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A STUDY ON BMI AND SKINFOLD THICKNESSES AS PREDICTORS OF BLOOD PRESSURE LEVEL IN ADOLESCENTS

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ABSTRACT

Hypertension is a global health challenge. Hence, the need for better understanding to promote awareness on its early detection and treatment is now emphasized in preventive medicine. This study examined the relationship between body mass index, skinfold thicknesses and blood pressure levels among adolescent children and attempts to find a better predictor for blood pressure. The subjects consisted of 522 adolescent (293 females and 229 males), ages 11 to 15 years, from secondary schools within Port-Harcourt, south-south, Nigeria. The height, weight and three skinfold thicknesses of the subjects were measured. Body mass Index was calculated in kg/m^2. Blood pressure readings were recorded. Data obtained were analysed for descriptive statistics, ANOVA and t-test were used to determine the age and sex-related differences among variables. Pearson correlation coefficients for the association between BMI ,skindold thicknesses and blood pressure were evaluated. The results showed that the mean age, BMI, Triceps skinfold, suprascapular and medial calf skinfold thicknesses were; 12.66±1.39years; 18.42±3.09kg/m^2, 8.18±4.13mm, 7.27±3.44mm, 8.67±4.03mm respectively.There was a statistically significant difference in the BMI and skinfold thicknesses between males and females for the entire sample studied ($p<0.05$) and no significant difference in blood pressure in respect to sex . Also, all variables, at different levels, showed statistical significance difference in respect to successive age group ($p<0.05$). BMI correlated positively and significantly with systolic blood pressure while no skinfold thicknesses except subscapular skinfold thickness correlated significantly with blood pressure. It therefore follows that both indices for general and central adiposity may be better predictors of blood pressure level than skinfold thicknesses used for assessment of regional adiposity.

KEYWORDS: body mass Index, skinfold thicknesses, blood pressure, adolescent.

INTRODUCTION

Anthropometry provides a cheaper clinical tool for assessment of risk factors associated with health.BMI and skinfold thicknesses are among several anthropometric variables that are used to screen for underweight, overweight and obesity, which are risk factors for elevated blood pressure and other metabolic abnormalities (Williams et al., 1992a,b[1][2]; Freedman et al.,1999a,b[3][4],Al-Sendi et al.,2003[5], Daniel et al,2013[6]). Underweight, overweight and obesity in early childhooh are likely to lead to elevated blood pressure and other risk factors for cardiovascular diseases, in the long term in adults (Weiss et al.,2004[7], WHO,2005[8], Longo-Mbenza et al.,2007[9], Daniel et al.,2013[6]). The prevalence of childhood and adolescent obesity in both developed and many developing countries is reported to have increased substantially in the last few decades and it is probable that this increasing trend will continue (WHO,1998[10]). Obesity and Hypertension (high B.P) among adult , also in children and adolescents are closely related each other (Stamler et al.,1978[11], Sorof et al.,2002[12]).

In children and adolescent, little or no attention is paid to the problem of high blood pressure unlike in adult, in which it is indisputable that such a burden, as a risk factor, has resulted in high mortality and morbidity from cardiovascular diseases (Vasan et al.,2001[13], WHO,2005[8]). The need for early detection and identification of this risk factor can be better promoted by studying various anthropometric variables that have been shown to have strong associations with blood pressure (Zhou et al.,2009[14]).BMI and skinfold thicknesses have been reported in several studies as anthropometric indicators of elevated blood pressure(Monyeki et al,2006[15], Schiel et al.,2006[16]; Daniel et al.,2013[6], Ying Xiu et al.,2013[17]). Both anthropometric variables have been recognized as important for estimating cardiovascular risk factors, particularly due to their positive association with elevated blood pressure(hypertension) (Dua and Kapoor, 2000[18]). Few of these studies which relates to the Nigerian children and adolescents majorly focus on the use of BMI alone, with very scanty reports on the relationship between skinfolds and blood pressure (Abah,JA,2011[19]; Senbanjo and Oshikoya,2012[20]). Furthermore, no available literature was found for studies on this relationship for children and adolescents living in Port-Harcourt, a southern region of Nigeria. Hence the need for this study to provide more evidence for the association already described for children in other parts of the world.

MATERIALS AND METHODS

Research group: This consisted of a total of five hundred and twenty (522) adolescent children aged 11 to 15 years. The children were drawn from five secondary schools within Port-harcourt, Rivers state, Nigeria. All selected subjects that participated in the study were informed about the study and expressed their willingness to participate in the study before they were recruited into the study.

Ethical consideration: Approval for the study was granted by the Research and Ethics committee of University of Port-Harcourt, Nigeria. Also, permission was obtained from each school principal or administrative head before accessibility to the students.
Study design/sampling procedure: The study is a cross-sectional study. The sampled subjects were taken from a large-scale data gathered from a chort study. The sampling procedure was a stratified randomized sampling.

Anthropometry: The Height and Weight of each subject were measured with the use of a portable Height-weight series weighing machine (floor-type model, RGZ-160,made in China, having an attached anthropometer)which is used in clinical settings. The height was measured, with the subjects bare-footed, to the nearest 0.1cm and weight was measured, with subjects in minimal clothing, to the nearest 0.1kg. BMI was calculated as weight in kilograms divided by height in meter squared. Triceps, subscapular and medial calf skinfolds were measured in millimetres, to the nearest 0.5mm, using a slimguide calliper, in accordance with International Society for Advancement in Kinanthropometry (ISAK)protocols.

Blood pressure measurement: This was taken using a digital BP machine OMRON (PK-HAEM-7321, made in Vietnam) which has been validated for clinical use. Measurement was done while the subject was seated in a relaxed state, with the left arm placed on a table at a level with the heart position. Two BP readings were taken at a 5-minuites rest interval. The average of these two readings was taken as the BP for each subject.

Statistical Analysis

SPSS software package version 20 was used to determine the descriptive statistics for anthropometric variables and blood pressure and also calculate for the Pearson correlation coefficients between BMI, skinfolds and blood pressure. The student t-test was done to evaluate for sex difference and a One-way ANOVA was carried out to evaluate the difference in age and sex-related groups.

RESULTS

Table1. shows the descriptive statistics (Mean±S.D) of anthropometric variables measured on subjects in respect to age for the entire sample

Age	Sex & Number (N)	height	weight	BMI	Triceps SF	Subscapular SF	Medial calf SF
11	m=59 f=74	1.41±0.08* 1.45±0.07*	33.24±5.32* 36.19±6.52*	16.84± 3.13 17.09±2.21	5.74±2.49* 7.66±3.66*	5.04±1.99* 6.53±2.84*	6.64±2.99* 8.40±3.50*
12	m=63 f=63	1.46±0.07* 1.49±0.09*	36.85±6.05* 40.99±7.86*	17.19±1.92* 18.37±2.28*	6.05±2.07** 9.29±3.60**	5.31±1.27** 7.76±2.99**	6.50±2.52** 9.49±3.13**
13	m= 34 f=67	1.49±0.07* 1.53±0.08*	39.17±6.85* 44.85±8.90*	17.56±3.06* 19.01±2.88*	6.10±2.12** 9.34±3.58**	5.47±1.55** 8.47±3.31**	6.25±2.64** 10.14±3.97**
14	m=44 f=53	1.57±0.12 1.56±0.07	49.10±15.03 48.40±8.93	19.70±3.84 19.91±2.77	7.88±5.02* 10.83±3.98*	7.67±4.93* 9.85±3.24*	8.99±5.62* 11.01±4.31*
15	m=29 f=36	1.63±0.98* 1.58±0.06*	51.78±10.75 53.08±8.55	19.34±3.28* 21.23±3.37*	7.07±4.70** 12.15±5.36**	7.03±3.25** 10.33±3.74**	7.83±3.94* 11.36±3.84*
Total	522	1.50±0.10	42.18±10.59	18.42±3.09*	8.18±4.13**	7.27±3.44**	8.67±4.03**

* indicates significant test value for students't-test * shows value is significant at $p< 0.05$;** value is significant at $p< 0.001$.

Table 1 shows that the mean weight and height increase with age in both sexes (except for age 17 years) The mean height and weight of females are relatively higher than that of males for most ages except at 14 years and 15 years(for height) and 14 years(for weight). Sexual dimorphism exists for all measured variables. This is seen in skinfold thickness across all ages while for height, weight and BMI, this occurred in some ages.

Table II shows the age-wise distribution of the anthropometric variables in respect to sex

Age	Number of subjects (n)	Height	Weight	BMI	triceps SF	subscapular SF	calf SF
Females 11	74	1.45±0.07[a]	36.19±6.52[a]	17.09±2.21[a]	7.66±3.66[a]	6.53±2.84[a]	8.40±3.50
12	63	1.49±0.09[ab]	40.99±7.86[ab]	18.37±2.28[a]	9.29±3.60[a]	7.76±2.99[a]	9.49±3.13
13	67	1.53±0.08[b]	44.85±8.90[bc]	19.01±2.88	9.34±3.58[b]	8.47±3.31[b]	10.14±3.97
14	53	1.56±0.07	48.40±8.93[cd]	19.91±2.77[b]	10.83±3.98[b]	9.85±3.24[b]	11.01±4.31
15	36	1.58±0.06	53.08±8.55[d]	21.23±3.37[b]	12.15±5.36	10.33±3.74	11.36±3.84
Males 11	59	1.41±0.08[a]	33.24±5.32[a]	16.84± 3.13	5.74±2.49	5.04±1.99	6.64±2.99
12	63	1.46±0.07[a]	36.85±6.05[a]	17.19±1.92	6.05±2.07	5.31±1.27	6.50±2.52
13	34	1.49±0.07[b]	39.17±6.85[b]	17.56±3.06[a]	6.10±2.12[a]	5.47±1.55[a]	6.25±2.64[a]
14	44	1.57±0.12[bc]	49.10±15.03[b]	19.70±3.84[a]	7.88±5.02[a]	7.67±4.93[a]	8.99±5.62[a]
15	29	1.63±0.98[c]	51.78±10.75	19.34±3.28	7.07±4.70	7.03±3.25	7.83±3.94

The superscripts: [a,b,c,d] indicates successive ages where significant differences were observed using ANOVA. These superscripts showed the mean differences in the variable values as significant at $p<0.05$

In Females there was significant difference in Height only between ages 11 and 12; and 12 and 13. whereas in Weight, significant difference occurred between all successive ages.BMI showed significant difference between ages 11 and 12; and 14 and 15 years.

In skinfold thicknesses, significant difference between successive ages only occurred in Triceps and subscapular skinfold thickness of the females (between ages 11 and 12 years; and 13 and 14 years) whereas in males there was significant difference in all three skinfolds ,between 13 and 14 years only.

In males, Height showed more significantdifference between successive ages, for three age groups (11 and 12 years; 13 and 14 years and 14 and 15 years) than in females. However, significance difference occurred in only one successive age group(13 and 14 years) for BMI in males.

Table III. shows age wise distribution of mean blood pressure in respect to sex

Age	Blood pressure SBP	DBP
Female		
11	92.95	58.19
12	96.10	59.98
13	99.03*	60.37*
14	105.79*	63.92*
15	106.83	65.69
Male		
11	94.93	60.27
12	97.22	61.14
13	99.85	62.24
14	100.68*	61.14*
15	109.69*	65.31*

*shows that values were significant for successive ages at $p<0.05$

In Table III, there was significant difference in blood pressure only one in successive age group (between 13 and 14 years in both blood pressures for female; and between 14 and 15 years in both SBP and DBP in males). Significant blood pressure variation between successive age group occurred much earlier in females than in males.

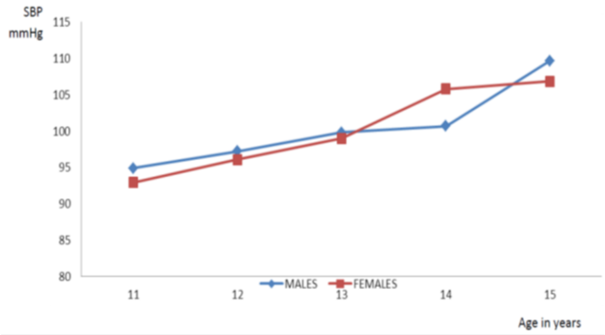

Figure 1, shows the mean systolic blood pressure distribution in male and female schoolchildren.

The mean values of SBP in males are relatively higher than those in females. However, there was no significant difference observed in the mean values of SBP between both sexes ($p>0.05$).

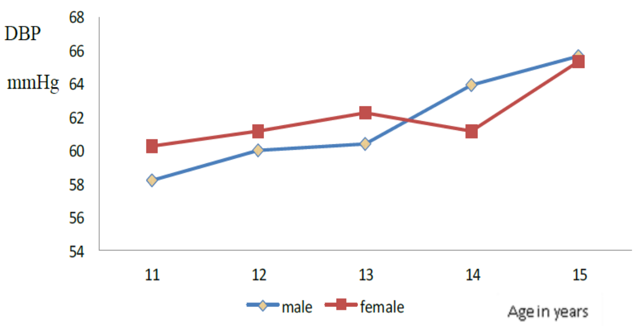

Figure 2. shows the distribution of mean diastolic blood pressure in both sexes.

The mean values of DBP in females are relatively higher than that of males. However, there was no significant differences in mean DBP between sex across all ages.

Table IV. shows the correlation between BMI, skinfold thickness and blood pressure (adjusted for age)

Blood pressure	Anthropometric variables			
	BMI	**tricepSF**	**subscapularSF**	**calf SF**
SBP	0.140**	0.082	0.115**	0.086
DBP	0.080	0.036	0.087*	0.079

sum SF implies skinfold sum(Triceps+subscapular skinfolds)
**correlation is significant at $p<0.01$, *correlation is significant at $p<0.05$

Table IV shows that both BMI, subscapular skinfold and sum of skinfold are significantly correlated with blood pressure. BMI strongly correlates with systolic blood pressure than subscapular skinfold thickness and skinfold sum (r=0.140, r= 0.115, r=0.101 at $p<0.05$; respectively)

Tables V shows correlation between BMI and skinfold thicknesses

	Skinfold thicknesses		
	tricepSF	**subscapularSF**	**calf SF**
BMI	0.696	0.712	0.661
pvalue	0.000*	0.000*	0.000*

* correlation is significant at $p<0.001$

Table V shows that all skinfold thicknesses have a high correlation with BMI.However, the subscapular skinfold thickness is most strongly correlated with BMI

DISCUSSION

In this study, the relationship between BMI, skinfolds and blood pressure was examined. The results in this study showed that the mean height and weight increase with age in both sexes. The mean height were relatively higher in female than in male except at ages 14 and 15. Also, female have relatively higher mean weight than in male (except at age 14).This observation may be attributed to the growth trend which occurs between sex during adolescence, such that females are said to be taller and heavier than boys in the early adolescent growth spurt, before there is a later catch up by boys, perhaps at 14 years as seen in the height, where the boys appear to be relatively taller than the female (Malina et al., 1974[21]). However, the girls after this age (14 years) became heavier than the boys, this may be as a result of the continued fat accumulation in females even after puberty which is regarded as a secondary sex characteristic (Bodzar,2000[22]).

There was no sex difference in the mean blood pressure. This agrees with the study conducted by Ramoshaba et al.,2015[23].

The BMI of females were significantly higher than that of male (except at ages 11 and 14 years) as reported in another study on Nigerian children (Senbanjo et al.,2013[24], Adesina et al.,2011[25], Ijarotimi et al.,2003[26]). This may be attributed to the consistent increase in the mean weight of females than that of boys which was observed in the present study to occur across all ages.

The mean skinfolds(for all skinfold measurements) were significantly higher in females than in males. This is in accordance with other studies reported for other population (Violet at al.,2012[27]; Freedman et al.,2015[28]) and also for a related population(Senbanjo et al,2013)[24](a Nigerian study). This agrees with the observation that the mean relative fatness of girls always exceed that of boys of the same age (Bodzar, 2000[22])

Blood pressure showed consistent increase down the ages except for DBP at age 14 years in males.

BMI among other indices of adiposity has been shown to correlate significantly and positively with BP (both SBP and DBP, Martin-Espinosa et al.,2017[29] or with systolic BP alone ,freedman et al.,2015)[28].The result of this study also maintained the views of previous authors in this regard.

In our study, among the various skinfold measures, subscapular skinfold alone correlated significantly with blood pressure. This skinfold thickness which indicates central adiposity has been shown to be a better marker for B.P than peripheral skinfold(Shear et al.,1987)[30]

This skinfold could be seen to have the highest correlation with BMI.

Some authors (Ying-Xiu et al.,2013[17], Freedman et al.,2013[31]) maintained that BMI and skinfold thickness were similarly related to levels of CVD risk factor levels among children and adolescents. However, our study, following the views of other authors (Sonmez et al.,2007[32]), have observed that BMI correlates better with blood pressure, as a risk factor for CVD.

CONCLUSION

We recommend that BMI should be preferred in assessing the B.P - risk factor among Nigerian schoolchildren.

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