RESEARCH ARTICLE

Prevalence of High Blood Pressure, Risks Factors, and Knowledge Deficit in Apparently Healthy College Students

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ABSTRACT

Background: College students are assumed to be generally healthy, thus, elevated blood pressure can be easily missed in this population. However, recent research on college students has demonstrated increasing rates of elevated blood pressure. Situations that increase risk of elevated BP include higher levels of stress related to college education as well as other common stress producing events in life. Additionally, college students may engage in behaviors that increase risk such as eating poor diets, drinking alcohol, and not exercising regularly. The purpose of this study was to assess the prevalence of elevated blood pressure and risk factors in undergraduate college students and develop a campus wide educational initiative.

Methods: Undergraduate students at a faith-based, Midwestern university (n = 138) participated in a cross-sectional study. Demographic data, standardized BP measurements, risk factors, and perceived stress levels were collected via a Google form and in-person assessments.

Results: Fifty-two percent of college students had an elevated systolic blood pressure, and 30% had elevated diastolic blood pressure. Male students had significantly higher systolic (X^2 = 101.343, p = .005) and diastolic blood pressure readings (X^2 = 144.44, p < .001) compared to female students. There was no association between year in school and stress levels (X^2 = 315.83, p = .102). Stress and systolic blood pressure were not correlated (r = .121, p = .180) nor were stress and diastolic blood pressure (r = .075, p = .408). Following the educational initiative, 96% of students (n = 91) were able to accurately define elevated blood pressure, risk factors for hypertension, and strategies to lower blood pressure.

Conclusions: It is vital that blood pressure assessments become a priority for college students. These assessments must be followed by interventions aimed at reducing blood pressure levels, stress, and risk factors related to hypertension to prevent the long-term effects of cardiovascular disease. Healthcare providers on college campuses, including and perhaps most effectively students in health-related fields, should be involved in working with this population to increase awareness and screening efforts.

Keywords: blood pressure, college students, risk factors, hypertension, education, prevalence

Introduction

The prevalence of hypertension is a well-known public health problem in adults 60 years and older, much less is known about the prevalence of elevated blood pressure (BP) in young adults. Even fewer studies have examined elevated BP in college students.[1] Since college students are assumed to be generally healthy, elevated BP is often missed in this population. With the update in diagnostic criteria for lowering the threshold for non-normal blood pressure,[2] the prevalence of hypertension in college students may be even higher than previously noted.[3] In a cross-sectional study of 13,512 young adults in the United States, 69% of students were found to have an elevated BP or hypertension, and 75% of these same students were unaware that they had hypertension.[4] In a more recent study, 46% of apparently healthy and physically active college students had elevated BP or hypertension.[1] Data on the prevalence of elevated BP or hypertension among college students internationally is limited as well. In recent research, 44.9% of college students in India,[5] 8.5% in China,[6] 24.4% in Congo,[7] and 6.9% in Iran[8] were found to be hypertensive.

These rates of elevated BP and hypertension are higher-than-expected and may be due in part to multiple situations and behaviors that increase college students' risk.[9] Lifestyle behaviors are influential in developing elevated BP and hypertension, and the college years can be a time of changing and establishing life-long health behaviors. Situations that increase risk of elevated BP and hypertension include managing higher levels of stress related to educational experiences, such as not doing well in an important course, poor sleep habits, and change in an academic major.[10,11] Common stress producing events in life such as the loss of a parent, change in health, serious argument with a close friend, and insufficient sleep are also risk factors for this population.[11] Higher prevalence of anxiety and depressive disorders which have been increasing in college students have been linked to hypertension.[12-14] Other risk behaviors seen in college students could lead to elevated BP and include alcohol use and binge drinking,[15-17] as well as prioritizing fast food intake and not exercising regularly.[15] Elevated body mass index (BMI) has been associated with high BP in college students. BMI was significantly higher in students with hypertension as compared to those with normal BP.[1] Besides lifestyle factors, genetics and family history can play a role in the development of hypertension. College students who have two parents with hypertension have a significantly increased risk of hypertension.[18] Additionally, sex differences have been associated with hypertension as hypertension is more common in males.[19] While most of these multiple situations and risk factors can be mitigated, lack of knowledge of elevated BP or hypertension and how to prevent cardiovascular disease (CVD) in college students contributes to the need to recognize this public health concern. In fact, college students have a low awareness of hypertension. Surveys in the United States showed that only 35% of college students understand about hypertension.[20]

According to Zhang and colleagues, higher-than-normal BP levels before the age of 40 increase the risk of developing CVD later in life.[21] The prevalence of CVD has led to a significant societal burden, and unfortunately, the college years is a time when young adults tend to experience a decrease in cardiovascular health.[22] Reducing CVD can lead to reducing one of the leading public health causes of premature deaths. Since there is limited research on the rates of elevated BP and hypertension in college students, our goals were to add to the growing body of literature on the prevalence of elevated BP in college students and develop a campus wide educational initiative managed by undergraduate nursing students to identify risk and increase awareness.

Methods

Following IRB approval, undergraduate students at a faith-based, Midwestern university were recruited to participate in a cross-sectional study. Over one academic semester, students were recruited via course announcements, electronic flyers, and word-of-mouth across campus. Demographic data, BP readings, BMI, body water and fat percent, hypertension risk factors, family history, and perceived stress were assessed. A Google form was created to collect self-report data related to knowledge about hypertension along with health habits, perceived stress, social and family history, and other factors that affect blood pressure. The Student Stress Scale was used to assess stressors associated with college;[23] it is an adaptation of the Life Events Scale developed originally by Holmes and Rahe.[24] Scores on the scale range from 0 to 300+ with scores < 150 representing very little stress and scores 300+ indicating major stress and a high health risk within two years. BP assessments were standardized to ensure reliability and validity of measurements. BP was measured using an aneroid sphygmomanometer and cuff unit and stethoscope according to American Heart Association (AHA) guidelines for BP measurement. BP pressure was categorized as normal, elevated, stage 1 or stage 2 hypertension according to the 2017 ACC/AHA Guidelines.[25] An average of two readings was recorded as the individual's resting

BP. Undergraduate nursing student members of a student-faculty collaborative research team collected all data following training on the research and BP assessment protocols. It has been shown that members of an undergraduate collaborative research team have the skills to effectively manage a program of research when mentored by faculty.[26]

Once undergraduate students agreed to participate, they were instructed to fill out the assessment Google Form that contained the items related to their knowledge and risks for hypertension. Resting BP, along with body fat, body water, and BMI were measured. Weight, body water, and body fat were collected via the TANITA® Body Fat/Body Water Monitor with glass platform. BMI was calculated from the TANITA® weight measurement and self-reported height. Resting BP was measured following this initial data collection. Next, the participants were asked to sit while they were interviewed about recent exercise, smoking/vaping, food, caffeine, and alcohol intake. Once these interview questions were completed, students were directed to sit and relax for 10 additional minutes before the second BP reading was collected. Both BP readings were then averaged. After these assessments, all participants received education on hypertension, BP risk factors, stress reduction, and lifestyle measures to control BP. Assessment sessions were held in two quiet places on campus, either a room in the student union or the library.

Results

A total of 138 undergraduate students participated (see Table 1). The mean age of participants was 20.80 (SD = 1.33). The majority of students were male (52.9%), white (85.3%), junior year rank in school (37.9%), and from the college of nursing and health professions (31.1%). When asked "have you had a blood pressure assessment?", 83.5% of students indicated 'yes', with 82.0% recalled being told their BP results, and 71.4% recalled being told the category of their BP reading. For family history, 24.8% reported they had a family history of hypertension; 31.7% did not have a family history; and 43.5% were not sure if they had a family history. When asked about recent activities that might impact BP readings, 12.6% had alcohol in the last two hours, 42.7% consumed caffeine, 4.9% vaped or smoked, and 17.5% exercised.

To assess knowledge levels, college students were asked to indicate if they knew what blood pressure was and if they believed their BP readings had been normal in the past. When asked "what is blood pressure?", there was a significant difference in correctly identifying BP based on gender (X^2 = 14.652, p < .001) (female 70.8%, male 33.0%, and gender fluid 100%) (see Table 1). When asked if they believed their previous systolic BP (SBP) readings were normal, the majority of students (40.8%) believed their SBP was normal, with 42.9% indicating they were unsure if their SBP reading was normal and 16.3% believed the reading was not normal. For diastolic BP (DBP), 41.5% believed their reading was normal, with 39.4% reporting they were unsure and 19.1% believed the reading was not normal. Following the in-person assessments of BP by the undergraduate research team, 52% of students had an elevated SBP (M = 120.53, SD = 14.17), and 30.4% had an elevated DBP (M = 74.94, SD = 8.72) (see Table 1). For those with an elevated BP reading, 14.4% were within Stage 1 hypertension for SBP, and 25.6% were within Stage 1 for DBP.

Table 1. Demographic Characteristics, Risk Factors, and Blood Pressure Readings (n = 138)

	%	Mean	SD
Gender			
Female	46.1		
Male	52.9		
Gender Fluid	1.0		
Race			
White	85.3		
African American	5.9		
Hispanic/Latino	5.9		
Asian	2.9		
Year in School			
Freshman	18.4		
Sophomore	24.3		
Junior	37.9		
Senior	18.4		
Fifth Year	1.0		

College Area of Study			
Arts and Sciences	26.2		
Business	11.7		
Christ College (honors)	1.0		
Engineering	30.1		
Nursing and Health	31.1		
Professions			
Knowledge of BP			
Males			
Yes	33.0		
No	67.0		
Females			
Yes	70.8		
No	29.2		
Gender Fluid			
Yes	100.0		
Assessed Systolic Blood Pressure		120.53	14.17
<120 Normal	48.0		
120 – 129 Elevated	32.8		
130 – 139 Stage 1	14.4		
>139 Stage 2+	4.8		
Assessed Diastolic Blood Pressure		74.94	8.72
<80 Normal	69.6		
80 – 89 Stage 1	25.6		
>89 Stage 2	4.8		

Body Mass Index (BMI), percent body water, and percent of body fat were calculated. Based on readings from the TANITA® Body Fat/Body Water Monitor, the majority of students (males and females) were in the healthy body water percent and body fat percent range, but they were in the slightly above healthy range for BMI (see Table 2).

Table 2. Tanita Readings and Stress Levels

Body Water			
Males		52.85	8.69
Underhydrated (<43%)	5.1		
Hydrated (43-47%)	94.9		
Overhydrated (>47%)	0		
Females		53.81	10.08
Underhydrated (<43%)	6.7		
Hydrated (43-47%)	87.2		
Overhydrated (>47%)	13.1		
Body Fat			
Males		21.50	11.60
Under (<8)	10.3		
Healthy (8-20)	35.9		
Overfat (21-25)	25.6		
Obese (>25)	28.2		
Females		24.79	10.64
Under (<21)	33.3		
Healthy (21-33)	50.0		
Overfat (34-39)	10.0		
Obese (>39)	6.7		
BMI			
Males		25.33	6.74
Underweight (<18.5)	2.2		
Healthy (18.5 to <25)	62.6		
Overweight (25 to <30)	14.8		

Obese (30 or higher)	20.4	24.47	3.73
Females			
Underweight (<18.5)	0.0		
Healthy (18.5 to <25)	68.1		
Overweight (25 to <30)	23.4		
Obese (30 or higher)	8.5		
Stress Score		141.88	117.13
<150	58.7		
150 – 299	31.2		
300+	10.1		
Number of Stressful Events		3.83	3.06

Students reported the number of stressful events on the Student Stress Scale[15] ($M = 3.83$, $SD = 3.06$, range $= 0 – 16$) (see Table 2). A total of 58.7% of students reported very little stress, and 10.1% reported major stress greater than 300 on the Student Stress Scale. The top five stressful events included: increase in workload at school (67.2%), change in sleeping habits (45.7%), change in social habits (40.5%), getting lower grades than expected (38.8%), and change in eating habits (31.0%). Students employed a variety of healthy and unhealthy stress relieving habits (see Table 3). Stress and SBP were not correlated ($r = .121$, $p = .180$) nor were stress and DBP ($r = .075$, $p = .408$). As expected, students with the highest stress scores also reported experiencing a greater number of stressful events in their life and these events had the highest scores on the stress scale ($r = .937$, $p < .001$).

Table 3. Reported Stress Relieving Habits

Healthy Habits	%	Unhealthy Habits	%
Listening/Music	87.5%	Eating	38.5%
Exercising	70.2%	Drinking	14.4%
Talking/Others	67.3%	Smoking	5.8%
Relaxing/Exercise	39.4%	Vaping	5.8%
Gaming	39.4%	Using Other Drugs	2.9%
Meditating	31.7%		
Praying	30.8%		

There was no association between year in school and elevated BP ($X^2 = 122.334$, $p = .793$) or between year in school and stress levels ($X^2 = 315.83$, $p = .102$). Male students were found to have significantly higher SBP than female students ($X^2 = 101.343$, $p = .005$) (SBP: Male, $M = 125.3$, $SD = 76.1$; Female, $M = 117.6$, $SD = 7.6$). For DBP, males were found to have significantly higher readings than female students ($X^2 = 144.44$, $p < .001$) (DBP: Male, $M = 76.1$, $SD = 8.4$; Female, $M = 74.0$, $SD = 8.8$).

There was no significant difference in SBP and caffeine intake ($t = .685$, $p = .50$) (Yes caffeine intake, $M = 121.68$, $SD = 9.8$; No caffeine intake, $M = 120.51$, $SD = 9.09$) and no significant difference in DBP and caffeine intake ($t = .563$, $p = .57$) (Yes, $M = 75.79$, $SD = 7.90$; No, $M = 74.93$, $SD = 8.85$). There was no significant difference in SBP and alcohol intake ($t = .318$, $p = .75$) (Yes alcohol intake, $M = 121.73$, $SD = 9.82$; No alcohol intake, $M = 120.91$, $SD = 9.36$), and no significant difference in DBP and alcohol intake ($t = -.047$, $p = .963$) (Yes, $M = 75.20$, $SD = 8.52$; No, $M = 75.31$, $SD = 8.46$). Since the total number of students who reported smoking/vaping was low, testing for differences was not completed.

EDUCATIONAL INITIATIVE AND INTERVENTIONS
After interpretation of the data and finding a lack of knowledge, the team concluded there was a need to implement more targeted educational interventions for greater awareness about BP, hypertension, and risks factors. As future healthcare providers who will be impacting public health regionally, nationally, and globally, it was unacceptable to the team to have identified a potential public health risk and not develop an intervention to begin the dissemination of information.

One educational tool was the development of four posters. Each poster included specific information on one of four areas: risk factors, stress reducing techniques, complications of hypertension, and student resources on campus. Individual posters were placed in various areas around campus such as residence halls, the student union, academic

buildings, the library, and the fitness center to encourage students to find all four poster displays. The posters were disseminated in the month of October with a Halloween theme with the thought that hypertension in college students, along with their lack of knowledge regarding hypertension, is a frightening topic. The team also provided students with a QR code on each poster that led them to a site which contained all four educational posters and a short Google survey measuring their knowledge about hypertension from reading the posters. Students who completed the survey were randomly entered into a raffle to win prizes to increase the response rate. This survey not only gave students the opportunity to test their knowledge, but also allowed the team to determine if the educational interventions were effective across campus. A total of 91 students responded, with a correct average score of 95.88% on the survey knowledge assessment.

An additional educational intervention included using social media platforms to provide awareness in a manner that is more likely to reach the targeted student population. A systematic review and meta-analysis of eight randomized controlled trials indicated use of social media was an effective way to deliver messages and resulted in positive behavior change.[27] An advantage of these platforms is the ability to reach many students. Undergraduate student members of the research team developed a video by randomly interviewing students around campus. Students were asked questions about hypertension and its risk factors. A variety of answers, correct and incorrect, were found. Several responses were humorous adding to the appeal of the video for viewing by the college population. This video was posted on Tik Tok, Instagram, and Facebook.

Discussion

The rates of elevated BP in college students in this study were higher than those reported in much of the literature,[6-8] but similar to the most recent findings of healthy and physically active college students in the United States.[1,5] Considering that over half of the students in this study had elevated SBP and nearly one-third had elevated DBP, the findings add further support to the growing public health concern for young adult/college students. Additionally, according to ACC/AHA guidelines,[25] over 14% of the students' SBP readings were within the Stage 1 classification for hypertension and nearly 5% were within Stage 2 classification, while nearly 25% had DBP readings within Stage 1 and nearly 5% within Stage 2. The assumption that college students are apparently healthy as it relates to hypertension and the potential

development of CVD may be a fallacy. While the BP assessments in this study were not completed to diagnose hypertension, the rates of elevated BP supported the need to refer these students to healthcare providers for assessment, lifestyle changes, and potential diagnosis and treatment interventions.

Significantly more males had elevated BP readings similar to the literature.[3,5] The prevalence of higher BP readings in males mimics the findings for all adult age groups. Evidence demonstrates that BP is consistent between the sexes until puberty, and after this time in development, males continue to have higher BP levels.[19] While blood pressure varies significantly based on sex, there are no sex or even gender-specific standards of care to reduce BP.[19] Thus, educational efforts to reduce blood pressures must focus on all potential risks and risky behaviors prevalent in male and female college students.

Several risk factors which can impact the development of hypertension were not related to elevated BP in this study but have been linked in a few studies.[9-11] Very few students had smoked/vaped, consumed alcohol, or exercised in the last two hours; thus, it was not surprising that these behaviors were not related to their BP readings. Even if these risk factors were not linked within this study, over time, these risk factors can have a cumulative effect on health and the development of CVD. Chronic diseases such as hypertension necessitate lifelong lifestyle changes. As demonstrated in this study, college students are often unaware of what blood pressure is and what factors can contribute to elevated BP risk. This lack of knowledge was found in supporting literature as well.[20] A lack of knowledge about hypertension can negatively influence young adults and college students' awareness and behaviors.[1,4] Results demonstrated more female college students were able to define BP correctly. This result is not surprising as more students were from the college of nursing and health professions, who are routinely exposed to information on cardiovascular health, and these students were predominately female in this sample. Educating college students about hypertension and individual risk factors such as increased BMI, use of alcohol, use of tobacco/vaping products, poor eating habits, lack of exercise, and college stressors, as well as knowing family history, are important foundational teaching points. General education provided during the college years can lead to a better understanding of health habits and their impact on future chronic diseases such as CVD.

While self-reported stressors were not significantly related to BP levels, 42% of students reported levels of stress that should be of concern. These rates of stressful experiences were similar to those reported by college students in the literature and should be of concern for the immediate health of students but also for the long-term effects from stress.[10,11] Evidence supports that the cumulative effects of stress producing events can lead to an increased risk of elevated BP and hypertension.[10,11] While students reported several unhealthy stress relieving habits, more students reported healthy habits such as listening to music, exercising, relaxing, and praying. These stress reducing habits should be encouraged in the college population and could have a positive cumulative lifestyle effect over time. The team did not measure the frequency, the recency, nor length of time these habits had been employed. Gathering additional data about the effect of stress relieving habits on student stress levels are needed.

Findings further support the ability of undergraduate nursing students to provide successful educational efforts.[16,28,29] As seen in this study, the undergraduate research team was able to develop an easily accessible, educational initiative available to students on campus. Using social media to educate students is a cost-effective means for disseminating accurate information to a large number of college students. Additionally, the use of students enrolled in health-related fields, such as nursing, provides leadership opportunities and adds credibility to these educational efforts. Not only are the nursing students' peers to the college population, but they also have knowledge about hypertension and how to best reach this population. Thus, college students may be more likely to value education from their peers and heed their advice to promote improved cardiovascular health.

The prevalence of hypertension in college students is understudied.[1] To complicate the public health concern about the prevalence of hypertension, the college population already exhibits signs of poor mental health, poor health choices, and an inability to practice self-care.[12-14] It is vital that healthcare providers on college campuses, including and perhaps most effectively students in health-related fields, be involved in working with this population. Ideas include educating practitioners that work with this population (e.g. student health centers and general practitioners) as well as disseminating information in journals such as this one. Additionally, supporting college policies that provide for nutritious food services and equitable physical activity opportunities to promote wellness could assist with hypertension prevention.[3] Providing

education about other risk behaviors that may be initiated while at college are also important to consider, such as smoking/vaping and using alcohol.[28,29] Without further screening and education, the cycle of hypertension and its related complications will continue to plague our healthcare system.

LIMITATIONS
The findings of this study should be considered in relation to its limitations. A convenience sample was used, which is associated with selection bias. Since students were self-reporting behaviors related to risk factors, their responses may be subject to social desirability bias and thus they may have underreported their unhealthful habits and behaviors. Obtaining objective measures of their health habits would have enhanced the validity of the results. The design was cross-sectional so causal inferences cannot be drawn but would be strengthened by a longitudinal design to assess potential changes in BP readings over time and after educational initiatives. Initially the methodology of this study included repeated measures design; however, most students failed to return for a second assessment limiting the ability to report these data. The assessment of BP was completed as a screening event. The true prevalence of hypertension in this study population cannot be determined because of a single assessment. However, other studies have reported similar rates of elevated BP, and strategies to accurately measure BP were followed. Findings also lack racial and ethnic diversity, but those who were screened are representative of the student population at the study university. A broader population from multiple colleges and universities would further add to the growing body of literature aimed at addressing the prevalence of elevated BP and hypertension in young adult, college students.

Conclusions
The findings from this study have practical implications. College students who self-reported as being healthy had elevated blood pressures, and the rates in this sample were slightly higher than those reported in the literature. Student services on college campuses should plan educational efforts to address the need for students to seek health assessments. Student health centers provide resources to offer these assessments. Additionally, campuses with nursing and health-related majors should design outreach clinical experiences within the curriculum to offer BP assessments and education to students across campus. Students who are found to have elevated BP should be directed to seek care from a college student health center or seek care from their usual provider. Education should address

strategies to manage the stressful events associated with being a college student. Stressful events may lead students to adopting some of the unhealthy behaviors reported by college students, such as excessive drinking, smoking/vaping, and poor eating habits which over time can affect BP and CVD. These assessment efforts could be effective in identifying elevated BP in apparently health college students and form a foundation to attenuate the risk of developing CVD later in life.

There is a potentially crippling public health crisis currently ongoing. The available research on elevated BP and hypertension in college students is limited, although some information is beginning to emerge. Findings from this study reveal the alarming prevalence of elevated BP in apparently healthy college students and their lack of awareness of what BP is and its risk factors. This information needs to be explored, re-studied, and disseminated to all healthcare professionals who care for this population. The college experience should help students prepare to meet life's uncertainties. One of those uncertainties may be the development of CVD because of unknown hypertension developed during college. Efforts to screen college students and offer education on the prevention of hypertension is needed. It is essential that BP screening happen early and regularly in college students.

Conflicts of Interest Statement
The authors declare that there are no conflicts of interest.

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