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Association between physical activity level and blood pressure: varied and graded mediating effects of obesity indices in schoolchildren

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Abstract

Objective: To explore the mediating effects of adiposity indices in the association between physical activity level and blood pressure in a Nigerian schoolchildren population. *Materials and Methods:* One thousand five hundred and seventeen schoolchildren (714 males and 803 females) from randomly selected primary schools participated. Physical activity level, sum of skinfold thickness at three sites, waist circumference, body mass index, and blood pressure were measured using standardised procedures. The statistical significance of the mediating effects of adiposity indices was determined using Sobel Test. *Results:* Some obesity indices mediated the association between physical activity level and systolic blood pressure [males: waist circumference ($t = 5.31$; $p < 0.001$), skinfold thickness ($t = 3.80$; $p < 0.001$), and waist circumference/height ($t = 2.21$; $p < 0.001$); females: body mass index ($t = 8.03$; $p < 0.001$), waist circumference ($t = 7.80$; $p < 0.001$), and skinfold thickness ($t = 5.94$; $p < 0.001$)]. Similarly, some obesity indices mediated the prediction of diastolic blood pressure in females [males: body mass index ($t = 1.95$; $p = 0.05$), waist circumference ($t = 2.65$; $p = 0.01$), and skinfold thickness ($t = 1.97$; $p = 0.05$); females blood pressure: body mass index ($t = 6.49$; $p < 0.001$), waist circumference ($t = 6.29$; $p < 0.001$), skinfold thickness ($t = 2.31$; $p = 0.02$), and waist circumference/height ($t = 2.59$; $p = 0.01$)]. *Conclusion:* The obesity indices that mediate the association between physical activity level and blood pressure vary, and their mediating effects are graded. While waist circumference and skinfold thickness exert the greatest mediating effects on the association in males, body mass index and waist circumference do in females.

Essential hypertension is a public health and socio-economic challenge to populations worldwide.[1] Childhood hypertension is common, and usually tracks into adulthood.[2] Childhood hypertension can be associated with adverse health outcomes which may track into adulthood.[3] Considering the personal and public health burden of hypertension, exploring the predisposing factors and their pathways to hypertension in children are necessary. Unravelling those factors will make it possible to address the problem early enough and thereby reduce future prevalence of hypertension in adulthood.[4,5]

Other than gene disorders for secondary hypertension, the causes of essential hypertension are not well understood.[6] Indeed, essential hypertension usually manifests through poor lifestyles. Physical inactivity and obesity are important lifestyle-related, public health concerns.[7] These concerns are independent risk factors for cardiovascular diseases.[8,9] Ample evidence from prospective studies shows that regular physical activity behaviour reduces the risks for hypertension.[7,10] This reduction is thought to be partly mediated through decreased body weight.[11] In fact, the predictors of future blood pressure are body mass index, and changes in body mass index has been documented in studies tracking blood pressure from childhood to adulthood.[10,12] Furthermore, overweight and obesity is one of the 10 leading risk factors for hypertension globally.[13] Thus, obesity management, weight control, and increased physical activity level are associated with long-term beneficial effect on blood pressure.[14] Despite the associated cardiovascular risks, physical inactivity and obesity are, however, rapidly increasing in countries of the world.[11,15]

Positive associations of body mass index and waist circumference with systolic and diastolic blood pressure have been reported in American,[2,16,17] Asian,[18–20] and European[21–23] children. In addition, inverse associations between physical activity level and blood pressure have been reported.[20,24,25] However, studies on associations of obesity indices[26–28] and physical activity level or physical fitness[27,29] with blood pressure in African population are not readily available. Furthermore, the accessible studies on the mediating roles of obesity indices in the association between physical activity level and blood pressure are scarce, and the few available are not on African populations.[25,30] The findings in studies from non-African countries may not be easily extrapolated to African children, perhaps, due to genetic variations among races.[31] In the current study, we hypothesised that obesity indices will mediate the association between physical activity level and blood pressure in schoolchildren. Thus, this study explored the mediating effects of adiposity indices in the association between physical activity level and blood pressure in a Nigerian schoolchildren population.

Materials and methods

Participants

This cross-sectional study involved 1517 pupils (714 males and 803 females) from 12 randomly selected primary schools (7 private and 5 public schools) out of a total of 107 primary schools (65 private and 42 public) registered with the Local Education Authority in Nnewi. Each of the selected schools has six grades (1–6). Where a grade had more than one class, a class was randomly selected. Otherwise, the only class in the grade was selected, and this was the case only in five private schools. The study sample was drawn from the selected class. The drawing of participants was done separately for public and private schools to ensure equal representation in the sample. Participants were excluded if they had any chronic conditions or physical deformity, such as sickle cell disease or poliomyelitis deformity, and any other conditions that could make measurement of height and weight difficult. They were also excluded if they could not show proof of informed consent from their parents or guardians.

Procedures

The procedures employed in this study were approved by the Ethics Committee of University Teaching Hospital affiliated to the institution of this study. At the first visit to the selected schools, the head teachers of the schools were approached with a letter introducing the researchers, explaining the nature and purpose of the study, and seeking their permission to collect information required in the study on their pupils. They all granted the permission, and approved dates and times for the data collection. Before the agreed day for data collection, another visit was paid to the schools to randomly select a class from different grades in the schools where it was necessary. The pupils in the selected classes were given letters to their parents and guardians, informing them about the nature and purpose of the study, and requesting their consent. The parents granted this request by signing against "accept" at the end of the letter.

On the day of data collection, the eligible pupils from the selected classes, who had obtained their parents' consent, were included in the study. All measurements were taken using the same type of instruments and following the same corresponding procedures. To ensure that none of the eligible pupils in a selected class was omitted, the class register was obtained from the class teacher, and each name was ticked off as the required data were collected on the respective pupils. The data collection spanned March 2017 to June 2017. Thirteen research assistants, who were final-year students of the physiotherapy programme in the institution of study, had been trained in the relevant assessment procedures, and were involved in the data collection in all the schools. In addition to the information collected on their age and gender, the following measurement procedures as well as derivations were carried out.

Physical activity level

The physical activity level of participants was assessed using Physical Activity Questionnaire for Older Children. It was administered while the students were seated in the classroom. Physical Activity Questionnaire for Older Children is a 10-item questionnaire. Items 1–9 are measured on five-point scales, ranging from "1" to "5," but with varying response sets, while the item 10 is measured on a two-point scale which could be denoted as "0" representing "No" and "1" representing "Yes." Only items 1–9 are used to calculate the Physical Activity Questionnaire for Older Children activity summary score. The detailed description of the questionnaire and the scoring criterion are available elsewhere.[32] Higher Physical Activity Questionnaire for Older Children activity summary scores indicate higher physical activity levels. Physical Activity Questionnaire for Older Children has been reported to have internal consistencies of $r = 0.83$ for females and $r = 0.80$ for males, and 1-week test–retest reliability of $r = 0.75$ for male and $r = 0.82$ for females.[33] Also, Physical Activity Questionnaire for Older Children has a convergent validity of $r = 0.63$.[34]

Obesity indices

Height of the patient was measured using a height meter (Seca, 213 Measuring Rod): participants stood barefoot and erect, looking straight ahead, and the height was read from the height meter at the level of vertex of the head, and recorded to the nearest 0.1 cm. Body weight was measured to the nearest kilogram using a weighing scale (Hana, model BR90 11, China). Before the participants got on the scale, the scale pointer was on the zero point. The participants were measured barefoot and with minimal clothing while standing on the weighing scale. The weight was read from the scale with the observer bending over the scale. Body mass index was determined from measured height and weight of the participants using the relation: Weight/height^2. From these body mass index values, age- and gender-specific overweight and obesity were determined using the International Obesity Task Force cut-off points.[35]

Waist circumference was measured at the level of the umbilicus to the nearest cm, at the end expiration, using an inelastic tape measure (Butterfly, China). In addition, waist circumference–height ratio was determined by dividing the measured waist circumference by the height.

Skinfold thickness was measured at the triceps, the abdomen, and the subscapular regions using a skinfold calliper (Slim Guide, Michigan, United States of America). The triceps skinfold thickness was taken at the mid-point between the acromion of the scapula and olecranon processes of the ulna of right upper limbs with the elbow relaxed and extended. The examiner pulled a perpendicular skinfold, about 1 cm to the left of the mid-point. The contact surfaces of the calliper were placed perpendicular to the length of the fold. Then the examiner released the calliper and read the dial after approximately 3–4 seconds, while the finger still held the skinfold. The reading was recorded to the nearest millimetre. For the abdominal skinfold measurement, the examiner located a point of intersection of right mid-clavicular line and a horizontal line from the umbilicus. Then the measurement was taken and recorded at the intersection, as described for the triceps skinfold. For subscapular skinfold measurement, the examiner located a point 1.0 cm below the inferior angle of the scapular and pulled a skinfold. Then the measurement was taken and recorded as described for the triceps skinfold. Three readings were taken on each site and the average of the last two readings was

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recorded to the nearest 0.01 mm. The averages of skinfold thicknesses from the three sites were added up to give sum of skinfold thickness.

Blood pressure

Resting systolic and diastolic blood pressure of the participants was taken using automatic blood pressure monitor (Omron, HEM-712) following the procedures explained elsewhere.[3,36] In brief, participants were asked to rest for at least 5 minutes, and seat, with back supported and the feet resting comfortably on the floor. Using cuffs of appropriate sizes, the right arm was supported at the heart level, measurements were taken three times in each patient, and at least 2 minutes was allowed between each measurement. Average of the last two measurements was recorded for systolic blood pressure and diastolic blood pressure. Five research assistants who had been trained in the assessments of variables examined in this study, and were trained in recording of the collected data, were involved in the data collection procedures.

Sample size estimation

A sample size of 652 participants was estimated to have 95% power to detect an effect size of 0.02 at 0.05 level of error using G*Power 3.0.10. However, considering that the analyses were carried out by gender, this was multiplied by 2 giving a minimum sample size of 1304 pupils.

Statistical analysis

The data were summarised using the descriptive statistics of mean and standard deviation, and distributions of categorical variables were presented using frequency and proportion. Bivariate Pearson correlation was used to determine correlations among physical activity, blood pressure, body mass index, waist circumference, waist circumference–height ratio, and skinfold thickness. Multiple linear regressions were used to determine the associations between physical activity level, systolic blood pressure, diastolic blood pressure, and each of body mass index, waist circumference, waist circumference–height ratio, and skinfold thickness in turn. Sobel Test was used to determine the significance of the mediating effects of each of body mass index, waist circumference, waist circumference–height ratio, and skinfold thickness in the predictive association between systolic blood pressure and diastolic pressure, and physical activity level. All analyses were carried out using SPSS version 21 at a significant level of 0.05.

Results

Table 1 shows that participants in this study comprised 52.9% females and had a mean age of 10.45 ± 1.71 years for males and 10.17 ± 1.64 years for females. Mean values for body mass index, waist circumference, skinfold thickness, waist circumference–height ratio, systolic blood pressure, diastolic blood pressure, and physical activity levels are as shown in Table 1. Table 2 shows that there were significant correlations among systolic blood pressure, diastolic blood pressure, body mass index, waist circumference, skinfold thickness, waist circumference–height ratio, and physical activity levels in males ($r = 0.1–0.7$; $p = 0.02$ to <0.001) and in females ($r = 0.1–0.7$; $p = 0.01$ to <0.001).

Data in this study showed that physical activity level significantly predicted systolic blood pressure ($B_o = 99.87$; $B = 7.33$; $p < 0.001$) and diastolic blood pressure ($B_o = 52.58$; $B = 7.0$; $p < 0.001$) in males, and systolic blood pressure ($B_o = 102.67$; $B = 8.33$; $p < 0.001$) and diastolic blood pressure ($B_o = 56.12$; $B = 5.52$; $p < 0.001$) in females (Table 3).

Table 1. Characteristics of the participants

	Male (n = 714)		Female (n = 803)	
	Mean	SD	Mean	SD
Age (year)	10.45	1.71	10.17	1.64
BMI (kg/m^2)	17.19	2.44	17.46	2.81
Σ3SFT (mm)	20.88	12.75	28.90	14.08
WC (cm)	59.91	5.12	61.29	6.42
WC/height	0.43	0.03	0.44	0.04
Systolic BP (mmHg)	109.10	12.22	112.98	12.38
Diastolic BP (mmHg)	61.04	9.95	62.96	9.22
PA level	2.67	0.54	2.38	0.52

BMI = Body mass index; BP = Blood pressure; PA = Physical activity; Σ3SFT = Sum of skinfold thickness at three sites; WC = Waist circumference

The unstandardised coefficients for the associations of physical activity level with body mass index ($B = 1.77$; standard error (SE) = 0.21), waist circumference ($B = 3.30$; $SE = 0.46$), skinfold thickness ($B = 13.12$; $SE = 1.07$), and waist circumference–height ratio ($\beta = 0.01$; $SE = 0.003$) in males, and body mass index ($B = 2.39$; $SE = 0.22$), waist circumference ($B = 5.86$; $SE = 0.49$), skinfold thickness ($B = 17.11$; $SE = 1.00$), and waist circumference–height ratio ($B = 0.02$; $SE = 0.003$) in females are as shown in Table 4.

Table 5 shows the unstandardised coefficients for the associations between systolic blood pressure and adiposity indices in males [body mass index ($B = 1.15$; $SE = 1.19$), waist circumference ($B = 0.71$; $SE = 0.09$), skinfold thickness ($B = 0.16$; $SE = 0.04$), and waist circumference–height ratio ($B = 40.80$; $SE = 13.84$)] and females [body mass index ($B = 1.79$; $SE = 0.15$), waist circumference ($B = 0.72$; $SE = 0.07$), skinfold thickness ($B = 0.19$; $SE = 0.03$), and waist circumference–height ratio ($B = 10.90$; $SE = 12.21$)], and between diastolic blood pressure and adiposity indices in males [body mass index ($B = 0.30$; $SE = 0.15$), waist circumference ($B = 0.20$; $SE = 0.07$), skinfold thickness ($B = 0.06$; $SE = 0.03$), and waist circumference–height ratio ($\beta = 18.33$; $SE = 11.21$)] and females [body mass index ($B = 0.97$; $SE = 0.12$), waist circumference ($B = 0.37$; $SE = 0.05$), skinfold thickness ($B = 0.07$; $SE = 0.03$), and waist circumference–height ratio ($B = 25.64$; $SE = 9.13$)].

Table 6 shows that the mediating effects of adiposity indices in the prediction of systolic blood pressure from physical activity level were significant for only waist circumference ($t = 5.31$; $p < 0.001$), skinfold thickness ($t = 3.80$; $p < 0.001$), and waist circumference–height ratio ($t = 2.21$; $p = 0.03$) in males, and for only body mass index ($t = 8.03$; $p < 0.001$), waist circumference ($t = 7.80$; $p < 0.001$), and skinfold thickness ($t = 5.94$; $p < 0.001$) in females. In addition, the mediating effects of adiposity indices in the prediction of diastolic blood pressure from physical activity level was significant for only body mass index ($t = 1.95$; $p = 0.05$), waist circumference ($t = 2.65$; $p = 0.01$), and skinfold thickness ($t = 1.97$; $p = 0.05$) in males, and body mass index ($t = 6.49$; $p < 0.001$), waist circumference ($t = 6.29$; $p < 0.001$), skinfold thickness ($t = 2.31$; $p = 0.02$), and waist circumference–height ratio ($t = 2.59$; $p = 0.01$) in females (Table 6).

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Table 2. Correlation matrix of the relationships among the BP, adiposity indices, and PA level of the participants

	SBP (r; p-value)	DBP (r; p-value)	BMI (r; p-value)	WC (r; p-value)	Σ3SFT (r; p-value)	PA level (r; p-value)	WC/height (r; p-value)
Male (n = 714)							
SBP (mmHg)	1	0.5; <0.001	0.3; <0.001	0.3; <0.001	0.3; <0.001	−0.3; <0.001	0.1; <0.001
DBP (mmHg)		1	0.2; <0.001	0.2; <0.001	0.2; <0.001	−0.3; <0.001	0.1; 0.02
BMI (kg/m^2)			1	0.5; <0.001	0.5; <0.001	−0.3; <0.001	0.5; <0.001
WC (cm)				1	0.5; <0.001	−0.3; <0.001	0.7; <0.001
Σ3SFT (mm)					1	−0.4; <0.001	0.4; 0.01
PA level						1	−0.1; <0.001
WC/height							1
Female (n = 803)							
SBP (mmHg)	1	0.5; <0.001	0.5; <0.001	0.4; <0.001	0.3; <0.001	−0.3; <0.001	0.1; 0.01
DBP (mmHg)		1	0.4; <0.001	0.3; <0.001	0.2; <0.001	−0.3; <0.001	0.2; <0.001
BMI (kg/m^2)			1	0.6; <0.001	0.5; <0.001	−0.4; <0.001	0.4; <0.001
WC (cm)				1	0.6; <0.001	−0.4; <0.001	0.7; <0.001
Σ3SFT (mm)					1	−0.5; <0.001	0.4; 0.01
PA level						1	−0.1; <0.001
WC/height							1

BMI = Body mass index; BP = Blood pressure; DBP = Diastolic blood pressure; PA = Physical activity; SBP = Systolic blood pressure; Σ3SFT = Sum of skinfold thickness at three sites; WC = Waist circumference

Table 3. Association between PA level and BP

	Unstandardised coefficients		
	B_o	B	p-value
Male (n = 714)			
Systolic BP (mmHg)	99.87	7.33	<0.001
Diastolic BP (mmHg)	52.58	7.0	<0.001
Female (n = 803)			
Systolic BP (mmHg)	102.67	8.33	<0.001
Diastolic BP (mmHg)	56.12	5.52	<0.001

BP = Blood pressure

Table 4. Unstandardised coefficients for the association between PA level and adiposity indices

	Unstandardised coefficients		
	B	SE	p-value
Male (n = 714)			
BMI (kg/m^2)	1.77	0.21	<0.001
WC (cm)	3.30	0.46	<0.001
Σ3SFT (mm)	13.12	1.07	<0.001
WC/height	0.01	0.003	<0.001
Female (n = 803)			
BMI (kg/m^2)	2.39	0.22	<0.001
WC (cm)	5.86	0.49	<0.001
Σ3SFT (mm)	17.11	1.00	<0.001
WC/height	0.02	0.003	<0.001

BMI = Body mass index; BP = Blood pressure; PA = Physical activity; Σ3SFT = Sum of skinfold thickness at three sites; WC = Waist circumference

Discussion

The objective of this study was to explore the mediating effects of adiposity indices in the association between physical activity level and blood pressure in a Nigerian schoolchildren population. The findings in this study showed that waist circumference, skinfold thickness, and waist circumference–height ratio significantly mediated the association between physical activity level and systolic blood pressure in males, and body mass index, waist circumference, and skinfold thickness in females. In addition, body mass index, waist circumference, skinfold thickness, and waist circumference–height ratio significantly mediated the association between physical activity level and diastolic blood pressure in females, but only body mass index, waist circumference, and skinfold thickness in males.

The multiplicity of factors that influence blood pressure is an indication of the complex nature of development of childhood hypertension. The lifestyle interventions recommended for hypertension management in children include weight reduction through dieting and/or regular physical activity behaviour as well as reduced salt intake.[30] Salt intake level, parental history of hypertension, and dieting are possible confounders in the association between physical activity level and blood pressure. However, these variables were not examined in this study, and their possible confounding effects may present a limitation to the findings in this study.[25] In addition, physical activity level was assessed in this study

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Table 5. Unstandardised coefficients for the associations between adiposity indices and BP when PA level is also a predictor

	SBP		DBP	
	Unstandardised coefficients		Unstandardised coefficients	
	B	SE	B	SE
Male (n = 714)				
BMI (kg/m^2)	1.15	1.19	0.30	0.15
WC (cm)	0.71	0.09	0.20	0.07
Σ3SFT (mm)	0.16	0.04	0.06	0.03
WC/height	40.80	13.84	18.33	11.21
Female (n = 803)				
BMI (kg/m^2)	1.79	0.15	0.97	0.12
WC (cm)	0.72	0.07	0.37	0.05
Σ3SFT (mm)	0.19	0.03	0.07	0.03
WC/height	10.90	12.21	25.64	9.13

BMI = Body mass index; BP = Blood pressure; DBP = Diastolic blood pressure; PA = Physical activity; SBP = Systolic blood pressure; Σ3SFT = Sum of skinfold thickness at three sites; WC = Waist circumference

Table 6. Mediating effects of adiposity indices in the prediction of BP from PA level among the participants using Sobel Test

	SBP			DBP		
	t-test	SE	p-value	t-test	SE	p-value
Male (n = 714)						
BMI (kg/m^2)	0.96	2.12	0.34	1.95	0.27	0.05*
WC (cm)	5.31	0.44	<0.001*	2.65	0.25	0.01*
Σ3SFT (mm)	3.80	0.55	<0.001*	1.97	0.40	0.05*
WC/height	2.21	0.19	0.03*	1.47	0.13	0.14
Female (n = 803)						
BMI (kg/m^2)	8.03	0.53	<0.001*	6.49	0.36	<0.001*
WC (cm)	7.80	0.54	<0.001*	6.29	0.35	<0.001*
Σ3SFT (mm)	5.94	0.55	<0.001*	2.31	0.52	0.02*
WC/height	0.89	0.25	0.38	2.59	0.20	0.01*

BMI = Body mass index; BP = Blood pressure; DBP = Diastolic blood pressure; PA = Physical activity; SBP = Systolic blood pressure; Σ3SFT = Sum of skinfold thickness at three sites; WC = Waist circumference
*significant at $P < 0.05$

through self-report. Self-report measures have been reported to have poor estimation of physical activity level in children, as childhood activity is sporadic.[37] This poor estimation can be compounded with recall bias.[25] However, the standardised physical activity level measure employed in this study was meant to minimise subjectivity and bias in reported physical activity. In addition, information on socio-economic background of the children was not collected. Inclusion of socio-economic status in the predictive models may affect the findings in this study. It is recommended that more studies of this nature adjusting out all these potential confounders of the association between physical activity level and blood pressure, and adopting objectively measured physical activity level be carried out. The strength of this study is the use of adequate sample size obtained through random selection of participants.

Obesity and low physical activity level have been serious public health concerns in about the last two decades because of its health consequences and increasing prevalence. Childhood obesity and inadequate physical activity level in children are particularly health concerns by virtue of their adverse effects on the future adult health. Low physical activity level or physical fitness and obesity in children have been well reported as contributing to childhood hypertension, which tracks into adulthood. In fact, many previous studies reported associations between obesity indices and blood pressure in children.[18,22,38,39] The obesity indices examined in those previous studies included body mass index, waist circumference, and percent body fat with the first two indices being the most frequently reported. Although, percent body fat was not examined in this study, the skinfold thickness examined in this study is a surrogate index of percent body fat. In addition, the findings of predictive inverse associations of physical activity level with body mass index, waist circumference, and skinfold thickness have been previously observed.[33,40] However, contrary to the findings in this study, Ribeiro et al observed no association between physical activity level and blood pressure in children aged 8–16 years in Portugal.[22]

The associations between physical activity level and each of systolic blood pressure and diastolic blood pressure were variedly mediated by body mass index, waist circumference, skinfold thickness, and waist circumference–height ratio. However, the strength of these mediations was graded, with waist circumference and skinfold thickness exerting the strongest effects on the association between physical activity level and blood pressure in males, while body mass index and waist circumference do in females. Similar to the findings in this study, the associations between physical activity level and blood pressure in children have been well reported in the literature.[24,25,41] However, reports on mediating roles of adiposity indices in the association between physical activity level and blood pressure are not readily available. A previous study has demonstrated that adjustment of body size and obesity index make the association between physical activity level and blood pressure weaker, in line with the findings in this study.[25] In addition, similar to the findings in this study, Maximova et al reported that changes in body mass index, waist circumference, and skinfold thickness, from early adolescence, attenuated the association between physical activity level and systolic blood pressure in males in late adolescence, whereas no such attenuation was observed in females.[30] Indeed, Leary[25] et al reported that it is difficult to isolate the interrelationships between physical activity level and body mass index, as body mass index is assumed to be on the causal pathway between physical activity level and blood pressure, and that including body mass index in the model predicting blood pressure from physical activity level may represent over-adjustment. Furthermore, a previous study demonstrated that, after adjusting for potential confounders, the volume rather than the intensity of physical activity is more important in the association with blood pressure.[25]

The findings in this study have implications for public health in schoolchildren. The findings of inverse relationship between physical activity level and blood pressure, in this study, suggest the need to emphasise adequate physical activity in these children, especially during the school hours. Leung et al have reported that two or more extracurricular sessions per week at school reduce the risk of childhood hypertension.[20] Similarly, a decline in moderate-to-vigorous physical activity by one session per week with each advancing age is associated with higher systolic blood pressure in males and females, and in males alone, in early and late adolescence.[30] Furthermore, a higher exercise frequency is associated

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with lower blood pressure.[35] In addition, the mediating effects of the adiposity indices in the predictions of systolic blood pressure and diastolic blood pressure from physical activity level in this study suggest the need for body fat management in these children either through increased physical activity level and/or proper dieting.[36] Although high blood pressure has been associated with family history,[42] this association is partly mediated by a shared and modifiable environment, which includes low physical activity level and improper dieting.[6,43] Furthermore, the findings also suggest the need for measurement of adiposity indices, especially body mass index and waist circumference, as part of clinical examinations and screening protocols in children. The clinical utility of these obesity indices as cardiovascular risk factors has been previously reported.[16,44]

In conclusion, the obesity indices that mediate the association between physical activity level and blood pressure vary, and their mediating effects are graded. While waist circumference and skinfold thickness exert the greatest mediating effects on the association in males, body mass index and waist circumference do in females.

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Conflict of Interest. None.

Ethical Standard. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national guidelines on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008, and has been approved by Ethics Committee of Nnamdi Azikiwe University Teaching Hospital.

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