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ORIGINAL ARTICLE

Association between Selected Body Composition, Blood Pressure and Musculoskeletal Fitness in Nigerian Children

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ABSTRACT

Background. Considerable research evidence shows that obesity negatively influences children's physical, physiological and musculoskeletal wellbeing. This study examined the relationship between triponderal mass index (TMI), blood pressure (BP), and musculoskeletal fitness (MSF) in a cross-sectional sample of school children in Ado-Ekiti, Southwest Nigeria. **Methods.** Body weight, stature, systolic and diastolic blood pressures (SBP & DBP), and three components of musculoskeletal fitness, comprising sit and reach (SR), sit-up (SUP), standing broad jump (SBJ), and 20-meter shuttle runs, were assessed in 1229 (boys=483, 39.3%; girls=746, 60.7%) school children (age range: 9-13 years). **Results.** A significant positive correlation was found between TMI and SBP (r= 0.182, P < 0.01), and DBP (r= 0.090, P < 0.01), while TMI and SR (r= -0.067, P < 0.05) and SBJ (r= -0.246, P < 0.01) yielded a substantial inverse relationship. Children with severe underweight were significantly less probable to perform well in SBJ (OR= 0.96, CI= 0.94; 0.99) and 20-meter shuttle run (OR= 1.39, CI= 1.22; 1.61). Childhood overweight was associated with increased SBP (OR= 1.03, CI= 1.02; 1.05) and poor SBJ (OR= 0.98, CI= 0.97; 0.99). Obese children were significantly associated with increased SBP (OR= 1.04, CI= 1.02; 1.06), poor SR (OR= 0.92, CI= 0.87; 0.98) and SBJ (OR= 0.94, CI= 0.93; 0.96) scores compared to age- and sex-specific norms. **Conclusion.** Elevated BP and poor musculoskeletal fitness could adversely affect the wellbeing of undernourished, overweight, and obese Nigerian children. Findings implicate the need to implement dietary and physical activity intervention programmes to promote desirable health-related quality of life in school-going children.

KEYWORDS: ***Triponderal Mass Index, Musculoskeletal Fitness, Children, Sub-Saharan Africa***

INTRODUCTION

Overweight and obesity in children are a public health challenge and should remain a national priority in countries around the world. The origin of cardiovascular disease (CVD) in adulthood, of which obesity remains one of its major risk factors, starts from childhood (1, 2). Obesity is strongly associated with major health risks such as hyperglycemia, asthma, arthritis, high BP, hyperlipidemia, and faltering quality of life (3). Numerous studies have shown that there is a connection between risk factors of CVD and poor musculoskeletal fitness in school children (1, 4). A number of studies have also reported that any child with a highly active lifestyle and improved musculoskeletal fitness could prevent himself or herself from the future occurrence of any kind of cardiovascular illness (5).

The major two anthropometric assessments most used to evaluate body fat in several age groups are body mass index (BMI) and tri-

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ponderal mass index (TMI) (6, 7). However, BMI has been most extensively recognised and used as a body weightiness valuation means among youths, while its association with physical or musculoskeletal fitness and performance has widely been investigated (8-11). However, it has been reported that BMI inherently has weaknesses in reliably measuring the fat mass percentage (7, 12). In contrast, recent studies have suggested that TMI could be as a better prognosticator of health in children than BMI (6, 7, 12). Despite its usefulness in body conformation research, the connection between TMI, blood pressure, and musculoskeletal fitness in children has not been conclusively elucidated.

Monyeki et al. (13) reported that the relations between body mass index and musculoskeletal health in children in industrialised countries have been explored, but relatively tiny empirical evidence in this regard is obtainable in underdeveloped countries. In addition, studies examining the association between TMI, blood pressure, and musculoskeletal performance in children from sub-Saharan Africa countries, especially Nigeria, have rarely been conducted. Examining the relationship linking TMI, BP, and musculoskeletal fitness status in children is important from a public health standpoint. First, it could provide useful data for planning the health system in reaction to youth excessive fatness (14). Second, findings of the study could facilitate early detection of children at risk of future cardiovascular and musculoskeletal dysfunction so that appropriate intervention could be instituted. Third, various health advantages were linked with musculoskeletal fitness. For example, it lower risk factors for coronary diseases, lower osteoporosis risk, improve elasticity, improved sugar forbearance, and help complete daily task without unnecessary fatigue (15). Finally, information on musculoskeletal fitness parameters, blood pressure, and TMI are usable markers of an individual's overall wellbeing, especially youths. Hence, this study examined the association between TMI, blood pressure, and constituents of musculoskeletal fitness (flexibility: sit-and-reach test; muscular endurance: sit-up test; explosive leg power: standing broad jump, and shuttle run counts) in a sample of school children aged 9 to 13 years old in Ado-Ekiti, Southwestern Nigeria.

MATERIALS AND METHODS

Ethical Considerations. We sought authorisation to carry out the study from the Ekiti State Ministry of Education. This was followed by contacting the local and school authorities and the children's parents. Information leaflet which contains the purpose of the study, its procedures, and where the study would take, place was distributed to all the children and their guardians/parents or carers, who subsequently provided written agreement form. Only children whose parents or guardians signed the consent forms were permitted to take part in the study. The children also gave verbal assent before the study commenced. The study was also executed following the ethical codes of Helsinki pronouncement for investigations relating to human subjects (16).

The methodology of this study followed the approach used in Toriola et al. (8) study where a cross-section research plan was utilised to gather data on TMI, blood pressure, and musculoskeletal health variables. These are flexibility (sit-and-reach test), muscular endurance (sit-up test), explosive leg power (standing broad jump), and shuttle run counts among 1229 (boys=483, 39.3% and girls=746, 60.7%) school children aged 9-13 years, haphazardly chosen from five municipal primary schools in Ado-Ekiti, Southwest, Nigeria. The children's ages were confirmed from their school register with the assistance of class teachers.

Measurements. Anthropometry. The practice of the International Society for the Advancement of Kinanthropometry was followed for the assessment of height, body weight, and skinfolds. The skinfolds assessed includes triceps and subscapular (17). Height of the participants was assessed closed to 0.1 cm barefooted while the participants stood erect alongside a fixed stadiometer. We used a numerical weighing gauge named Tanita HD 309 manufactured by Creative Products, MI, USA, to assess body weight with participants flippantly dressed. Regular calibration of the weighing gauge closed to 0.1 kg was performed after every 15 assessments. Based on the value derived from the participants' height and body weight, TMI was computed by apportioning weight (kg) by height cubed (m^3). Thus, TMI expressed as kg/m^3 poses a better assessment of plumpness in youths (12). The youngsters' TMI was afterwards grouped as severe underweight, underweight, normal, overweight, and obese for age and gender using the age- and sex-specific TMI limit points (12). Waist-to-height ratio (WHtR) was derived from waist splitted by height in centimetre. All data were collected by a group of trained field workers and documented using appropriate datasheets.

Blood Pressure. Blood pressure (BP) was assessed (in mm Hg - millimetres of mercury) with an automated BP censor (Omron HEM - 705 CP devices, Tokyo, Japan). The regular procedures of the Blood Pressure Association (18) were applied for the children's BP assessment. We used the last two readings to calculate the average for systolic (SBP) and diastolic (DBP) measurements, respectively. The four BP categories as documented by the BP association are Low (90 over 60, i.e., 90/60 or less), Normal (More than 90 over 60 or 90/60) and less than 120 over 80, i.e., 120/80), pre-hypertension (More than 120 over 80 and less than 140 over 90 (120/80-140/90)), and hypertension (140 over 90, i.e., 140/90 or higher).

Musculoskeletal Fitness Assessment. We followed the protocol of the European test of physical fitness to assess health-related physical fitness variables (19). The tests were chosen based on their easiness of usability in a big number of participants. The test also provides dependable and useable health-related musculoskeletal and physical fitness assessments. Distinctively, the musculoskeletal fitness parameters that encompassed sit-and-reach, sit-up, standing broad jump, and 20-meter endurance shuttle-run (i.e., bleep test) were performed as follows:

Sit-and-Reach Assessment. The SR tests were conducted to evaluate flexibility. We used a normal sit-and-reach wooden box. Participant progressively pushed the ruler on topmost of the reach box by stretching their hands, with no twitching and bent their trunk in an attempting to lean forward as far as probable with the two hands upright and knees wholly stretched. This test was performed in a seated position with knees and feet positioned tightly alongside a flooring mat. During the test, the fingertips of the subject need to attain the similar expanse at the equivalent time with no leaping. The farthest gap touched in centimetres was noted after the test has been performed twice i.e., improved result was chosen and logged.

Sit-Up Assessment. The muscular strength was assessed using the sit-up (SUP) test. This was to examine the belly and hip flexor powers in 30 seconds sequencing. The participants sat on a laid mat on the floor with their back straight forward and hands fastened at the rear of the neck. The participants knees were also stretched at an angle 90º with cads and feet level on the floor mat. The participant then laid with their back so that their shoulders contacted mat on the floor and reverted to their inactive or sitting spot while their elbows were put forward to contact their knees. The assessments were completed when participants become exhausted to finish a full sit-up. Only the total number of appropriately executed performance was documented.

Standing Broad Jump Assessment. To assess the youth's explosive power, SBJ test was used. The subjects stand at the back of the starting line after which they were informed to get-up-and-go energetically and hurdled horizontally as far as they can. The children were advised to land with both feet at the same time and stayed standing all through the jump. The assessments were performed twice with better scores documented. On the other hand, the score with the highest distance out of the two assessment was documented closed to 0.1 centimetres. Note that the "distance between toes at take-off and heels at landing, or whichever body part landed nearest to the take-off point" was recorded.

20 Metres Shuttle Run. A sufficiently large flat and non-slippery space was determined with a measuring tape from which the 20m shuttle run track which was subsequently demarcated with cones to set up a boundary, was marked. The participants were told to take a position at the rear of one of the lines opposite the subsequent mark, 20m apart, and start to sprint once instructed by the soundtrack, i.e., participants ran continuously between dual mark 20 meters away from each other in tune with soundtrack hoots. At each minute, the echo reflects an intensification in speediness and the time interval between the beeps progressively shortens. If the subject gets to the mark prior to the beep soundtrack, he or she needs to slow down for the beep sounds to complete before he or she can continue. Contrarily, if the subject does not get to the line prior to the sound of the hoot, the participant is served with a caution and must sprint faster to meet up. The subject was served with a caution the first time they are unable to get to the line and disqualified after the next caution. The weather was favourable, and the testers led the participants in 15 minutes warming up exercise before the test.

Pilot Test. A pilot study involving 20 school children (male: n=10; female: n=10) of similar age category was undertaken prior to data gathering to fine tune the logistics of test administration and data collection. Specifically, we conducted a training workshop which was led by professionals in Kinanthropometry. The workshop was to sharpen the proficiency of field workers during the assessment of youths kinanthropometric and musculoskeletal fitness parameters.

Statistical Analysis. Means and standard deviations of kinanthropometric and musculoskeletal aptness variables were analysed. Deviations in the body weight, height, TMI, BP, SR, SUP, SBJ, and 20 meters shuttle run were estimated by gender using independent samples *t*-test. We performed a bivariate correlation analysis to examine the relationships between the children's TMI and musculoskeletal fitness variables and performed a regression analysis to determine the association between TMI categories, BP, and musculoskeletal fitness among the study participants. We used the Statistical Package for the Social Sciences (SPSS) version 27.0 (SPSS Inc., 2020), while the alpha level was set at p≤0.05.

RESULTS

This study examined the association between TMI, blood pressure, and components of musculoskeletal health in youths aged nine to thirteen years from Ado-Ekiti, Southwestern Nigeria. Presented in Table 1 are the anthropometric, physiological, and musculoskeletal performance features of the children. There were significant gender differences in almost all the children's measurements, except for waist-to-height ratio and TMI. For example, the mean value for age in girls (11.8 years) was significantly higher than that of boys (11.6 years) (P =0.007). Boys were significantly heavier (38.0 kg) (P =0.001) and taller (144.8 cm) than girls (P =0.038). Mean values of systolic (105.7 mmHg) and diastolic (62.5 mmHg) BP were higher in boys compared to girls (P<0.001). Furthermore, the mean flexibility score in boys (23.9 cm) was significantly higher when compared to that of girls (22.5 cm) (P =0.004). In contrast, girls performed significantly better in SUP (21.8 no/min) (P < 0.001), SBJ (136.0 cm) (P < 0.001), and 20 meters shuttle run (4.51) (P < 0.001) than their male counterparts.

Results of the correlation analyses are provided in Table 2. There was a significant positive correlation between the TMI and SBP (r= 0.182, P < 0.01) and DBP (r= 0.090, P < 0.01). Also, a significant inverse relationship was found between the children's TMI and SR (r= -0.067, P < 0.05) performances. Similarly, TMI was significantly correlated with SBJ (r= -0.246, P < 0.01). Furthermore, there was a relationship between the SBP and SR (r= 0.079, P <0.01), SUP (r= -0.077, P < 0.01), and 20m shuttle run (r= 0.154, P <0.01). Similar trends in the relationships were observed for DBP and SR (r= 0.107, P < 0.01) and (r= 0.090, P < 0.01) Table 2.

Table 1. Anthropometric, Physiological and Musculoskeletal Fitness Characteristics of Nigerian Children

Variables	Total (n= 1229)	Male (n=483)	Female (n=746)	P- Value
	M±SD	M±SD	M±SD	
Age (y)	11.7±1.05	11.6±1.05	11.8±1.05	0.007
Body mass (kg)	37.1±7.60	38.0±8.14	36.5±7.17	0.001
Height (cm)	144.2±9.49	144.8±9.54	143.7±9.43	0.038
WHtR	0.42±0.06	0.42±0.07	0.42±0.05	0.427
BMI (kg/m^2)	17.8±3.20	18.0±3.49	17.6±2.98	0.019
TMI (Kg/m^3)	12.4±2.89	12.5±3.13	12.3±2.73	0.184
SBP (mmHg)	102.5±15.6	105.7±15.1	100.5±15.7	0.000
DBP (mmHg)	60.4±11.5	62.5±11.4	58.9±11.4	0.000
SR (cm)	23.1±7.34	23.9±8.93	22.5±6.04	0.004
SUP (min)	20.1±7.34	17.5±6.86	21.8±7.13	0.000
SBJ (cm)	130.2±23.3	121.2±22.6	136.0±21.8	0.000
Shuttle run	4.32±2.16	4.02±2.16	4.51±2.14	0.000

Y, year; WHtR, waist-to-height ratio; BMI, body mass index; BP, blood pressure; SR, Sit and Reach; SUP, sit-up; SBJ, standing broad jump; Kg, kilogram; Kg/m^2, kilogram per meter square; TMI, tri-ponderal index; Kg/m^3, kilogram per meter cubic; mm, millimetre; M, mean; SD, standard deviation; SBP, Systolic blood pressure; DBP, diastolic blood pressure; mmHg, millimetre mercury; cm, centimetres; m, metres.

Table 2. Pearson's Correlation Matrix Showing Interrelationships between Triponderal Mass Index, Blood Pressure and Musculoskeletal Fitness (n=1229)

Variables	Age (y)	Body mass (kg)	Height (cm)	WHtR	BMI (kg/m^2)	TMI (kg/m^3)	SBP (mmHg)	DBP (mmHg)	SR (cm)	SUP (sec)	SBJ (cm)	Shuttle run
Age (y)	1	0.297**	0.358**	-0.062*	0.084**	-0.035	0.138**	0.065*	-0.025	0.020	0.213**	0.064*
Body mass (kg)	0.297**	1	0.637**	0.193**	0.684**	0.361**	0.492**	0.318**	0.037	-0.095**	0.002	0.084**
Stature (cm)	0.358**	0.637**	1	-0.155**	-0.094**	-0.430**	0.319**	0.206**	0.070*	-0.117**	0.217**	0.102**
WHtR	-0.062*	0.193**	-0.155**	1	0.357**	0.350**	0.080**	0.164**	0.028	0.014	-0.082**	-0.298**
BMI (kg/m^2)	0.084**	0.684**	-0.094**	0.357**	1	.924**	0.338**	0.198**	-0.034	0.002	-0.196**	0.034
TMI (kg/m^3)	-0.035	0.361**	-0.430**	0.350**	0.924**	1	0.182**	0.090**	-0.067*	0.054	-0.246**	0.011
SBP (mmHg)	0.138**	0.492**	0.319**	0.080**	0.338**	0.182**	1	0.576**	0.079**	-0.077**	-0.043	0.154**
DBP (mmHg)	0.065*	0.318**	0.206**	0.164**	0.198**	0.090**	0.576**	1	0.107**	-0.023	-0.004	0.090**
SR (cm)	-0.025	0.037	0.070*	0.028	-0.034	-0.067*	0.079**	0.107**	1	-0.025	0.119**	0.020
SUPs (sec)	0.020	-0.095**	-0.117**	0.014	0.002	0.054	-0.077**	-0.023	-0.025	1	0.275**	0.072*
SBJ (cm)	0.213**	0.002	0.217**	-0.082**	-0.196**	-0.246**	-0.043	-0.004	0.119**	0.275**	1	0.084**
20m Shuttle run	0.064*	0.084**	0.102**	-0.298**	0.034	0.011	0.154**	0.090**	0.020	0.072*	0.084**	1

****. Correlation is significant at the 0.01 level (2-tailed).**
***. Correlation is significant at the 0.05 level (2-tailed).**
Y, year; WHtR, waist-to-height ratio; BMI, body mass index; BP, blood pressure; SR, Sit and Reach; SUP, sit-up; SBJ, standing broad jump; Kg, kilogram; Kg/m^2, kilogram per meter square; TMI, tri-ponderal index; Kg/m^3, kilogram per meter cubic; mm, millimetre; SBP, Systolic blood pressure; DBP, diastolic blood pressure; mmHg, millimetre mercury; cm, centimetres; m, metres

Table 3. Association between TMI and Musculoskeletal Fitness in Children

Musculoskeletal Variables	Sit & Reach (cm)	P-Value	Sit-Ups (sec)	P-Value	SBJ (cm)	P-Value	Shuttle Run	P-Value
	Adjusted OR (95% CI)		Adjusted OR (95% CI)		Adjusted OR (95% CI)		Adjusted OR (95% CI)	
TMI Categories								
Severe underweight	1.00 (0.92; 1.08)	0.93	0.99 (0.90; 1.08)	0.87	0.96 (0.94; 0.99)	0.008	1.39 (1.21; 1.60)	0.000
Underweight	0.98 (0.96; 1.00)	0.20	0.98 (0.96; 1.00)	0.07	1.00 (0.99; 1.01)	0.11	1.02 (0.95; 1.10)	0.52
Overweight	1.01 (0.98; 1.03)	0.38	0.98 (0.95; 1.01)	0.24	0.98 (0.97; 0.99)	0.007	1.04 (0.94; 1.14)	0.37
Obese	0.92 (0.87; 0.98)	0.009	1.03 (0.99; 1.08)	0.09	0.94 (0.93; 0.96)	0.000	1.12 (0.98; 1.28)	0.07
Normal weight	1		1		1		1	

Provided in Table 3 are the regression coefficients on the association between TMI and the Nigerian school children's musculoskeletal fitness. The children with severe underweight were significantly less likely to perform well in SBJ (OR= 0.96, CI= 0.94; 0.99) and SRCs (OR= 1.39, CI= 1.22; 1.61). Being overweight was significantly associated with poor SBJ (OR= 0.98, CI= 0.97; 0.99) performances compared with participants with normal body weight. Obese children were also significantly associated with poor flexibility (OR= 0.92, CI= 0.87; 0.98) and SBJ (OR= 0.94, CI= 0.93; 0.96) compared with the performances of children with normal weight (Table 3).

Consequently, underweight children were significantly less likely to be hypertensive compared to those with normal weight (OR= 0.98, CI= 0.97; 0.99). Results also showed a significant association between overweight and SBP, which suggests that overweight school children have a higher propensity of being hypertensive (OR= 1.03, CI= 1.01; 1.05) compared to those with normal weight. Similarly, obese children also have a greater likelihood of being hypertensive (OR= 1.04, CI= 1.02; 1.07) compared to their peers with normal body weight (Table 4).

Table 4. Association between TMI Categories and Blood Pressure Categories in Children

TMI Categories	Severe Underweight	P-Value	Underweight	P-Value	Normal Weight	Overweight	P-Value	Obese	P-Value
	Adjusted OR (95% CI)		Adjusted OR (95% CI)			Adjusted OR (95% CI)		Adjusted OR (95% CI)	
BP Variables									
Systolic BP	1.01 (0.96; 1.06)	0.56	0.98 (0.97; 0.99)	0.008	ref	1.03 (1.01; 1.05)	0.000	1.04 (1.02; 1.07)	0.000
Diastolic BP	0.99 (0.93; 1.06)	0.95	0.98 (0.97; 1.00)	0.07	ref	1.00 (0.98; 1.02)	0.64	0.98 (0.95; 1.01)	0.21

Table 5. Association between Blood Pressure Categories and Musculoskeletal Fitness in Children

Blood Pressure categories	Low	P-Value	Normal	Systolic BP Pre-hypertensive	P-Value	Hypertensive	P-Value	Low	P-Value	Normal	Diastolic BP Pre-hypertensive	P-Value	Hypertensive	P-Value
	Adjusted OR (95% CI)			Adjusted OR (95% CI)		Adjusted OR (95% CI)		Adjusted OR (95% CI)			Adjusted OR (95% CI)		Adjusted OR (95% CI)	
Musculoskeletal fitness														
Sit & reach (cm)	0.965 (0.943; 0.988)	0.003	ref	1.014 (0.993; 1.035)	0.182	0.997 (0.889; 1.118)	0.953	0.964 (0.945; 0.983)	0.000	ref	0.996 (0.952; 1.042)	0.856	0.909 (0.813; 1.016)	0.092
Sit-ups (sec)	1.036 (1.016; 1.057)	0.000	ref	0.988 (0.963; 1.014)	0.368	0.991 (0.890; 1.104)	0.872	0.997 (0.981; 1.014)	0.741	ref	1.015 (0.970; 1.062)	0.526	0.947 (0.860; 1.043)	0.270
SBJ (cm)	1.001 (0.995; 1.008)	0.676	ref	1.001 (0.993; 1.009)	0.840	0.998 (0.965; 1.032)	0.917	1.002 (0.996; 1.007)	0.555	ref	0.989 (0.975; 1.003)	0.120	0.999 (0.970; 1.029)	0.940
Shuttele run	0.891 (0.826; 0.962)	0.003	ref	1.099 (1.024; 1.179)	0.009	1.076 (0.802; 1.443)	0.625	0.897 (0.848; 0.950)	0.000	ref	1.007 (0.875; 1.158)	0.927	0.876 (0.615; 1.249)	0.465

The regression analyses also showed a significant association between the children's SBP and musculoskeletal fitness performance categories. Those with low BP were less likely to perform well in SR (OR=.96, CI= .94; .98) and 20m shuttle run (OR=.89, CI=.82; .96). However, a child with low BP had a significantly higher predisposition to demonstrate superior sit-up performance (OR=1.03, CI=1.01; 1.05). It was also found that children with low BP were more susceptible of scoring high in SBJ, but the result was not significant (OR=1.00, CI=.99; 1.00). Furthermore, pre-hypertensive children, compared with those with normal BP, had an increased likelihood of performing well in SR (OR=1.09, CI=1.02; 1.17). For DBP, those with low BP were significantly less likely to exhibit good sit and reach (OR=.96, CI=.94; .98) and Shuttle run scores (OR=.89, CI=.84; .95) compared to their normotensive counterparts (Table 5).

DISCUSSION

This study findings revealed that significant relationships exist between TMI and musculoskeletal fitness in Nigerian children. Since TMI is currently regarded as a better adiposity marker than the BMI in children and adolescents (6, 7, 12), it is important to examine how it relates to BP and musculoskeletal fitness in children. To the best of our knowledge, this is one the few studies to examine how TMI relates to blood pressure and musculoskeletal fitness in Nigerian children. Consistent with the findings of a previous study, which reported that TMI is a better predictor of metabolic syndrome (MetS) in children than BMI (6), our findings showed that a positive relationship exists between TMI and BP. In a study that examined the regression of age-standardized weight for age-standardized height for which the standardization was attained by articulating weight and height as portions of the fiftieth centile for age from an appropriate growth norm, it was reported that during puberty, a superior power than two is necessary (20), therefore making TMI to be a suitable obesity indicator (6) in predicting BP in youths.

The results of this study also displayed that TMI was significantly inversely related to SBJ. Furthermore, a relationship was found between BP and musculoskeletal performance. For example, SBP was found to be positively correlated with the children's sit and reach, 20-meters shuttle run and inversely correlated with sits-ups performances, while DBP was positively correlated with sit and reach, and 20-meters shuttle run. Several studies have reported inverse relationships between body conformation and physical fitness (2, 10, 13, 21-23). However, the direction of the relationship might not always be as expected. Although, physical fitness could also be used interchangeably with musculoskeletal fitness, this depends on the parameters assessed. A study that examined the longitudinal association between muscular fitness and blood pressure to understand if changes in muscular fitness over twenty-four months were related with BP changes among youths found that muscular health during youth was inversely associated with SBP and DBP. Therefore, a small decrease in muscular capacity could result in increased levels of cardiometabolic disease risk, DBP and SBP inclusive (24).

Studies have revealed the association between several adiposity indicator categories and musculoskeletal performances in youths (8, 13, 25) but not TMI, which makes it difficult to compare our findings with other fat indicators such as BMI and waist circumference. In this study, findings from the regression analysis of the association between the triponderal mass index and musculoskeletal performance showed that severely underweight individuals performed poorly in SBJ and SR. Similarly, excessively weighty persons may perform poorly in SBJ as opposed to participants with normal body weight. Being obese could also negatively influence children's flexibility and SBJ performances when compared with similar performances in children with normal body weight. A Brazilian study that examined the relations between physical fitness and the anthropometrical, and demographical determinants among children stated that unhealthy fitness status was associated with numerous features such as being female, obesity, and extreme abdominal fat (25). Ajisafe et al. (22) also reported that an increased obesity rate among youths could trigger musculoskeletal incapability which may be indicative of deficient motor skill aptitude. It is important to understand that obese persons have disparate physical fitness features when compared to normal-weight individuals, and this could result in poor running- and jumping-related effort and strength (26). In addition, a negative association of excessive body fat with cardiorespiratory endurance, muscle explosive strength, and speed has been reported amongst Chinese youth (27).

Furthermore, our study finding based on the association between TMI classifications and BP showed that underweight children may have lesser odds of being hypertensive. Consequently, overweight and obese persons may have a higher tendency of being hypertensive compared to those with normal weight classification. Shim (28), who evaluated the allocation of triponderal mass index in accordance with age and sex, and the association of excessive fatness groups in accordance to sex- and age-specific triponderal mass index with MetS and its components, found that children in the overweight and obese groups had a higher propensity for increased BP compared with individuals having normal-weight.

Subsequently, studies have acknowledged the association between BP and musculoskeletal fitness among children (24, 29-31). In the same vein, our study findings showed a significant association between BP and musculoskeletal fitness among the participants. Children with low systolic and diastolic BPs were less likely to have a good sit and reach and 20m shuttle run performances. By contrast, children with low BP have a higher likelihood of exhibiting better sit-ups performances. Furthermore, pre-hypertensive individuals significantly had an increased likelihood of recording superior shuttle run ability. However, this was not the same for the hypertensive children as they were less likely to perform well in sit and reach, SUPs, and SBJ, but have a higher likelihood of producing good performance in 20m shuttle run. These findings are in harmony with those of Agostinis-Sobrinho et al. (24) study which also indicated that hypertensive individuals had a reduced capability of exhibiting good musculoskeletal performance. This suggests that increased fitness score is associated with reduced SBP in youths (31). Additionally, the risk of experiencing health problems could be associated with low fitness status among many individuals (30).

Since TMI has now been recognized as a more accurate adiposity evaluation tool, this study adds important information to the body of knowledge regarding the association between TMI, blood pressure and musculoskeletal fitness among school going children and adolescent in Nigeria. However, the study has some limitations. First, to date, there is currently no perfect or accurate adiposity evaluation tool for children, except that the TMI has been found to be a more accurate index than BMI. These two adiposity prognosticators of health have shortcomings and would remain in use until a new and accurate evaluation tool for children is invented. Second, all the musculoskeletal fitness tests conducted in this study are field tests and may not be as precise as laboratory-based protocols. Third, there is a dearth of data on the association between TMI, BP and musculoskeletal fitness in children to which the present findings could be compared. This calls for the need for more studies to clarify the observed findings. Therefore, it is important that the present findings are not generalized and consequently should be interpreted cautiously.

CONCLUSION

TMI was inversely associated with BP and musculoskeletal fitness. This could have an adverse influence on the health and wellbeing of undernourished, overweight, and obese children. It is also important that school feeding, and physical activity programmers be implemented to promote health-related quality of life in school-going children and adolescents.

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