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Original Article

Prevalence of pre-hypertension and hypertension and its related risk factors among undergraduate students in a Tertiary institution, Ghana

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ABSTRACT

Objectives: This study sought to provide information about pre-hypertension and hypertension status among undergraduate students at the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana.

Methods: This cross-sectional study was conducted among a total of 540 students. Participants were interviewed using questionnaires and their blood pressures (BP), height, weight were measured and Body Mass Index 'BMI' and Waist-to-Height Ratio (WHtR) were calculated. Repeated measurements were obtained on two successive times in students with persistently elevated BP. Data obtained was entered and analyzed using SPSS version 23. Final prevalence was adjusted for loss-to- follow up on participants with first elevated BP from the reading and logistic regression used to evaluate risk factors. *P*-value less than .05 was considered statistically significant.

Results: Twelve (2.2%) of the students were hypertensive, whilst pre-hypertension was prevalent in 26.1% of the student. Family history of hypertension [OR = 1.68(0.73–1.68)], kidney failure [OR = 1.38(0.34–5.60)], stroke [OR = 1.10(0.64–1.91)] and heart failure [OR = 1.03(0.27–3.94)] were associated with increased risk of developing pre-hypertension; however no significant association was observed ($p > .05$). WHtR and BMI were independent positively correlated with blood pressure status after controlling for gender and age ($p < .05$). Further analysis revealed that, obesity detected by WHtR [OR = 3.67 (1.13–11.94), $p = .031$] and BMI [OR = 6.89(0.71–66.48), $p = .0005$] were significant predictors of hypertension using logistic regression analysis.

Conclusion: The study revealed considerable prevalence rates of pre-hypertension and hypertension among undergraduate students, with significant risk factors such as obesity detected by BMI and WHtR. Gender as male was also significant for pre-hypertension and hypertension. Sound prevention and control programmes of hypertension should be devised among students, to improve their knowledge and lifestyle practices early in life.

1. Introduction

Hypertension also known as high blood pressure (HBP) is a non-communicable disease, which is associated with high morbidity and mortality. The disease is a silent threat to the health of people all over the world,[1] with up to one third of world population affected.[2] In 2010, hypertension caused greater than 7 million deaths globally.[3] Hypertension doubles the risk of cardiovascular diseases (such as coronary heart diseases, congestive heart failure, peripheral arterial diseases, and stroke), and renal failure.[4] The situation is not different in Ghana where the disease has contributed

Abbreviations: HBP, high blood pressure; BMI, Body Mass Index; WHR, waist-to-hip ratio; WHtR, waist-to-height ratio; WC, waist circumference; HC, hip circumference.

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to the alarming prevalence of heart and renal failure.[5] Pre-hypertension is a precursor of clinical hypertension and consequently of cardiovascular disease.[7] The term pre-hypertension was introduced as a new class of blood pressure by the 7th Joint National Committee on Prevention, Detection, Evaluation and Treatment of Hypertension. The committee proposed that a systolic BP between 120 and 139 mmHg and/or diastolic BP between 80 and 89 mmHg is indicative of a pre-hypertensive state.[6] Subjects with pre-hypertension have higher chance of developing hypertension later and increased risk of major cardiovascular events independent of other risk factors.[8] Hypertension is common in the aged individuals. There are a number of modifiable risk factors of hypertension which include diet, physical activity, diabetes, obesity and smoking. The relationship between increasing age and rise in systolic blood pressure is suspected to emulate from the length of time people are exposed to these modifiable risk factors. Generally, both hypertension and pre-hypertension are significantly more prevalent in males than females and this is possibly due to the differences in hormonal activity between males and females in early life.[9,10] Hypertension is also more common in some ethnic groups, for example it is more prominent in black Caribbean males and females, and less common in Bangladeshi males and females.[11] Stewart and his colleagues considered such differences in prevalence of the disease to be associated with inherited variations in the way the body reacts to salt.[12] Remarkably, there is a paucity of data in Ghana indicating prevalence of hypertension and its risk factors among teenagers and young adults, as they are considered to be at a lower risk of developing the disease.[13] With growing problem of hypertension worldwide, there is a concern that hypertension in young adults may also be on the rise and that cases are not detected because of inadequate screening in this age group.[14] However, most countries where research has been carried out among young adults indicated a rise in hypertension and/or pre-hypertension.[15,16] Therefore, it is against this background that this study sought to determine the prevalence of pre-hypertension and hypertension among undergraduate students in KNUST and to evaluate risk factors related to the disease.

2. Patients and methods

This was a cross-sectional study used for assessing the prevalence of pre-hypertension and hypertension among undergraduate students in KNUST from February to April 2016. KNUST is a public university located in Kumasi in the Ashanti Region of Ghana. The main university campus which is about 7 square miles in area is situated about 8 miles (13 km) to the east of Kumasi. There are 6 halls of residence at the main campus. The university has about 42,000 undergraduate students and it consists of 6 colleges.

2.1. Ethical approval

Ethical approval was obtained from the Committee on Human Research, Publications and Ethics of School of Medical Sciences at Kwame Nkrumah University of Science and Technology, and Komfo Anokye Teaching Hospital, Kumasi, Ghana. Permission to carry out the study on the University campus was obtained from the University authorities. Informed consent was also sought from students before recruitment.

2.2. Sample population and sample size and selection criteria

Using a simple random sampling stratified by the 6 colleges, a total of 540 students from the first to fourth academic year were recruited for the study with 100 students each from the Colleges of Art and Built, Social Sciences, Health Sciences, Engineering, Sciences, and Architecture; and 40 students from College of Agriculture. Undergraduate students who had hearing impairment were not included in the study. Well structure questionnaires were administered to the participants to obtain socio-demographic (age, gender, religion) and lifestyle risk factors (drinking of alcohol and smoking) information. All questionnaires were verified for completed information and participant with completed data had their blood pressure and anthropometric parameters measured.

2.3. Sample size determination

A total of 540 students were recruited from a population of 42,000 students at KNUST using an assumed distribution response rate among the respondent at 50%, at 95% confidence interval (z-score 1.96). Using the Cochran's formula,[17] the minimum size required was 381. However, to accommodate a non-response rate of 10.0% and stronger statistical power and effect size, the samples were projected to 540 students.

2.4. Blood pressure measurement

Blood Pressure (BP) was recorded after subjects had relaxed for at least 5 min. Measurements were taken with the subject being in the seated position using a mercury sphygmomanometer and by an automated BP monitor (Omron HEM-5001, Kyoto, Japan) placed on the subject's right arm. Measurement was done two times, and the average reading was recorded. Repeated measurements were obtained on two successive times, six (6) hours apart in students with persistently elevated blood pressure.

2.5. Anthropometric measurements

Body weight was measured using an automated scale. Portable Height Rod Stadiometers were used for body height to the nearest centimeters. The subject stood straight, with feet placed together and flat on the ground. Body Mass Index (BMI) was calculated as body weight divided by height squared (kg/m^2). With respect to the BMI, there were four groupings of subjects: under-weight (BMI < 19 kg/m^2), normal (BMI between 19 and 24.9 kg/m^2), over-weight (BMI between 25 and 29.9 kg/m^2) and obese (BMI > or = 30 kg/m^2).[18] Hip Circumference (HC) was measured at the level of maximal gluteal protrusion and waist circumference at the mid-point between the anterior superior iliac crest and the lowest rib using a tape measure while the subject stood with feet 25–30 cm apart. The tape measure was placed directly on the skin. Patients were allowed to breathe out normally and measurements were taken. The tape was held lightly so as not to compress the skin. Waist circumference was measured at the point of the umbilicus. Waist-to-Height Ratio (WHtR) and Waist-to-Hip Ratio (WHR) were calculated as WC (cm) divided by height (cm) and HC, respectively.

WHR was also defined for both males and females with WHR < 0.90 and $\geq$ 0.90 defined as normal and risk respectively, for males <0.80 and $\geq$0.80 defined as normal and risk respectively, for females. With WHtR < 0.5 is considered normal and $\geq$0.5 is considered risk.[19]

3. Data analysis

The data were coded, entered and analyzed using IBM Statistical Package for the Social Sciences (SPSS) software 23. Descriptive statistics were performed and data were presented as frequency and percentage. Chi-square test was employed for group comparison. Pearson's correlation was performed to determine linear correlation. The p-value of $\leq$.05 was considered as significant. Final prevalence was adjusted for loss-to- follow up on participants with

first elevated BP from the reading and binary logistic regression used to evaluate risk factors.

4. Results

4.1. Socio-demographic characteristics

The majority, 325 (60.2%), of the students were male and students living in urban areas (88.1%) were higher compared to those living in rural areas. Third year students were the highest frequency represented group to take part in the study (41.7%) and predominate of the study population were single (99.3%). With respect to gender, significantly higher percentage of males were pre-hypertensive (69.5%, p-value .006) compared to females participants whereas significantly higher percentage were normal (43.7%, p-value .006). Students in fourth year were significantly less likely to be pre-hypertensive (p = .014) **[**Table 1**].**

4.2. Blood pressure status, anthropometry, lifestyle and family history

Overall, **t**welve (2.2%) students were hypertensive whiles 26.1% and 71.7% had pre-hypertension and normal blood pressure, respectively [Fig. 1].

The majority of the participants had a normal BMI (73.7%), while 13.1% were overweight, 5.4% were obese and 7.8% were underweight (Table 2). Whiles WHtR categorizes 17.4% of the students at risk, WHR classified only 8.0% of the students at risk. About 18.0% of the participants were alcohol drinkers. Students smoking cigarette were 2.0%. Most of the participants eat junk food (59.4%) and majority of them were involved in physical activities (70.2%) **[**Table 2**].**

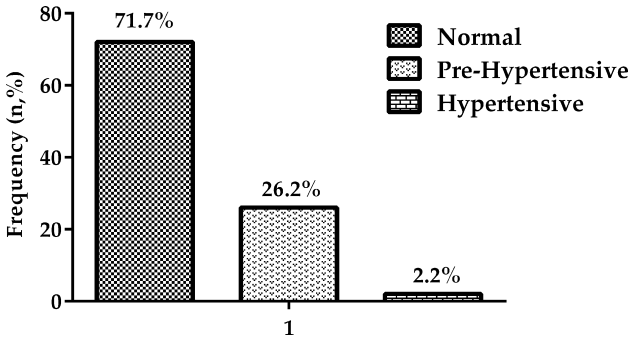

Fig. 1. Blood pressure status chart of the study participants.

As shown in Table 3, students with the family history of hypertension [OR = 1.68(0.73–1.68)], kidney failure [OR = 1.38(0.34–5.60)], stroke [OR = 1.10(0.64–1.91)] and heart failure [OR = 1.03(0.27–3.94)] were associated with a greater likelihood of developing pre-hypertension; however, the association was not statistically significant (p > .05).

As shown in Table 4, WHtR (p < .0001) and BMI (p < .0001) were independent positively correlated with systolic and diastolic blood pressure after controlling for gender and age.

Table 1
Socio-demographic characteristics of study participants stratified by blood pressure status.

Variables	Total	Hypertensive	Pre-hypertensive	Normal	P-value[a]	P-value[b]	P-value[c]
Age groups							
<18	1(0.2%)	0 (0.0)	1 (0.7)	0 (0.0)	.772	NA	.097
18–20	235(43.5%)	5 (41.7)	64 (45.4)	166 (42.9)	.803	.936	.610
≥21	304(56.3%)	7 (58.3)	76 (53.9)	221(57.1)	.764	.936	.509
Residency							
Urban	478(88.1%)	12 (100.0)	128 (90.8)	336 (86.8)	.271	.177	.219
Rural	64(11.9%)	0 (0.0)	13 (9.2)	51 (13.2)	.271	.177	.219
Gender							
Male	325(60.2%)	9 (75.0)	98 (69.5)	218 (56.3)	.689	.197	**.006**
Female	215(39.8%)	3 (25.0)	43 (30.5)	169 (43.7)	.689	.197	**.006**
Colleges							
Engineering	100(18.5%)	3 (25.0)	33 (23.4)	64 (16.5)	.897	.441	.072
Health Science	100(18.5%)	4 (33.3)	29 (20.6)	67 (17.3)	.303	.153	.390
Arts & Built	100(18.5%)	3 (25.0)	31 (22.0)	66 (17.1)	.810	.471	.197
Science	100(18.5%)	1 (8.3)	20 (14.2)	79 (20.4)	.569	.303	.105
Social Science	100(18.5%)	0 (0.0)	19 (13.5)	81 (20.9)	.162	.075	.053
Agriculture	54(7.4%)	1 (8.3)	9 (6.4)	30 (7.8)	.795	.944	.596
Year of study							
1st Year	93(17.2%)	4 (33.3)	26 (18.4)	63 (16.3)	.211	.119	.337
2nd Year	158(29.3%)	2 (16.7)	42 (29.8)	114 (29.5)	.337	.337	.944
3rd Year	225(41.7%)	6 (50.0)	64 (45.4)	155 (40.1)	.757	.490	.271
4th Year	64(11.9%)	0 (0.0)	9 (6.4)	55 (14.2)	.368	.159	**.014**
Religion							
Christianity	462(85.6%)	11 (91.7)	121 (85.8)	330 (85.3)	.569	.535	.873
Islam	74(13.7%)	1 (8.3)	19 (13.5)	54 (14.0)	.610	.575	.889
Traditional	2(0.4%)	0 (0.0)	0 (0.0)	2 (5.0)	NA	.803	.390
Others	2(0.4%)	0 (0.0)	1 (0.7)	1 (3.0)	.772	.857	.452
Marital status							
Single	536(99.3%)	12 100.0)	140 (99.3)	384 (99.2)	.772	.757	.936
Married	3(0.6%)	0 (0.0)	1 (0.7)	2 (5.0)	.772	.803	.795
Divorced	1(0.2%)	0 (0.0)	0 (0.0)	1 (3.0)	NA	.857	.549

NA, not applicable. Categorical data was presented as percentage and compared to each other using Chi-square analysis. All bold numbers are significant at 95% confidence interval.

[a] Hypertension vs. pre-hypertension.
[b] Hypertension vs. Normal.
[c] Normal vs. Prehypertension.

Table 2
Anthropometry and lifestyle characteristics of study participants.

Anthropometry and lifestyle characteristics	Frequency n = 540	Percentage (%)
BMI (kg/m²)		
Underweight	42	7.8
Normal	398	73.7
Overweight	71	13.1
Obesity	29	5.4
WHR		
Normal	497	92.0
Risk	43	8.0
WHtR		
Normal	446	82.6
Risk	94	17.4
Alcohol intake		
Yes	97	17.0
No	448	83.0
Drinks/Day		
None	448	83.0
1 or 2	75	13.9
3 or 4	12	2.2
5 or 6	4	7.0
7 or 9	1	2.0
Smoking		
Yes	11	2.0
No	529	98.0
Exercise		
Yes	379	70.2
No	161	29.8
Salty food		
Yes	196	36.3
No	344	63.7
Junk food		
Yes	321	59.4
No	219	40.6
Fruits &Vegetable/Week		
None	212	39.3
1–2 Times	113	20.9
3–4 Times	119	22.0
5–7 Times	96	17.8

BMI = Body Mass Index, WHR = Waist-to-hip ratio, WHtR = Waist-to-height ratio.

Obesity detected by WHtR was associated with increased risk of prehypertension [OR = 1.16(0.70–1.93) p = .558] and hypertension [OR = 3.67(1.13–11.94), p = .031], however, the association was significant only for hypertension. Obesity identified by BMI was significantly associated with increased likelihood of hypertension [OR = 6.89(0.71–66.48), p = .0005] **[**Table 5**]**.

5. Discussion

Non-communicable diseases such as hypertension have been largely ignored in African countries such as Ghana, because of the over-powering effect of poverty-related diseases such as malaria and other infectious diseases.[20] Recent suggestions indicate the rise of non-communicable diseases (hypertension) among old adults in Ghana,[20–22] which has necessitated the need to screen the young adult population for early diagnosis and proper management/treatment of the condition. Therefore, this study aimed to determine the prevalence of prehypertension and hypertension among students at KNUST, Ghana. In this study, 26.1% of the participants had pre-hypertension; this is similar to the 27.1% prevalence, which was found in a university in Palestine.[23] However, other studies have found rather higher prevalence of prehypertension among undergraduate students such as the 42.9% in Malaysian university,[16] 40.0% in Columbia[15] and 39.5% in Kuwait.[24] This probably could be due to the loss-to-follow up situation met among participants with persistently elevated blood pressure in the first two readings for final validation and prevalence estimation adjusted for loss-to- follow up. Contextual lifestyle has been shown to be associated with the incidence of pre-hypertension and hypertension.[25,26] Therefore differences in context were a probable reason for the differences in prevalence.

The prevalence of hypertension obtained in this present study was 2.2%; which is lower than 7.4% hypertension prevalence found among university students in Gondar, Ethiopia,[27] 19.3% prevalence of hypertension reported in a study from Nigeria,[28] 35.1% among students from a study in Tunisia[29] and 38.0% among university students from a study in Gambia.[30] Differences in sampling methods used might have introduced sampling bias and posed effect on

Table 3
Association between family history of study participants and their blood pressure status.

Family history	Hypertensive	Pre-hypertensive	Normal	P-value*	P-value#	OR(95% CI)*	OR(95% CI)#
Hypertension							
Yes	5 (0.9)	43 (7.9)	110 (20.4)	.642	.325	1.68(0.73–1.68)	1.80(0.56–5.79)
No	7 (1.3)	98 (18.1)	277 (51.3)	–	–	1	
Heart failure							
Yes	0 (0)	3 (0.5)	8 (1.4)	.966	–	1.03(0.27–3.94)	–
No	12 (2.2)	138 (25.5)	379 (70.1)	–	–	1	–
Kidney failure							
Yes	0 (0)	3 (0.5)	6 (1.1)	.652	–	1.38(0.34–5.60)	–
No	12 (2.2)	138 (25.5)	381 (70.6)	–	–	1	–
Stroke							
Yes	1 (0.2)	21 (3.8)	53 (9.8)	.726	–	1.10(0.64–1.91)	0.57(0.07–4.53)
No	11 (2.0)	120 (22.2)	334 (61.8)	–	–	1	–
Diabetes							
Yes	3 (0.5)	36 (6.6)	107 (19.8)	.662	.696	0.91(0.58–1.40)	1.28(0.37–4.32)
No	9 (1.6)	105 (19.4)	280 (51.8)	–	–	1	1
Ischemic HD							
Yes	0 (0)	1 (0.2)	6 (1.1)	.466	–	0.45(0.05–3.80)	–
No	12 (2.2)	140 (25.9)	381 (70.6)	–	–	1	–
Obesity							
Yes	0 (0)	4 (0.7)	15 (2.7)	.220		0.72(0.24–2.22)	–
No	12 (2.2)	137 (25.3)	372 (68.9)	–		1	–

HD, heart disease, OR, odds ratios.
* Predictive of family history of risk factors for pre-hypertension.
# Predictive of family history of risk factors for hypertension.

Table 4
Partial correlation between blood pressure status of participants and their anthropometric measurements.

Variables		Systolic blood pressure	Diastolic blood pressure
BMI (kg/m²)			
	r	0.187	0.195
	p-value	<.0001	<.0001
WHtR			
		0.132	0.168
	p-value	.002	<.0001
WHR			
	r	−0.046	−0.045
	p-value	.287	.296

r = Correlation Coefficient, BMI = Body Mass Index, WHR = Waist-to-hip ratio, WHtR = Waist-to-height ratio.

statistical power which might have generated such differences. Contextual factors and lifestyle differences relative to study participants was also a factor that could be attributed to the differences in hypertension prevalence. Differences may also be due to differences in data collection methods, population age groups studied, and time. Gender is closely linked to development of certain diseases. From this study, the percentage of males that had hypertension was significantly higher than females, an observation that had been proven in several studies.[4,24,29]

The prevalence of overweight and obesity as well as other modifiable lifestyle factors such as smoking and alcohol intake have been implicated in the pathogenesis of pre-hypertension and hypertension development.[13,31] This present study reported a significant association between pre-hypertension development, hypertension development and obesity indices (BMI and WHtR). Increasing BMI was associated with the increased likelihood of developing pre-hypertension; however, the significance of central obesity measurements predictive of hypertension was seen with increasing WHtR measurements. Several studies have reported similar outcomes which support the present findings.[32,33] It is also vital to comment that overweight and obese people were at higher risk of hypertension compared to normal BMI, a similar outcome was reported in a study among university students in Gondar, Ethiopia.[27] Contrasting other studies,[34,35] alcohol intake, smoking, salt intake and inactive lifestyle was not significantly associated with the prevalence of pre-hypertension and hypertension. This might be due to the low prevalence of these factors in the community studied. Family history of hypertension, kidney failure, stroke and heart failure were associated with a greater likelihood of developing pre-hypertension, however, the association was not statistically significant. Hypertension has been reported to be about twice as common in subjects who have one or two hypertensive parents,[36] and many epidemiological studies propose that genetic factors account for nearly 30% of the variation in blood pressure in various populations. Experimental models of genetic hypertension have shown that the inherited tendency to hypertension resides primarily in the kidney[36] which consistently could elaborate the findings of this present study. Although, findings in this study are comparable to other studies, there were some limitations. This was a cross-sectional study conducted with small sample size which limited our ability to explain the causal correlations between risk factors, pre-hypertension and hypertension. Moreover, echocardiography was not performed for the positive cases for hypertension and pre-hypertension in the study.

Table 5
Binary logistic analysis of anthropometric measurements for predicting hypertension and pre-hypertension among participants.

Variables	Pre-hypertension		Hypertension	
	OR (95% CI)	P-value	OR (95% CI)	P-value
WHtR				
Normal	1	–	1	–
Risk	1.16(0.70–1.93)	.558	3.67(1.13–11.94)	**.031**
WHR				
Normal	1	–	–	–
Risk	0.73(0.34–1.57)	.422	1.07(0.13–8.64)	.947
BMI				
Underweight	1	–	1	–
Normal	1.07(0.50–2.27)	.855	0.53(0.06–4.69)	.569
Overweight	1.55(0.65–3.70)	.324	1.35(0.12–15.51)	.811
Obese	1.21(0.39–3.72)	.742	6.89(0.71–66.48)	**.005**
Alcohol Intake				
No	1	–	1	–
Yes	1.01(0.66–1.54)	.728	1.53(0.41–5.82).	.528
Exercise				
No	0.99(0.65–1.51)	.967	O.78(0.21–2.93)	.779
Yes	1	–	1	–
Salt consumption				
No	1	–	1	–
Yes	0.83(0.55–1.24)	.354	0.33(0.07–1.53)	.156
Junk food intake				
No	1	–	1	–
Yes	0.79(0.53–1.16)	.227	0.92(0.28–2.94)	.915

WHtR, waist-to-height ratio, WHR, waist-to-hip ratio, BMI, body mass index, OR, odds ratios, CI, confidence interval, p < .05 is statistically significant.

6. Conclusion

The study revealed considerable prevalence rates of pre-hypertension and hypertension among undergraduate students, with risk factors such as male gender, obesity detected by BMI and WHtR, while family history of hypertension and kidney failure exhibiting a possible influence in the development of pre-hypertension and hypertension. Sound prevention and control programmes should be devised among students, to improve their knowledge and lifestyle practices early in life. Moreover, parents as well as school and health authorities need to work more toward creating awareness about hypertension in young people.

Compete of interest

Authors of this article have no competing interest.

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