PRINT: ISSN 0970-9274 ONLINE: ISSN 2456-6608
J Hum Ecol, 76(1-3): 1-12 (2021)
DOI: 10.31901/24566608.2021/76.1-3.3324

Prevalence of Hypertension in Nigerian Children and Adolescents: A Comparison of the Fourth Working Group Report and the American Academy Pediatricians' Guidelines

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KEYWORDS Adolescents. Children. Hypertension Prevalence. Hypertension Guidelines. Low Resourced Nations. Well-being

ABSTRACT The purpose of this study was to compare the prevalence of hypertension based on the Fourth Report (FR) guidelines issued in 2004 and the 2017 American Academy of Pediatrics (AAP), medical practice commendation of defining high blood pressure among Nigerian youths. A cross-sectional study of 1758 boys and girls aged between 9 and 19 years in Ado-Ekiti, Southwest Nigeria participated in the study. Physiological and anthropometry parameters were determined using the standard protocols. The prevalence of hypertension by gender based on the AAP guideline systolically stands at 9.5 percent and 5.9 percent compared to the FR guidelines of 1.5 percent and 1.7 percent for boys and girls, respectively, and diastolically stands at 6.3 percent and 3.9 percent compared to the 1.6 percent and 0.9 percent for boys and girls, respectively. A high prevalence of hypertension was found in children and adolescents following the recent AAP guidelines compared to the FR guidelines highlighting the need to scale up the intervention and prevention in children especially from low-income countries.

INTRODUCTION

Globally, primary high blood pressure has become a major communal health worry and a life-long ailment leading to an untimely death in individuals (Falkner 2010). This is due to a multifaceted interaction of hereditary, ecological, and behavioural influences (Falkner 2010) which has been understood to begin from childhood and persist into adulthood (Essouma et al. 2015). Hypertension affects almost one billion adults with a high mortality rate of over nine million deaths each year (Noubiap et al. 2017). In the year 2015 alone, hypertension became the major contributor to worldwide disability-adjusted life-years which account for 9·2 percent for men and 7·8 percent for women (Noubiap et al. 2017).

In Africa, especially in sub-Sahara Africa, the high prevalence of hypertension in adults has mainly been linked to behavioural determinants such as smoking, consumption of diets rich in excess sugar and salt, fatty food intakes, and physical inactivity, but not limited to technological advancement, urbanization and a change in ways of living similar to western life (Essouma et al. 2015). However, hypertension in children seems not as common and not well pronounced when compared to adults. Meanwhile, the problem of high blood pressure has intensified in children and adolescents in many African countries. One study showed a high incidence of high blood pressure among youths in Africa implicating excessive body fatness and obesity as a major driving force (Noubiap et al. 2017).

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Nigeria is one of the countries in Africa, sub-Sahara part of the continent specifically. Despite the increasing level of hypertension among the youths, some studies have highlighted a low to moderate levels of blood pressure in youth in Nigeria (Ejike 2017; Okpokowuruk et al. 2017). However, assessments of hypertension in children, especially in Nigeria, has commonly been based on the use of the Fourth Report procedures of 2004 and not known what the estimate would be under the new guideline. The purpose of this study was to compare the prevalence of hypertension based on the Fourth Report guidelines established in 2004 regarded as old, and the recent American Academy of Pediatrics (AAP) clinical practice recommendation established in 2017 (regarded as new) for describing hypertension among Nigerian children and adolescents. Secondly, to examine and compare the association of selected body composition indicators with blood pressure groupings using both 2017 AAP clinical practice guidelines and the 2004 Fourth Report in boys and girls.

MATERIALS AND METHOD

Research Design and Sample

The procedure followed in this study was in line with the methods described in Toriola et al. (2017) where a cross-sectional research method was utilised to gather data from 1758 (boys= 631; 35.9% and girls=1127; 64.1%) school children aged between nine and nineteen years, who were randomly chosen from five community schools in Ado-Ekiti, Southwestern Nigeria. The pupils' ages were confirmed from school records with the assistance of class teachers. Height, body weight, abdominal/central obesity, and blood pressure were assessed using the normal procedures, and BP for all children at each screening were categorised according to FR and AAP classifications. The study was carried out from March 2015 and October, 2015.

Measurements

Anthropometry

The procedures of the International Standard for the Advancement of Kinanthropometry (ISAK) were utilised to evaluate the participants' height and body weight (Marfell-Jones et al. 2012). Body mass index (BMI) was calculated by fractioning the participants' body weight in kilograms by the square of their height in metres [body weight (kg) /height $(m)^2$] which offers a reasonable measure of fatness in children. BMI was categorised as underweight, normal, overweight, or obese for age and gender (Cole et al. 2007) using the age- and sex-specific BMI cut-off point recommended by the Childhood Obesity Working Group of the International Obesity Task Force (IOTF). Valerio et al. (2013) stated that the IOTF cut-off points has been broadly acknowledged and utilised universally for age and gender-specific custom of BMI groupings to classify overweight and obesity in youth.

Blood Pressure Assessment

Blood pressure (BP) was assessed with the use of an automated blood pressure monitor (Omron HEM- 705 CP devices, Tokyo, Japan). The standardized procedures of the American Heart Association (2018) were employed for BP assessment. Elevated BP was defined as the average systolic blood pressure (SBP) and the diastolic blood pressures (DBP) above the 95^{th} percentile for age and gender after the weight and height has been adjusted for (Cooper 2007). We utilised the last two readings to estimate the average for both systolic and diastolic BP.

Pilot Testing

To illuminate on the methodical management principles of the measurement, a pilot study was performed. A workshop was administered by two experts who are knowledgeable about children Kinanthropometry. The objectives of the training were to ensure that the data collector possesses the skill necessary to follow during the data collection period.

Study Ethics and Participation Consent

This study approval was obtained from the Institutional Ethics for Research Committee of the Ekiti State University, Ado Ekiti. Endorsement to carry-out the research was also gotten from Ekiti State Ministry of Education, Ado Eki-

ti, Ekiti State. Permission was also sought from the children's parents and school authorities. The early circulation of information leaflets about the study was executed, followed by an explanation of the aim and technique of the study to the children and their guardian. Written informed consent was afterward attained from the children's parents/guardians. We also sought for verbal assent from the children if they are interested in participating in the study that was executed in line with the ethical guideline of the Helsinki declaration for research involving human subjects.

Statistical Analysis

Data analysis was performed using the IBM Statistical Package for the Social Sciences (SPSS) version 26.0 (Armonk, NY: IBM Corp). Mean and standard deviation were executed to determine the characteristics of the participants by gender. Analysis of variance (ANOVA) was performed to determine whether there are any statistically significant differences between the means independent groups (age, anthropometry, and blood pressure). To determine the prevalence of hypertension, cross-tabulation was performed to determine the prevalence of hypertension by age and gender for the old and new guidelines. Multinomial regression analysis was performed to examine the association of selected physiological indicators and blood pressure categories in both 2017 AAP clinical practice guidelines and the 2004 Fourth Report in boys and girls. All p-values were set at d" 0.05.

RESULTS

The results shows that the mean body weight, waist-to-hip ratio (WHR), BMI, body fat percentage and both systolic and diastolic blood pressure were significantly higher among boys compared to girls (Table 1).

Based on the new guideline (AAP), the prevalence of systolically hypertension by gender stands at 9.5 percent and 5.9 percent (Table 2) compared to the Fourth Report Guidelines of 1.5 percent and 1.7 percent for boys and girls, respectively (Table 3). Diastolic blood pressure stands at 6.3 percent and 3.9 percent (Table 2) compared to 1.6 percent and 0.9 percent for boys and girls, respectively (Table 3). Furthermore, based on AAP and by age, 12.1 percent and 12.8 percent of children aged 15 and 16 years were systolically and diastolically hypertensive, respectively (Table 2). The result of the hypertension prevalence based on the Fourth Report criteria by age revealed that 5.8 percent and 2.8 percent of those aged 15 and 14 years were systolically and diastolically hypertensive, respectively (Table 3).

For 2017 AAP recommendation, predictors of systolic hypertension among boys were age (O.R = 1.29), height (O.R = 1.15), and BMI (O.R =1.26), while for 2004 Fourth Report were age (O.R = 1.35), height (O.R = 1.15), and BMI (O.R =1.31) (Table 4).

For 2017 AAP recommendation, predictors of systolic hypertension among girls were height (O.R = 1.06), BMI (O.R = 1.22), and central obesity (O.R =1.07), while for 2004 Fourth Report were age (O.R = 1.44), height (O.R = 1.01), BMI (O.R =1.23) and central obesity (O.R =1.07) (Table 5).

The overall AAP guidelines predictors for systolic hypertension were height (O.R=1.10) and BMI (O.R=1.23), while for fourth report were age (O.R = 1.34), height (O.R = 1.05), BMI (O.R =1.25) and central obesity (O.R =1.02) (Table 6). Those children with age increase, being taller, increase in body mass index and central obesity were at risk of developing hypertension compared to those with normal blood pressure.

DISCUSSION

In this study, we compared the prevalence of high blood pressure centred on the Fourth Report guidelines established in 2004 and the 2017 American Academy of Pediatrics clinical practice recommendation for describing high blood pressure among Nigerian youths. The 2004 Fourth Working Group account has been in existence for more than twelve years, recognised, and has been used widely to classify hypertension among many individuals (Samuels and Samuel 2018).

Although, several issues have been raised as a concern which accentuates a necessity to revise the long-standing recommendations. Some of the issues raised were (1) the inclusion of obese children in the normative data which could puff up the limit for irregular blood pressure (2)

Table 1: Characteristics of the participants by gender and age (n=1758)

Variables		*Height*	*Body Mass*	*BMI (kg/m²)*	*C/Obesity*	*WHR*	*WHtR*	*BF%*	*SBP*	*DBP*
		Mean ± SD								
Gender	Boys	146.4±10.2	39.4± 8.59	18.3 ±3.54	61.5±11.5	0.86±0.09	0.42±0.07	16.9±7.86	107.7±15.5	63.5± 11.8
	Girls	146.5±10.6	38.4± 7.85	17.8 ±3.11	60.2± 8.41	0.87±0.08	0.41±0.05	12.9±4.91	102.6±16.4	59.7± 11.5
†*p-value*		0.85	0.03	0.006	0.52	0.05	0.44	< 0.001	< 0.001	< 0.001
	9	136.5± 9.04	32.9± 8.46	17.4 ±2.88	59.6± 8.91	0.87±0.05	0.43±0.04	15.1±7.02	97.8±17.8	60.2± 11.1
	10	137.3± 7.43	31.9± 5.80	16.9 ±2.67	58.8± 5.71	0.87±0.04	0.42±0.03	13.9±4.53	97.1±13.2	58.8± 10.7
	11	142.3± 8.84	36.0± 7.45	17.7 ±3.15	59.9± 8.21	0.87±0.06	0.42±0.05	15.0±5.66	101.5±14.9	59.7± 10.9
	12	144.8± 9.74	37.6± 7.51	18.0 ±3.85	60.3±11.0	0.86±0.12	0.41±0.07	14.6±5.23	103.4±16.4	60.4± 11.8
	13	147.9± 8.32	39.5± 7.12	18.0 ±2.49	61.8± 9.15	0.86±0.05	0.41±0.05	14.3±5.32	104.6±15.5	61.4± 11.7
Ages (yr)	14	149.7±10.0	41.0± 7.44	18.3 ±3.46	61.9±10.8	0.86±0.13	0.41±0.07	14.3±5.51	108.8±16.1	62.7± 12.3
	15	153.3±11.6	43.6± 7.87	18.6 ±3.87	63.8± 9.94	0.86±0.04	0.41±0.06	13.2±4.45	110.3±18.0	63.1± 12.3
	16	154.3± 7.98	44.4± 9.19	18.5 ±2.41	64.1± 7.99	0.86±0.05	0.41±0.05	13.8±8.30	107.4±16.4	62.3± 13.3
	17	153.3±13.4	46.1± 7.93	19.5 ±2.14	68.7± 5.58	0.88±0.05	0.45±0.03	14.6±4.24	106.0±12.1	65.8± 7.66
	18	156.3± 3.77	48.7± 1.85	19.9 ±1.04	69.6± 4.76	0.87±0.04	0.44±0.03	16.1±5.25	114.3±15.2	62.9± 10.6
	19	141.6±23.7	36.3± 16.1	17.4 ±2.40	62.4±14.3	0.89±0.06	0.44±0.07	8.90±2.93	96.6±15.2	62.3± 7.23
‡*p-value*		<0.001	<0.001	<0.001	<0.001	0.91	0.26	0.04	< 0.001	0.007

BMI – body mass index; C– central; WHR – waist-to-hip ratio; WHtR – waist-to-height ratio; BF% - body fat percent; SBP – Systolic blood pressure; DBP – diastolic blood pressure; SD – standard deviation; yr – year; kg/m² – kilogram per meter square.
† *p-value from independent sample T-test*
‡*p value from ANOVA*

Table 2: Comparison of the prevalence of hypertension by gender and age using AAP criteria among Nigerian children and adolescent

	New guideline									
	Hypor-tension	*Systolic BP normal*	*Elevated*	*Hyper-tension*	*p-value*	*Hypor-tension*	*Diastolic BP normal*	*Elevated*	*Hypor-tension*	*p-value*
Gender										
Boys	74 (11.7)	424 (67.2)	73 (11.6)	60 (9.5)	< 0.001	212 (33.6)	374 (59.3)	5 (0.8)	40 (6.3)	< 0.001
Girls	238 (21.1)	723 (64.2)	100 (8.9)	66 (5.9)		529 (46.9)	553 (49.1)	1 (0.1)	44 (3.9)	
Ages (yr)										
Overall 9	12 (38.7)	14 (45.2)	3 (9.7)	2 (6.5)		15 (48.4)	14 (45.2)	0 (0.0)	2 (6.5)	
10	38 (28.6)	89 (66.9)	3 (2.3)	3 (2.3)		69 (51.9)	60 (45.1)	1 (0.8)	3 (2.3)	
11	58 (19.9)	203 (69.8)	14 (4.8)	16 (5.5)		140 (48.1)	142 (48.8)	1 (0.3)	8 (2.7)	
12	79 (19.2)	270 (65.5)	37 (9.0)	26 (6.3)		183 (44.4)	211 (51.2)	0 (0.0)	18 (4.4)	
13	61 (16.7)	245 (67.1)	39 (10.7)	20 (5.5)	< 0.001	150 (41.1)	196 (53.7)	2 (0.5)	17 (4.7)	0.018
14	31 (12.4)	161 (64.4)	30 (12.0)	28 (11.2)		85 (34.0)	148 (59.2)	2 (0.8)	15 (6.0)	
15	21 (12.1)	99 (57.2)	32 (18.5)	21 (12.1)		59 (34.1)	103 (59.5)	0 (0.0)	11 (6.4)	
16	10 (12.8)	50 (64.1)	9 (11.5)	9 (11.5)		33 (42.3)	35 (44.9)	0 (0.0)	10 (12.8)	
17	1 (7.7)	9 (69.2)	3 (23.1)	0 (0.0)		2 (15.4)	11 (84.6)	0 (0.0)	0 (0.0)	
18	0 (0.0)	5 (55.6)	3 (33.3)	1 (11.1)		4 (44.4)	5 (55.6)	0 (0.0)	0 (0.0)	
19	1 (33.3)	2 (66.7)	0 (0.0)	0 (0.0)		1 (33.3)	2 (66.7)	0 (0.0)	0 (0.0)	

BP – blood pressure; yr. - year

Table 3: Comparison of the prevalence of hypertension by gender and age using 4th Report criteria among Nigerian children and adolescent

	New guideline									
	Hypor-tension	*Systolic BP normal*	*Elevated*	*Hyper-tension*	*p-value*	*Hypor-tension*	*Diastolic BP normal*	*Elevated*	*Hypor-tension*	*p-value*
Gender										
Boys	74 (11.7)	424 (67.2)	122 (19.3)	11 (1.7)	< 0.001	212 (33.6)	374 (59.3)	35 (5.5)	10 (1.6)	< 0.001
Girls	238 (21.1)	723 (64.2)	149 (13.2)	17 (1.5)		529 (46.9)	553 (49.1)	35 (3.1)	10 (0.9)	
Ages (yr.)										
Overall 9	12 (38.7)	14 (45.2)	5 (16.1)	0 (0.0)		15 (48.4)	14 (45.2)	2 (6.5)	0 (0.0)	
10	38 (28.6)	89 (66.9)	6 (4.5)	0 (0.0)		69 (51.9)	60 (45.1)	4 (3.0)	0 (0.0)	
11	58 (19.9)	203 (69.8)	29 (10.0)	1 (0.3)		140 (48.1)	142 (48.8)	6 (2.1)	3 (1.0)	
12	79 (19.2)	270 (65.5)	60 (14.6)	3 (0.7)		183 (44.4)	211 (51.2)	14 (3.4)	4 (1.0)	
13	61 (16.7)	245 (67.1)	54 (14.8)	5 (1.4)	< 0.001	150 (41.1)	196 (53.7)	16 (4.4)	3 (0.8)	0.011
14	31 (12.4)	161 (64.4)	51 (20.4)	7 (2.8)		85 (34.0)	148 (59.2)	10 (4.0)	7 (2.8)	
15	21 (12.1)	99 (57.2)	43 (24.9)	10 (5.8)		59 (34.1)	103 (59.5)	9 (5.2)	2 (1.2)	
16	10 (12.8)	50 (64.1)	16 (20.5)	2 (2.6)		33 (42.3)	35 (44.9)	9 (11.5)	1 (1.3)	
17	1 (7.7)	9 (69.2)	3 (23.1)	0 (0.0)		2 (15.4)	11 (84.6)	0 (0.0)	0 (0.0)	
18	0 (0.0)	5 (55.6)	4 (44.4)	0 (0.0)		4 (44.4)	5 (55.6)	0 (0.0)	0 (0.0)	
19	1 (33.3)	2 (66.7)	0 (0.0)	0 (0.0)		1 (33.3)	2 (66.7)	0 (0.0)	0 (0.0)	

BP – blood pressure; yr. - year

Table 4: Comparison of the association of selected body composition indicators with blood pressure categories using both 2017 AAP clinical practice guidelines and the 2004 Fourth Report in boys

Variables	*Boys*							
	2017 AAP (Systolic BP)				*2004 Fourth Report (Systolic BP)*			
	Hypotension	*Normal*	*Elevated*	*Hypertension*	*Hypotension*	*Normal*	*Pre-hypertension*	*Hypertension*
Age	1.10 (0.92-1.32)		1.18 (0.99-1.41)	1.29 (1.06-1.58)	1.11(0.93-1.33)		1.22 (1.05-1.42)	1.35 (0.88-2.05)
Height	0.89 (0.76-1.05)		1.07 (0.99-1.15)	1.15 (1.05-1.25)	0.89 (0.76-1.05)		1.09 (1.03-1.17)	1.15 (0.93-1.42)
BMI	0.60 (0.52-0.72)	Ref	1.19 (1.10-1.28)	1.26 (1.15-1.38)	0.61 (0.52-0.72)	Ref	1.21 (1.13-1.30)	1.31 (1.13-1.52)
C/	1.12 (0.78-1.62)		0.94 (0.81-1.09)	0.88 (0.74-1.05)	1.12 (0.78-1.62)		0.92 (0.81-1.05)	0.89 (0.62-1.32)
Obesity	$4.22x10^{-7}$		4406.6	147290208.7	$3.93x10^{-7}$		193452.7	1093062496.1
WHtR	($1.62x10^{-19}$-$1.09x10^{16}$)		($5.54x10^{-7}$ - $3.50x10^{13}$)	(0.00-2.14x 10^{20})	($1.74x10^{-29}$ - $8.87x10^{15}$)		(0.00-$1.05x10^{14}$)	($1.97x10^{-16}$ - $6.06x10^{33}$)
	Diastolic BP				*Diastolic BP*			
	Hypotension	*Normal*	*Elevated*	*Hypertension*	*Hypotension*	*Normal*	*Pre-hypertension*	*Hypertension*
Age	0.94 (0.83-1.05)		1.01(0.53-1.94)	1.15 (0.92-1.45)	0.94 (0.83-1.05)		1.13 (0.89-1.44)	1.15 (0.73-1.78)
Height	0.93 (0.87-0.99)		0.65(0.26-1.62)	0.98 (0.81-1.18)	0.93 (0.87-0.99)		0.99 (0.82-1.20)	0.91 (0.58-1.43)
BMI	0.91 (0.85-0.97)	Ref	0.82(0.49-1.33)	1.12 (1.03-1.22)	0.91 (0.85-0.97)	Ref	1.08 (0.98-1.20)	1.17 (1.00-1.37)
C/Obesity	1.09 (0.95-1.25)		3.26(0.39-26.9)	1.18 (0.79-1.75)	1.09 (0.95-1.25)		1.14 (0.75-1.71)	1.49 (0.54-4.12)
WHtR	$4.22x10^{-7}$		$6.93x10^{-73}$	$3.54x10^{-8}$	$4.79x10^{-7}$		$6.91x10^{-6}$	$8.66x10^{-24}$
	($5.67x10^{-16}$ - 313.4)		($1.48x10^{-203}$ - $3.24x10^{58}$)	($2.75x10^{-33}$ - $4.54x10^{17}$)	($6.76x10^{-16}$ - 338.9)		($3.16x10^{-32}$ - $1.51x10^{21}$)	($7.76x10^{-89}$ - $9.67x10^{41}$)

BMI – body mass index; C– central; WHtR – waist-to-height ratio; SBP – Systolic blood pressure.

Table 5: Comparison of the association of selected body composition indicators with blood pressure categories using both 2017 AAP clinical practice guidelines and the 2004 Fourth Report in girls

Variables	*Girls*							
	2017 AAP (Systolic BP)				*2004 Fourth Report (Systolic BP)*			
	Hypotension	*Normal*	*Elevated*	*Hypertension*	*Hypotension*	*Normal*	*Pre-hypertension*	*Hypertension*
Age	1.05 (0.94-1.16)		1.05 (0.92-1.21)	0.85 (0.72-1.01)	1.04 (0.94-1.15)		0.93 (0.82-1.04)	1.44 (1.06-1.95)
Height	0.87 (0.77-0.99)		1.14 (1.01-1.27)	1.06 (0.96-1.16)	0.87 (0.77-0.99)		1.14 (1.03-1.26)	1.01 (0.91-1.12)
BMI	0.73 (0.66-0.81)	Ref	1.08 (0.98-1.18)	1.22 (1.13-1.31)	0.73 (0.66-0.80)	Ref	1.09 (1.01-1.18)	1.23 (1.10-1.36)
C/Obesity	1.15 (0.85-1.54)		0.90 (0.70-1.15)	1.07 (0.87-1.32)	1.15 (0.85-1.54)		0.92 (0.74-1.15)	1.07 (0.85-1.35)
WHtR	$7.39x10^{-10}$ ($2.36x10^{-28}$ - 23149500120		$4.14x10^{10}$ ($1.01x10^{-6}$ - $1.69x10^{27}$)	0.00 ($1.10x10^{-17}$ - $1.87x10^{10}$)	$6.67x10^{-10}$ ($1.69x10^{-28}$ - 2615350897)		808784744.0 ($4.85x10^{-7}$ - $1.35x10^{24}$)	$2.78x10^{-6}$ ($2.57x10^{-20}$ - 301005374.2)
	Diastolic BP				*Diastolic BP*			
	Hypotension	*Normal*	*Elevated*	*Hypertension*	*Hypotension*	*Normal*	*Pre-hypertension*	*Hypertension*
Age	1.01 (0.94-1.10)		0.47 (0.09-2.53)	0.89 (0.74-1.09)	1.02 (0.94-1.10)		0.87 (0.70-1.09)	0.91 (0.61-1.35)
Height	0.95 (0.89-1.02)		0.95 (0.43-2.13)	1.07 (0.94-1.23)	0.95 (0.89-1.02)		1.11 (0.95-1.27)	0.87 (0.59-1.31)
BMI	0.87 (0.82-0.92)	Ref	0.99 (0.55-1.77)	1.14 (1.04-1.25)	0.87 (0.82-0.92)	Ref	1.14 (1.02-1.26)	1.05 (0.84-1.33)
C/Obesity	0.99 (0.85-1.15)		1.05 (0.15-7.18)	0.98 (0.75-1.28)	0.99 (0.85-1.16)		0.93 (0.69-1.25)	1.51 (0.57-3.94)
WHtR	0.10 (1.97x10-11 -528649128.0)		2.87x10-5 (1.03x10-121 - 8.05x10111)	1085.7 (4.60x10-16 - 2.56x1021)	0.09 (1.62x10-11 - 571623233.8)		2362165.5 (7.00x10-15 - 7.97x1026)	1.32x10-24 (1.29x10-83 - 1.35x1035)

BMI - body mass index; C- central; WHtR - waist-to-height ratio; SBP - Systolic blood pressure.

Table 6: Comparison of the association of selected body composition indicators with blood pressure categories using both 2017 AAP clinical practice guidelines and the 2004 Fourth Report in both sexes

Variables	*Overall*							
	2017 AAP (Systolic BP)				*2004 Fourth Report (Systolic BP)*			
	Hypotension	*Nor-mal*	*Elevated*	*Hypertension*	*Hypotension*	*Nor - mal*	*Pre-hypertension*	*Hypertension*
Age	1.08 (0.99-1.18)		1.08 (0.97-1.21)	0.97 (0.86-1.10)	1.08 (0.98-1.18)		1.01 (0.93-1.11)	1.34 (1.06-1.69)
Height	0.88 (0.81-0.96)	Ref	1.08 (1.02-1.15)	1.10 (1.03-1.17)	0.88 (0.81-0.97)	Ref	1.09 (1.04-1.15)	1.05 (0.95-1.16)
BMI	0.69 (0.64-0.75)		1.15 (1.08-1.21)	1.23 (1.16-1.30)	0.69 (0.64-0.75)		1.17 (1.12-1.23)	1.25 (1.15-1.36)
C/Obesity	1.13(0.92-1.38)		0.96 (0.84-1.09)	0.97 (0.85-1.13)	1.13 (0.92-1.38)		0.95 (0.85-1.07)	1.02 (0.83-1.26)
WHtR	$4.48x10^{-8}$ ($9.21x10^{-21}$ -218486.6)		6695.7 ($5.81x10^{-6}$ $-7.72x10^{12}$))	161.8 ($3.02x10^{-8}$ $-8.66x10^{11}$)	$4.59x10^{-8}$ ($9.26x10^{-21}$ 228025.7		808784744.0 ($7.82x10^{-5}$ $-1.14x10^{12}$)	0.162 ($9.82x10^{-15}$ $-2.66x10^{12}$)
	Diastolic BP				*Diastolic BP*			
	Hypotension	*Nor-mal*	*Elevated*	*Hypertension*	*Hypotension*	*Nor - mal*	*Pre-hypertension*	*Hypertension*
Age	1.02 (0.95-1.08)		0.79 (0.45-1.38)	0.98 (0.85-1.14)	1.02 (0.95-1.08)		0.96 (0.83-1.13)	0.99 (0.75-1.31)
Height	0.94 (0.90-0.98)	Ref	0.65 (0.32-1.31)	1.03 (0.94-1.13)	0.94 (0.90-0.98)	Ref	1.05 (0.95-1.16)	0.88 (0.69-1.13)
BMI	0.88 (0.84-0.92)		0.85 (0.56-1.29)	1.14 (1.07-1.21)	0.88 (0.85-0.92)		1.12 (1.05-1.20)	1.13 (0.99-1.27)
C/Obesity	1.05 (0.95-1.15)		3.23 (0.59-17.6)	1.07 (0.88-1.31)	1.05 (0.95-1.15)		1.02 (0.82-1.25)	1.52 (0.86-2.66)
WHtR	$9.14x10^{-5}$ ($5.43x10^{-11}$ -153.7)		5.69x10-72 ($3.25x10^{-176}$ $-1.00x10^{33}$	0.009 ($1.42x10^{-15}$ -5.37x1010)	$9.62x10^{-5}$ ($5.41x10^{-11}$ -171.1)		47.2 ($6.30x10^{-13}$ $-3.54x10^{15}$)	$1.57x10^{-24}$ ($2.82x10^{-59}$ $-8.78x10^{10}$)

BMI - body mass index; C- central; WHtR - waist-to-height ratio; SBP - Systolic blood pressure.

lack of comparison with adult guidelines for youths, and (3) unsatisfactory debate on the assessment of blood pressure at consistent intervals, to lower the white coat high blood pressure consequences. These then led to updates with significant changes which include thirty (30) major action statements and twenty-seven (27) additional suggestions resulting from a broad analysis of many published articles distributed within twelve years (Flynn et al. 2017). However, the prevalence of hypertension in youths following the 2004 Fourth Report has been found to vary between 2 percent and 4 percent (Bell et al. 2019; Centers for Disease Control and Prevention 2020).

The findings of the current study revealed a big increase in the prevalence of hypertension with the 2017 AAP guideline compared with the 2004 Fourth report guideline in both genders. For example, the fourth report guideline for systolic blood pressure shows that the prevalence of hypertension was 1.5 percent for boys and 1.7 percent for girls. For diastolic blood pressure, a prevalence of 1.6 percent was found in boys and 0.9 percent in girls. When using the AAP guidelines, the prevalence of systolic hypertension skyrocketed to 9.5 percent for boys and 5.9 percent for girls. Similarly, there was an increase in the prevalence of diastolic blood pressure among boys (6.3 percent) and girls (3.9 percent). These findings corroborate Kibria et al. (2019) findings which estimated changes in the prevalence and tendencies of youthful blood pressure proportion in the United States and found an increase in the prevalence of hypertension in youths following the 2017 AAP protocols.

Our study findings also showed that by age, following the AAP guideline, 12.1 percent and 12.8 percent of children aged 15 and 16 years old were hypertensive, respectively, while the hypertension prevalence based on the Fourth Report criteria by age revealed that 5.8 percent and 2.8 percent of those aged 15 and 14 years were hypertensive, respectively. The findings of this study are also consistent with a previous study which found the prevalence of hypertension among youths to be consistently higher in boys than in girls (Flynn et al. 2017). Studies have shown that the prevalence of hypertension could differ in accordance with age, gender, and other socio-demographic features among youths (Toriola et al. 2017; Muntner et al. 2018; Sharma et al. 2018; Dorans et al. 2018). Kibria et al. (2019) stated further that understanding the trends of socio-demographic features among youths should be prioritised due to the undesirable effect of youthful hypertension. Other factors reported to have played an important role in the increased blood pressure structures in children and adolescents were early life factors, dietary behaviours, and physical inactivity (Dong et al. 2019).

Consequently, our study regression analysis findings showed that there was an association between the selected physiological indicators (Age, height, BMI, central obesity, and waist to height ratio) with blood pressure categories in both the 2017 AAP clinical practice guidelines and the 2004 Fourth Report. Age increase, height, and children with excessive fat indicators, especially the body mass index and central obesity were more likely to have their blood pressure elevated and hypertensive compared to those children with normal fat distributions following 2017 AAP regulations. The same trends were found for the 2004 Fourth Report among the participants. As part of the consistent several risk factors which has been heavily linked with paediatric high blood pressure were overweight and obesity. Studies have shown that the prevalence of hypertension was greatly high among overweight and obese children (Falkner 2010; Rao 2016; Flynn et al. 2017; Noubiap et al. 2017; Bell et al. 2019; Dong et al. 2019).

Furthermore, high blood pressure prevalence differed according to age, gender, ethnicity, and stature. For example, the short young male individual was more likely to be hypertensive following the 2017 AAP compared with the 2004 Fourth Report, while older male persons were less likely to be hypertensive (Ezeudu et al. 2018; Bell et al. 2019; Dong et al. 2019), although, these assumptions were not consistent in females (Bell et al. 2019). In addition, central obesity, assessed as increased waist circumference, has been revealed to be related to high blood pressure, autonomous of body mass index (Rosner et al. 2013). The present growing youth obesity widespread and its robust association of hypertension with excessive body fat shows that the prevalence of hypertension may continue to increase in youths (Falkner 2010). Of concern is the prevalence of pre-hypertension and hypertension in

asymptomatic youths which needs attention (Falkner 2010).

The findings of this study should be interpreted with caution following some limitations. First, two blood pressure assessments were performed, and values obtained at a single visit. This could result in overvalue of hypertension prevalence (Dong et al. 2019). Second, the reference values of both the 2017 AAP and 2004 Fourth Report recommendations were based on American children, which may influence its use in the Nigerian populace. Previously, the 2004 Fourth Report was commonly utilised in some studies published in Nigeria, meanwhile using the current AAP guideline should be welcome as new development across the country and should be used in Nigerian youths. The data used in this study was obtained from only one state geographically located in the South-West of Nigeria. On this ground, the findings cannot be generalised across the country. Future study is necessary to confirm these assumptions.

CONCLUSION

In conclusion, this study suggests a high prevalence of hypertension in children and adolescents following the recent AAP guidelines compared to the Fourth Report guidelines.

RECOMMENDATIONS

This study recommends the need to scale up the identification, examination, intervention, and prevention using a policy formulation and implementation approaches in children especially from a low-income country like Nigeria. Priority should be given to primary prevention by encouraging youths to engage in a healthy lifestyle.

ACKNOWLEDGEMENTS

The authors acknowledge the participants of this study and their parents. The authors also thank the school head and teachers of all the participating schools.

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Paper received for publication in June, 2021
Paper accepted for publication in September, 2021