstrated to reduce DBP [82]. Elevated WC

was linked to SBP and DBP, consistent with previous research involving college students [31]. Additionally, we found a weak association between gender and student classification based on BP category. Female students exhibited higher SBP than males, contrasting with Kessler and Raymon's research, which indicated that males had higher SBP and DBP, with a more significant proportion of male participants being overweight or obese [5]. In our study, the higher SBP in females may be explained by the finding that the females had a higher WC compared to males. Previous studies have noted that males typically had higher DBP than females, a trend that continues until age 60 when both genders display similar prevalence of HTN [1].

The first regression model which aimed to predict SBP indicated that higher SBP was a function of greater WC, being female, and marginal food security. Overall, the model accounts for 26% of the variance in SBP. Findings were similar to those of Abshire and colleagues, who reported that a higher WC predicted SBP better than BMI; in addition, they showed that being female was associated with lower SBP and did not consider food security status [31]. This model is consistent with the FI/Obesity paradox, where grocery stores with healthy foods are not accessible, leading to poor nutritional choices and habits that may be perpetuated into adulthood. As previously discussed, FI is associated with delay discounting, the tendency to prioritize immediate rewards over future gains, which may result in food choices that are low in nutrients. Providing educational programs to college students with strategies to combat delay discounting when hungry may help them avoid elevated WC and BMI levels associated with impulsive eating.

The second regression model aimed at predicting DBP indicated that higher DBP is associated with greater WC, being male, and lower diet quality. Overall, the model accounted for 20% of the variance in DBP. Waist circumference emerged as the strongest predictor in this model, similar to the findings of Abshire and colleagues, who, however, did not identify fruit and vegetable intake as a predictor of DBP [31]. We found that low diet quality, as measured by REAPS, was a predictor of DBP, similar to previous research [63].

The third regression model which predicted chronic disease risk in college students indicated that measuring SBP enhanced the accuracy of determining chronic disease risk. Blood pressure measurements can be easily integrated into the BMI and WC calculations during health screenings to increase the precision of the screening process for chronic diseases such as HTN, CVD, and diabetes among college students.

The final regression model revealed the relationship between WC and attempting to lose weight and dietary intake. More research is needed to ascertain the roots of this association, but it may be explained by the relationship between restricting food intake and over-eating as a response to extreme hunger. Another possibility is that WC is elevated, and the attempts to reduce food intake and eat healthier foods follow to obtain desirable body weight.

Limitations

This study has limitations that offer opportunities for further investigation. The cross-sectional design did not allow for determination of causality. The participants were obtained through convenience sampling; thus, sampling bias may have been present. Due to social desirability bias, participants may have reported the consumption of higher-quality diets in their responses, and this may have decreased the strength of diet quality as a predictor of HTN. Future studies may want to consider including biochemical analysis to augment the physical assessment findings. This would enhance the health screening assessment and provide more information and opportunities to inform and educate students about healthy eating to prevent HTN and CVD. Due to the university's rural location and highly diverse student body, the results may be generalizable to other public universities in the southern U.S.

5. Conclusion

This study reveals a particularly high prevalence of elevated BP and HTN among students on our campus, at 71.6%. Greater emphasis should be placed on BP screening for students to identify HTN and its risk factors for CVD and enhance student awareness. Future research and program development should take gender differences into account. For example, the relationship between FI, WC, and females with high SBP indicates the necessity for multiple strategies addressing all relevant factors. These strategies could include resources for managing FI, nutrition education promoting healthy eating, and encouraging healthy behaviors. Alternatively, most students may benefit from nutrition information and cooking skills to improve their diet quality and achieve and maintain a healthy weight. University administrators and policymakers could utilize these findings to advocate for support in providing programs aimed at reducing HTN and chronic diseases among students. The future burden of CVD in Texas could be alleviated by improving health screening methods, increasing screening for HTN and chronic diseases, and implementing additional nutrition education programs.

Data Availability

Data from the study is available upon request of the authors (lgf011@shsu.edu).

Authors' Contributions

Conceptualization and data collection were completed by Tabbetha Lopez, Laura Shelby, Yemisi Oguntuwase, Anna Sullivan, and Linda Fergus. The methodology, design, analysis, draft-writing, editing, and final approval were completed by Tabbetha Lopez and Linda Fergus.

Conflicts of Interest

The authors declare that they have no conflict of interest in relation to this article.

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