Prevalence of Hypertension and Prognosis of Associated Dysfunction on Specific Organ Function among Ghanaian Adolescent Students

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Original Research Article

ABSTRACT

Aims: To determine prevalence of hypertension among adolescent students and prognosis of associated dysfunction on specific organ function among adolescent students.
Study Design: A cross-sectional study
Place and Duration of Study: Three senior high schools (SHS) in Ashanti region of Ghana, namely Anglican SHS, Konongo Odumase SHS and Bonwire SHS, between October 2016 and March 2017.
Methodology: A multi-stage sampling method was used to select 909 adolescents from the three SHS. Participants were screened for elevated blood pressure. A total of 142 participants had high blood pressure and were used for this study. Anthropometries; body mass index (BMI), percent body fat (%BF), visceral fat (VF), waist circumference (WC) and blood pressure levels were measured with recommended instruments and biochemical and haematological parameters were assessed. Sociodemographic data were taken with questionnaire.
Results: Out of 909 adolescent students, the prevalence of high blood pressure from first screening was 9.1%. However, upon second screening from those with high blood pressure from the first screening, prevalent rate for high blood pressure had declined to 1.21%. Hypertension was higher in males (10.7%), compared to females (4.5%, *P*= 0.658). There were no significant differences between BMI (*P*= 0.847), %BF (*P*= 0.501), VF (*P*= 0.195), WC (*P*= 0.450) among hypertensive, pre-hypertensive and normotensive participants. There was no significant mean difference between urea (*P*= 0.236), creatinine (*P*= 0.995), serum sodium (*P*= 0.126), serum chloride (*P*= 0.516), serum potassium (*P*= 0.878) and alanine aminotransferase (ALT) levels (*P*= 0.397) and blood pressure status. Total cholesterol (*P*= 0.765), triglycerides (*P*= 0.381), HDL (*P*= 0.777) and LDL (*P*= 0.768) was not significantly associated with blood pressure status.
Conclusions: Participants had high blood pressure level. Despite the prevalence of high blood pressure among adolescent population, it had no impact to cause any dysfunction in kidney, cardiovascular and liver. Hence, appropriate diet and lifestyle management are needed to prevent early and/or future complication of hypertension among adolescents.

Keywords: High blood pressure; organ function; Ghanaian adolescents; hypertension.

ABBREVIATIONS

TCHOL : Total Cholesterol
HDL : High density lipoprotein
LDL : Low density lipoprotein

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1. INTRODUCTION

The prevalence of hypertension among adolescents has become an emerging health problem across the globe [1]. Hypertension is a non-communicable disease that is very common and affects both male and female adolescents of all races [2]. It is detected when the Systolic Blood Pressure (SBP) is greater than 140 mmHg or Diastolic Blood Pressure (DBP) is greater than 90 mmHg or a combination of both [3]. It can be classified as pre-hypertension, essential hypertension and secondary hypertension [4]. Within the age group of 3 to 18 years, the prevalence of pre-hypertension is 3.4 % and the prevalence of both essential and secondary hypertension is 3.6 % [5]. A hypertensive individual is susceptible to increased cardiovascular diseases such as ischemic heart disease, left ventricular hypertrophy and pathological vascular changes and renal failure [6]. It is also identified to be associated with a high risk of chronic kidney disease, cerebro- and cardiovascular diseases and insulin resistance. The hazard ratio of cerebrovascular disease is 1.41 and that of cardiovascular disease is 2.0 in male and female respectively [7,8]. Consequently, it is argued that cardiovascular diseases have resulted in the death of approximately 16.7 million in the adult population in both developed and developing countries. This figure is expected to increase to about 23 million, with an increasing rate of 37.72 % by the year 2030 [9]. This portrays the risky nature of hypertension on the adolescent population [10]. Kaerney *et al.* [11] describe the disease as a silent threat to the health of a population. This is because records indicate that about 1 billion adult population worldwide had hypertension in 2000. This figure is expected to increase to about 1.56 billion by 2025 [11].

In Ghana, the prevalence rate of hypertension among adolescent is increasing and this has become a major concern to health practitioners. In Ashanti region, a prevalence of 28% was reported by Cappucio *et al*. [12]. Though researches have been done on the prevalence of hypertension in Ghana and other countries, data on adolescent hypertension and its effects on organs function are very scarce [13]. The consequences of adolescent hypertension are spreading across the globe, despite the growth of the economy. Adolescent stage provides opportunity for smooth healthy transition from childhood to adulthood [14]. This is the best time to address childhood problems and promote good dietary choices and healthy living for adulthood. However, since this age has been assumed as a healthy stage globally, issues on adolescent hypertension have been ignored [15]. Also, few studies have been conducted to establish the precise extent of the hypertension prevalence rates and incidence of hypertension risk factors in adolescents [13, 16-17].

The conditions in the school setting do not promote much activity, coupled with students' low intake of nutrients, irregular meal times and high intake of sugary and salt-based products. These lifestyles can expose them to risk factors of hypertension. Also, bad dietary pattern practised at this period may lead to obesity and eating disorders that may result in several chronic diseases of which hypertension is one. Early assessment of the risk factors and prevalence of hypertension among adolescents in Senior High School (SHS), as well as diabetes and dyslipidaemia is warranted to curb future development especially for Ghana, where much data does not exist.

2. METHODOLOGY

2.1 Study Design and Eligibility

A cross-sectional study was carried out on adolescent SHS students aged 13-19 years, in three administrative districts of Ghana. Using the Cochrane's formula; $n= (Z^2 p (1-p))/e^2$, a sample size of 909 was determined. SHS students between 13 and 19 years and in boarding house were included. Students who stayed at home and above 19 years were excluded from the study.

2.2 Study Population and Sampling

First, a multi-stage sampling was used; the 29 districts in the Ashanti region were grouped into three, using the number of schools in each district as the basis. Using this criterion, the Ejisu-Juaben Municipality, the Asante Akim Central Municipality and the Kumasi Metropolis were randomly selected. A school was then selected from each of the districts. The schools were selected, based on the location (such as being a well-known area), the condition of the boarding facilities and the number of students who were in the boarding house. The Anglican Senior High School (KASS), the Bonwire Senior High School (BOSS) and the Konongo Odumase Senior High School (KOSS) were selected for this study. A simple random sampling was used to select 909 participants. Students were asked to pick 'yes/no' paper in a bowl and those who

picked 'yes' were chosen for the study. Out of the 909 selected participants, 142 participants had elevated blood pressure and were automatic included for follow-up study. The study population was made up of adolescents in the three SHSs, from year one to year three. The reconnaissance survey to the school revealed that the three SHSs had a student population of 7,036. This was made up of 3246 in KASS, 2803 in the KOSS and 887 in BOSS.

2.3 Ethical Approval

Ethical clearance for the study was obtained from the Committee on Human Research Publication and Ethics (CHRPE) of the School of Medical Sciences, KNUST, Kumasi and the ethical number given was CHRPE/AP/491/16 and consent was sought from the selected schools. All participants signed an informed consent form, in accordance with the CHRPE regulations, before answering the questionnaire and taking blood samples.

2.4 Data Collection

A questionnaire was used to collect data on demography of participants. Data was collected between October, 2016 and March, 2017.

2.4.1 Anthropometric measurements

The Omron Body composition monitor (BF511, UK) was used to take body composition parameters from participants, by entering their age, sex and height. Participants were asked to take off any heavy clothing and step on the monitor bare-footed. After weight was measured to the nearest 0.1 kg, they continued to stand on the monitor with hands on the monitor's horns and held at waist level, at right angles to their bodies until the total body fat, Body Mass Index (BMI), visceral fat and muscle mass were automatically calculated and displayed digitally. A metric measuring tape was tied around the abdomen at the level of the umbilicus, while subject stood straight to measure the waist circumference. Hip circumference was taken around the maximum part of the buttocks. The waist circumference (cm) was divided by the hip circumference (cm) to estimate the waist to hip ratio.

2.4.2 Blood pressure measurement

Blood pressure reading was taken during the initial screening of the 909 students, to recruit participants with elevated blood pressure.

Table 1. Participants selected for screening

Screening/School	Anglican SHS	Konongo SHS	Bonwire SHS	Total
First Screening	376	342	191	909
Re-screening	60	62	20	142

Source: Author's Construct, 2017

Participants with high blood pressure were recruited for biochemical and haematological analyses. Blood pressure reading was taken by trained personnel using a mercury sphygmomanometer and stethoscope. Measurements were taken from the left upper arm after participants had relaxed for about 5 minutes. Different cuff sizes were used for different body sizes and placed to cover the left arm at the heart level. Systolic and diastolic blood pressure were taken three times, with at least 5 minutes interval, using a digital sphygmomanometer. The average of the three readings was used for the analysis.

2.4.3 Biochemical assessment

Participants were asked to fast overnight prior to blood sample collection. Three ml of venous blood sample were collected into gel-activated tubes (Channel Med, England) for biochemical analysis. The activator vacuum tubes were left to stand for 30 minutes and centrifuged (Heraeus Christ-labofuge A, Germany) to obtain serum. The serum was then analysed for lipid profile, ALT, urea, creatinine and electrolytes; to examine liver and kidney function. Reagents used were manufactured by Fortress Diagnostic (UK).

2.5 Data Analysis

Data were analysed using Statistical Package for Social Sciences version 23 (SPSS Inc Chicago, IL). Categorical variables for sociodemography, anthropometric, and blood pressure status were presented as absolute and relative frequencies. A one-way analysis of variance (ANOVA) was performed to determine to mean difference (standard error mean) between age, anthropometric, lipid profile, liver function parameters, kidney function parameters among blood pressure groups. A bivariate correlation was done to determine the relationship between

lipid profile, liver function parameters, kidney function parameters and blood pressure. All reported p-values were compared to a significance level of 0.05.

3. RESULTS

The study included 909 adolescents; however, biochemical tests were assessed among the 142 participants who had high blood pressure during the first screening. Results are presented for both first and second screening. Among 142 adolescent students, 75 (52.8%) participants were males and 67 (47.2%) participants were females. The occupational status of the parents and the blood pressure status of the participants showed no significant difference (p>0.05) with the majority of the detected cases being associated with the self-employed parents (Table 2).

The prevalence of elevated blood pressure using the first screening was 9.1%. However, upon second screening from those who had high blood pressure the first screening, prevalent rate for high blood pressure for the entire study population had reduced to 1.21%. Majority of the participants (66.1%) had normal blood pressure

Table 2. Socio-demographic characteristics of participants based on blood pressure status

Parameters	Normotensive n (%)	Pre-hypertensive n (%)	Hypertensive n (%)	% Total n (%)	*P-value*
Gender					0.200
Male	32 (42.6)	35 (46.6)	8 (10.6)	75(52.8)	
Female	37 (55.2)	27 (40.3)	3 (4.5)	67(47.2)	
Mothers occupation					0.830
Civil servant	3 (50.0)	3 (50.0)	0 (0.0)	6 (4.2)	
Public Servant	7 (46.6)	7 (46.6)	1 (6.6)	15 (10.5)	
Unemployed	1 (20.0)	3 (60.0)	1 (20.0)	5 (3.5)	
Self employed	58 (50.0)	49 (42.2)	9 (7.7)	116(81.6)	
Fathers occupation					0.950
Civil Servant	11 (47.8)	9 (39.1)	3 (13.0)	23 (16.2)	
Public Servant	11 (47.8)	10 (43.4)	2 (8.7)	23 (16.2)	
Unemployed	2 (50.0)	2 (50.0)	0 (0.0)	4 (2.8)	
Self employed	45 (48.9)	41 (44.5)	6 (6.5)	92 (64.7)	

P-value is significant at P < 0.05

level. There were significant differences in blood pressure status and selected schools, with participants from KASS (15.2%), having high blood pressure level (*P* <0.001).

According to the second screening, there was higher prevalence of hypertension among male participants (10.7%) compared to female participants (4.5%). This was not significant (*P* = 0.658) (Table 3).

The age, waist circumference, BMI, body fat, muscle mass and visceral fat was assessed to determine their relationship with the blood pressure status of participants. There was no significant mean difference between age (*P* = 0.461), WC (p= 0.450), BMI (*P* = 0.847), % BF (*P* = 0.501), visceral fat (*P*= 0.195) and blood pressure status (Table 4).

3.1 Effects of Blood Pressure on Organ Function of Participant

Table 5 shows the comparison of lipid profile and blood pressure status of participants. There was no significant mean difference between total cholesterol (TC, *P*= 0.765), triglycerides (TG, *P*= 0.381, high-density lipoprotein (HDL, *P*= 0.777) and low-density lipoprotein (LDL, *P*= 0.768) and blood pressure status.

Table 6 presents the effect of blood pressure on liver and kidney functions. There was no significant mean difference between urea (*P*= 0.236), creatinine (*P*= 0.995) and alanine aminotransferase (ALT) levels (*P*= 0.397) and blood pressure status.

Table 7 presents effect of blood pressure on blood electrolyte levels. There was no significant mean difference between serum sodium (*P*= 0.126), serum chloride (*P*= 0.516) and serum potassium levels (*P*= 0.878) and blood pressure status.

Table 8 presents the correlation coefficient of the relationship between the biochemical parameters and blood pressure. The correlation coefficients were weak and not significant ($P > 0.05$).

Table 3. Distribution of blood pressure among KOSS, KASS and BONWIRE students

SHS students	Blood pressure status			X^2	df	*P-value*
	Hypertensive	Pre-hypertensive	Normotensive			
N (%) = 909						
Senior high schools				32.993	4	<0.001
KOSS (%)	19 (5.6)	82 (28.9)	241 (70.5)			
KASS (%)	57 (15.2)	82 (21.8)	237 (63.0)			
BOSS (%)	7 (3.7)	61 (31.9)	123 (64.4)			
Total	83 (9.1)	225 (24.8)	601 (66.1)			
Second screening	11 (1.21)					
Gender N=142						0.658
Male	10.7	46.6	42.7			
Female	4.5	40.3	55.2			

P-value is significant at P < 0.05

Table 4. Age, anthropometric and body composition of normotensive, pre-hypertensive and hypertensives participants

Parameter	Normotensive	Pre-hypertensive	Hypertensive	*P-value*
Age (years)	17.12±1.39	17.45±1.71	17.91±1.14	0.461
WC (cm)	74.42±8.09	74.18±7.50	74.27±7.72	0.450
BMI (Kg/m^2)	18.88±8.56	20.02±7.41	20.66±6.99	0.847
Body Fat (%)	23.88±12.60	22.07±12.72	20.79±12.42	0.501
Muscle mass (%)	36.46±8.10	36.75±8.39	39.14±8.52	0.416
Visceral Fat	1.43±1.87	1.66±2.13	2.73±1.90	0.195

Values are presented as means ± SEM, P-value is significant at P < 0.05

Table 5. Comparison of lipid profile of respondents on different blood pressure ratings

Blood pressure status	HDL (mmol/L)	LDL (mmol/L)	TCHOL (mmol/L)	TG (mmol/L)
Normotensive	1.60±0.03	1.73±0.08	3.97±0.18	0.97±0.04
Pre-hypertensive	1.60±0.03	1.73±0.11	3.83±0.12	1.02±0.04
Hypertensive	1.65±0.06	1.90±0.18	4.02±0.20	0.89±0.06
F-ratio	0.252	0.264	0.269	0.971
Df	2	2	2	2
P-value	0.777	0.768	0.765	0.381

Values are presented as means ± SEM, P-value is significant at P < 0.05 Tchol- Total cholesterol; TG-Triglycerides; HDL- High density lipoprotein; LDL- Low density lipoprotein

Table 6. Effect of blood pressure status on kidney (urea, creatinine) and liver (ALT) functions of respondents

Blood pressure status	Kidney function		Liver function
	Urea (mmol/L)	Creatinine (µmol/L)	ALT (U/L)
Normotensive	3.71±0.10	56.82±1.05	13.14±0.85
Pre-hypertensive	3.50±0.10	56.90±1.03	12.06±0.65
Hypertensive	3.43±0.15	56.64±2.02	14.36±1.11
F-ratio	1.459	0.005	0.930

Df	2	2	2
P-value	0.236	0.995	0.397

Values are presented as means ± SEM, P-value is significant at P < 0.05.

Table 7. Effect of blood pressure status on electrolytes (Na^+, Cl^-, K^+) of respondents

Blood pressure status	Na^+ (mmol/L)	Cl^- (mmol/L)	K^+ (mmol/L)
Normotensive	139.77±0.18	100.74±0.21	4.04±0.02
Pre-hypertensive	140.31±0.20	99.02±1.61	4.05±0.03
Hypertensive	140±0.38	99.91±0.48	4.05±0.05
F-ratio	2.099	0.665	0.131
Df	2	2	2
P-value	0.126	0.516	0.878

Values are presented as means ± SEM, P-value is significant at P < 0.05.

Table 8. Relationship between biochemical parameters and blood pressure parameters

Biochemical parameters	Systolic	Diastolic
	Correlation coefficient, r	
Tchol	0.02	0.048
Trig	0.048	0.014
HDL	0.05	0.15
LDL	0.017	0.012
UREA	-0.113	-.175
CREAT	0.043	-0.125
ALT	-0.084	-0.03
Na^+	0.105	-0.095
K^+	0.084	0.01
Cl^-	-0.09	-0.111

*P values were above 0.05. Tchol- Total cholesterol; Trig- Triglycerides; HDL- High density lipoprotein; LDL- Low density lipoprotein; ALT- Alanine aminotransferase; Na^+- Sodium; K^+ - Potassium; Cl^-Chloride, *P-value is significant at P < 0.05*

4. DISCUSSION

Finding from the initial screening` showed the prevalence of elevated blood pressure among adolescents in the selected schools was 9.1%, whilst 24.8% of them were pre-hypertensive. Blood pressure readings were measured three times at a relaxed state and the average was considered the study data. However, in the second screening, which considered participants (N=142) with high blood pressure from the first screening, prevalence of high blood pressure for the entire study population had dropped to 1.21% among the adolescents. The decline in the prevalent rate of elevated blood pressure may be due to be some uncontrolled confounding factors such as stress, personal fear exhibited by study population. The prevalence of high blood pressure is of significant consideration in this setting, as it poses threat to our public health, owing to the affected population group. As such, collaborative efforts by various stakeholders are needed to identify a population at risk and effectively manage this menace using comprehensive approaches that can be delivered at both health facilities and community level. This prevalence of hypertension was significantly higher among participants from KASS (15.2%), compared to KOSS (5.6%), and BOSS (3.7%; *P* <0.001). Similar but higher prevalence of hypertension among adolescents was found in a study by Kumar *et al*. [18]. On the other hand, another study by Tadesse and Alemu [19] in Ethiopia found a slightly lower prevalence of hypertension (7.7%) among adolescents. KASS and KOSS are located at urban communities whereas; BOSS is located in a sub-urban area of Ashanti region. Considering the location of these schools, it could be deduced that hypertension was more prevalent in the urban adolescents (KASS and KOSS), compared to sub-urban to rural adolescents (BOSS). An observed high prevalence of pre-hypertension and hypertension among adolescent students raises alarm that the disease is no longer found in adults but is gradually emerging among adolescents. This calls for awakening of health stakeholders to develop appropriate intervention health programs

to curb the menace among the youth of the country.

High prevalence of hypertension among adolescents would affect the public health system in Ghana, if appropriate measures are not put in place. According to Amma et al. [20] and Widjaja et al. [21], hypertension was associated with low socio-economic status, waist circumference, overweight/obesity, high soft drinks consumption, low fruit consumption and physical inactivity. Out of the 142 participants, 116 (81.6%) of them have parents who are self-employed, which is a key factor to note. Self-employed persons tend to dedicate much time to their business, thus have little time for themselves and their families. This mostly results in their wards eating from fast food joints and resorting to other seemingly unwholesome and unhealthy eating patterns, such as late-night eating as they report home late from work. The data showed that 81.6% of the mothers, who are primarily responsible for the diet of their families, were self-employed with extended working hours, leading to poor eating patterns in their households. However, there is no statistical significance in the link between the parents' occupation and the hypertensive status of their wards ($P > 0.05$). Age did not have a significant effect on blood pressure.

There was a higher prevalence of hypertension in males than females, though not statistically significant. The higher prevalence in males is similar to the finding by Goncalves *et al*. [22], where they showed a prevalence of 9.3% in males as against 6.5% in females. Moselakgomo *et al*. [23] also reported a higher prevalence of 4.1% in males, as opposed to 2.8% in females. They attributed the cause of the increasing prevalence of hypertension to the changing lifestyles of the population, following the rural-urban drift, particularly in sub-Saharan Africa with the primary causes being poor diet, salt intake and physical inactivity. They also observed that the poor socio-economic and environmental conditions the children were exposed to from childhood to adolescence were the risk factors to the development of hypertension. The high prevalence of hypertension in males, as opposed to females, could be attributed to the higher tendency of males to eat more and resort to unhealthy lifestyle practices such as alcoholism and smoking [24]. Studies have shown that sedentary lifestyles, use of tobacco and alcohol, lack of physical exercises, and an unhealthy diet are mostly found among adolescents [25].

There was no significant mean difference between age ($P = 0.461$), WC ($P= 0.450$), BMI ($P = 0.847$), % BF ($P = 0.501$), visceral fat ($P = 0.195$) and blood pressure status. Obesity, abdominal obesity is known risk factors of hypertension [26]. However, in this study, the waist circumference, BMI and visceral fat did not contribute significantly ($P > 0.05$) to the hypertension status of participants. A study by Danasekaran and Vinoth [27], showed a positive correlation between BMI ($P <0.001$) and family history ($P = 0.03$) in adolescents with hypertension.

The high prevalence of hypertension warranted an investigation into the probable toll the condition might be having on the kidney and liver organ functions of the participants. According to Tedla *et al.* [28], hypertension can be directly or indirectly related to chronic kidney disease (CKD) and electrolyte imbalances. There was no significant mean difference between urea ($P = 0.236$), creatinine ($P = 0.995$), serum sodium ($P = 0.126$), serum chloride ($P = 0.516$), serum potassium levels ($P = 0.878$) and alanine aminotransferase (ALT) levels ($P = 0.397$) and blood pressure status. This means that the presence of high blood pressure did not influence the electrolytes, kidney and liver parameters of participants. Also, lipid profile such as total cholesterol ($P = 0.765$), triglycerides ($P = 0.381$), HDL ($P = 0.777$) and LDL ($P = 0.768$) was not significantly associated with blood pressure status. Although the prevalence of hypertension was high among the adolescent population, there was no target organ damage in the affected participants. However, these affected participants need to be given close follow-up for early detection of target organ damage.

Additionally, a correlation between total cholesterol, triglyceride, high density lipoprotein cholesterol, low density lipoprotein cholesterol, kidney and liver parameters and systolic and diastolic blood pressure showed no significant association. The fact however is, hypertension is a chronic disease which progresses gradually to cause damage to heart, kidney and liver, as the duration of hypertension extends. The early detection of hypertension in adolescents, timely dietary and lifestyle management are helpful to avoid future hypertension complications. An observed high blood pressure among boarding school adolescents is worrying and calls for immediate attention by stakeholders to look at

the diet and lifestyle engagement of these school children. Also, there is a need to include nutrition education in our various second cycle institutions to help promote healthy eating and right food choices. Stakeholders can promote an enabling environment which can stimulate healthy lifestyle behaviours among the adolescents.

5. CONCLUSIONS

Prevalence of pre-hypertension (24.8%) and hypertension (9.1%) was high among adolescent students. Despite the high prevalence of pre-hypertension and hypertension among the adolescent population in the study, there was no target organ damage in the affected participants. However, these affected participants need to be given close follow-up for early detection of target organ damage. There is also the need for appropriate diet and lifestyle management to prevent the progression of the pre-hypertension and hypertension to stages where they can cause target organ damage.

CONSENT AND ETHICAL APPROVAL

All authors declare that written informed consent was obtained from the participants in accordance with Ethics review regulation for publication of this study. Also, Ethical clearance for the study was obtained from the Committee on Human Research Publication and Ethics (CHRPE) of the School of Medical Sciences, KNUST, Kumasi and ethical number given was CHRPE/AP/491/16.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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