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Study of Body Mass Index and Blood Pressure of Adolescent Students in Bomo Secondary School, Zaria

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ABSTRACT

Background: Body mass index (BMI) and blood pressure are among vital parameters used to assess nutritional and health status of individuals. Abnormal increase in BMI leads to overweight and obesity, which are associated with comorbidities including high blood pressure. Recently, childhood and adolescent obesity are becoming a major global health problem. This study aims to investigate whether the BMI and blood pressure pattern of adolescents in Government Secondary School Bomo, Zaria, is different in 2018 from what was obtained in 2004. A total of three hundred and five students were divided into 2 groups based on the year of study. Group1 (141 students from 2004 data) and group 2 (164 students, from 2018 data), comprising of both males and females within the age of 12 to 19 years. Age, weight height, systolic and diastolic blood pressures were measured using standard protocols, and BMI was calculated by dividing weight in kilogram by the square of height in metres, for each respondent. There was a significant ($p< 0.05$) increase in height (1.57± 0.102m); weight (48.21 ± 9.567kg); BMI (19.40 ± 2.163 kg/m^2); SBP (115.47 ± 8.660 mmHg) and DBP (72.49 ± 8.304 mmHg) in group 2 when compared with group 1 (height (1.44 ± 0.112 m); weight (36.73 ± 8.759 kg); BMI (17.38 ± 2.074 kg/m^2); SBP (103.00 ± 10.405 mmHg) and DBP (58.76 ± 10.661mmHg). SBP in females was not significantly different between the groups. **Conclusion:** There are significant changes in BMI and blood pressure in adolescents of Bomo, Zaria, in 2018 compared with 2004.

Key words: Body mass index, Blood pressure, Adolescents

INTRODUCTION

Body mass index is the simplest acceptable tool for determining the weight of an individual in relation to height. It gives an indication of the weight status on a scale of being underweight, normal, overweight or obese, and has been recommended in both clinical and epidemiological studies as a universal criterion for overweight and obesity.[1]

The prevalence of overweight and obesity among children and adolescents is increasing worldwide, and becoming a major health challenge. Three hundred forty (340) million children and adolescents aged 5-19 years in 2016 were either overweight or obese[2]. This

value indicates an increase of about 18% from the rate of 4% that was obtained in 1975 [2]. Previous studies among children and adolescents have shown a rise in prevalence of obesity in Nigeria with a current prevalence in children and adolescence ranging between 0 to 4%.[3]

Obesity is often known to progress from childhood to adulthood, such that the chances of an obese child maturing to obese adult is greater than having a normal weight child developing obesity in adulthood.[4] The increasing prevalence of obesity in childhood and adolescence is a major concern based on the relationship between obesity and co-morbid conditions including hypertension.[3] Childhood obesity is usually as a result of overeating, and drinking of high-calorie sweetened beverages, with less exercise or physical activities, but it can also be due to genetic factors [4]. Body weight is regulated by various physiological mechanisms that maintain the balance between energy intake and energy expenditure.[5] When this balance is disrupted, weight problems most likely ensue.

High blood pressure in adult and adolescents is a growing public health problem that is often overlooked by physicians due to the assumptions that the adolescents are generally healthier. Similarly, the process of determining high or normal blood pressure in children and adolescent is not as straight forward as in adults and this probably discourages health workers from routinely checking adolescents' blood pressure.[3] Normal blood pressure values for children and adolescents are based on age, sex, and height, and are available in standardized tables)[6]. Prehypertension is defined as a blood pressure in at least the 90th percentile, but less than the 95th percentile, or a measurement of 120/80 mm Hg or greater. Hypertension is defined as blood pressure in the 95th percentile or greater [4-6].

Childhood hypertension is also predictive of adulthood hypertension which is the leading cause of morbidity and mortality around the world.[7] Children with hypertension may have evidence of target organ damage associated with cardiovascular diseases such as left ventricular hypertrophy, pathologic vascular changes, hyperlipidemia and diabetes mellitus.[6-8]. Children at risk include those with family history of hypertension or cardiovascular diseases, male sex and maternal smoking during pregnancy, or children who were not breast-fed. Breastfed children are known to have a reduced risk of hypertension.[6]

Overweight and obesity among adolescents are now becoming prevalent in developing countries as a result of an environment characterized by easily available and cheap energy dense food, accompanied with sedentary lifestyles such as prolonged time

spent watching films, prolonged video games and computer games.[3,8]

Globally the prevalence of childhood obesity varies in over 30% in USA, 20% in UK and Australia.[3] Previous studies among children and adolescent in Nigeria have shown a high prevalence of hypertension of 5%-10% in urban centres in the southern part of the country while most studies in the northern part of the country among adolescent have used adult criteria in defining hypertension, and this could affect the result.[4] Reports on BP and BMI among children and adolescents in northern Nigeria are scanty. The present study adds to the efforts in achieving substantial reports to fill the gap in this area of research. Early detection, follow up and adequate treatment of elevated blood pressure and obesity in adolescents may prevent complications and progression of overweight/obese status into adulthood.

Methods

Study location

The study was conducted in Government Secondary School, Bomo, Sabon Gari Local Government Area, Zaria, Nigeria. It is a co-educational institution with no boarding facilities. It lies between latitude 11.811ºN and Longitude 7.038ºN and at an altitude of 635meters. The school provides education for children in the village and neighbouring communities. The school, consisting of both junior and senior pupils, is composed of students from different ethnic groups and social background.

Study Design

A prospective comparative study of students in Government Secondary School, Bomo, Zaria. The study compared data obtained in 2004 with the data obtained in 2018, on BMI and blood pressure of students in government secondary school Bomo, Zaria.

Study Population and Groupings

The study population comprises of both male and female students of Government Secondary School, Bomo, within the ages of 12-19. A total of three hundred and five (305) students, participated in the study with one hundred and seventy-six (176) males and one hundred and nineteen females (119). Group 1 (2004) had a total of seventy-eight (78) males and sixty-three (63) females while group 2 (2018) had a total of a hundred and eight (108) males and fifty-six (56) females. The data of the year 2004 was collected from an unpublished retrospective study that was conducted by the lead author of this manuscript in 2004.

Ethical Approval

Ethical approval was obtained from research ethics committee, Ahmadu Bello University Zaria in 2004, and from Kaduna State Ministry of Education Zonal Office, Giwa, Zaria, before the commencement of the

research in 2018. Permission was also obtained from the principal of the school on both occasions (2004 and 2018), and written informed consents from each respondent and their parents/guardians.

The sample population was based on students who brought back the consent form signed by their parents/guardian, students whose consent forms were not signed and who do not wish to participate were excluded from the study.

Measurement of Height, Weight and Body Mass Index

Weight and height were measured by using a calibrated bathroom scale and a metre-rule respectively, according to standard protocols.[3] Weight and height were used to calculate BMI by dividing the weight in kilogram by the square of the height in meters.[3]

Measurement of Blood Pressure

Blood pressure was measured with a sphygmomanometer and stethoscope by the auscultatory method as described by[9].

Statistical Analysis

Values were expressed as means ± standard deviation for age, height, weight, body mass index and blood pressure. Student t-test was used to compare the means. Values for $p < 0.05$ was considered statistically significant.

Results

In the present study, the general population of respondents comprise of 141 in group 1, and group 2 has a population of 164. Among these, group 2 was observed to have a significantly higher mean age than participants in group 1. Also, other parameters showed significant increase in group 2 when compared with group 1. In other words, height, weight, BMI, SBP and DBP were observed to be higher in students from group 2 (Table 1).

TABLE I: MEAN ANTHROPOMETRIC INDICES AND BLOOD PRESSURE OF THE TOTAL STUDENTS OF GROUP 1 AND GROUP 2 THAT PARTICIPATED IN THE STUDY.

Parameters	**Group 1(n=141)**	**Group 2 (n=164)**
Age (years)	12.66 ± 2.393	15.69 ± 2.185*
Height (meters)	1.44 ± 0.112	1.57 ± 0.102*
Weight (kg)	36.73 ± 8.759	48.21 ± 9.567 *
BMI (kg/m²)	17.38 ± 8.759	19.40 ± 2.163 *
SBP (mmHg)	103.00 ± 10.405	115.47 ± 8.660*
DBP (mmHg)	58.76 ± 10.661	72.49 ± 8.304*

*P <0.05, BMI=Body mass index, SBP= Systolic blood pressure, DBP= Diastolic blood pressure

When we divided the study population according to sex, group 1 had less number of males (78) than group 2 (108). When comparing mean anthropometric indices of males in both groups, again, there was a statistically significant increase in height, weight, BMI, SBP and DBP in group 2 when compared to group 1 (Table II).

TABLE II: COMPARISON OF MEAN ANTHROPOMETRIC INDICES AND BLOOD PRESSURE BETWEEN MALE STUDENTS OF GROUP 1AND GROUP 2.

Parameters	**Group 1 (n=78)**	**Group 2 (n=108)**
Age (years)	13.19 ± 2.523	16.17 ± 2.374*
Height (meters)	1.46 ± 0.126	1.58 ± 0.113*
Weight (kg)	38.46 ± 9.984	48.93 ± 10.766*
BMI (kg/m²)	17.66 ± 2.085	19.26 ± 2.186*
SBP (mmHg)	102.37 ± 10.611	115.44 ± 9.194*
DBP (mmHg)	58.06 ± 10.833	72.62 ± 8.197*

*P <0.05, BMI= Body mass index, SBP= Systolic blood pressure, DPB= Diastolic blood pressure

In the females, all measured indices of age, height, weight, BMI and DBP in group 2 were significantly higher than in group 1, except SBP which is not significantly different between the 2 groups (Table III).

TABLE III: COMPARISON OF MEAN ANTHROPOMETRIC INDICES AND BLOOD PRESSURE BETWEEN FEMALE STUDENTS OF GROUP 1 AND GROUP 2

Parameters	**Group 1 (n=63)**	**Group 2 (n=56)**
Age (years)	12.00 ± 2.056	14.77 ± 1.362*
Height (meters)	1.42 ± 0.088	1.54 ± 0.069*
Weight (kg)	34.59 ± 6.407	46.82 ± 6.541*
BMI (kg/m²)	17.05 ± 2.027	19.66 ± 2.110*
SBP (mmHg)	103. 78 ± 10.173	115.57 ± 7.583
DBP (mmHg)	59.63 ± 10.463	72.24 ± 8.528*

* P <0.05, BMI=Body mass index, SBP=Systolic blood pressure, DBP=Diastolic blood pressure

TABLE IV: PEARSON CORRELATION OF ANTHROPOMETRIC INDICES, SYSTOLIC BLOOD PRESSURE AND DIASTOLIC BLOOD PRESSURE OF FEMALE STUDENTS IN GROUP 2

	Age	**Height**	**Weight**	**BMI**	**SBP**	**DBP**
Age (years)	1					
Height (meters)	0.407	1				
Weight (kg)	0.510	0.664	1			
BMI (kg/m^2)	0.348	0.059	0.781	1		
SBP (mmHg)	0.184	0.021*	0.027*	0.026*	1	
DBP (mmHg)	0.135	-0.019*	0.125	0.190	0.621	1

*p < 0.05, BMI=Body mass index, SBP= Systolic blood pressure, DBP= Diastolic blood pressure

Discussion

The studied population, even after a fourteen (14) year interval, did not record a rise in the incidence of childhood and adolescent obesity. This contrasts with reports from different parts of the world which are indicating alarming increase in the prevalence of childhood and adolescent obesity, including obesity-related health conditions like hypertension and type 2 diabetes mellitus)[10].

In the present study Group 2 showed a significant increase in mean anthropometric indices and blood pressure (Table 1). Normally, increasing age can cause an increase in height, weight, body mass index and blood pressure [11]. The age of students in this study suggests that the students could most likely be undergoing puberty and with puberty comes an increase in height and weight, with an expected corresponding increase in BMI[10]. This is a normal physiologic pattern.

The increase in mean systolic and diastolic blood pressure agrees with the findings of Cossio-Bolanos *et al*. [11] who carried out a cross sectional study on the relationship between age, BMI and blood pressure among adolescents. Group 2 are observed to have a significantly higher height, and increased blood pressure. The increase in height may have contributed to the rise in blood pressure,

an observation that conforms to the findings of Cossio-Bolanos *et al.* [11] who reported that increase in height presents with an increase in blood pressure, especially in educational concepts. In addition, the increase in weight can also lead to the rise in blood pressure seen in group 2, which concurs with the study of Hagman *et al.* [12] where it was seen that an increase in weight leads to an increase in blood pressure.

Table 2 and table 3 show that the mean blood pressure of both girls and boys were higher in group 2 than group 1, a finding which is consistent with Dong *et al.* [13] who carried out a research on trends on blood pressure and body mass index among adolescent from 2005 to 2010, they discovered that mean systolic blood pressure were 1.5 mmHg and 1.2 mmHg higher in boys and girls of 2010 than 2005 respectively and mean diastolic blood pressure were 1.1 mmHg and 1.0 mmHg higher in 2010 than 2005 respectively. These may indicate an overall change in blood pressure pattern of adolescents from a lower value obtained in earlier years, to a higher value in recent years. Liang *et al.* [14] reported a similar trend of blood pressure among Chinese children and adolescent aged 6-17 years in 1991 compared with value obtained in 2004. The reason for this observation could be a change in lifestyle factors which can be attributed to advanced technology on one side, as can be seen in children opting for video games as against physical activities. This promotes a sedentary lifestyle. On the other hand, changes in diet pattern from healthy home-cooked food to energy-dense high-fat fast-food meals may have influenced the observed increase in blood pressure and BMI.

Mean anthropometric indices and blood pressure of males and females as reported in table II and table III respectively, showed a significant ($p < 0.05$) increase in all the parameters in males and in females of group 2 except for systolic blood pressure in females. The increase in mean blood pressure in all the students in group 2 could be due to increasing body mass index. Although physical activity was not measured in the study, the advent of new technology in the form of video games and more programmes on television channels in 2018 than in 2004, could also contribute to decreased physical activity, thereby increased BMI in group 2 [13].

Pearson correlation revealed a significant ($p <0.05$) positive correlation between systolic and diastolic blood pressure with height and weight of female students in group 2. This finding may indicate an increase in systolic blood pressure seen with increasing body mass index. Sanchez-Zamorano *et al.* [15] also reported a positive correlation between BMI and systolic blood pressure in Mexican school aged adolescents. Furthermore,

significant ($p < 0.05$) negative correlation of height with respect to diastolic blood pressure was observed, this is in contrast with the findings of Regnault *et al.* [16] and Sirazuddin *et al.* [17] who found a positive association between trunk and leg length with blood pressure and a positive strong correlation of diastolic blood pressure with height in adolescent students respectively. The disparity in the present finding may be due to environmental changes, procedures during measurement, genetic factors or life style of the participants.

Conclusion

It can be concluded that there was a significant increase in the age, height, weight, body mass index, systolic blood pressure and diastolic blood pressure investigated for students in Bomo secondary school in the year 2018, when compared with the data obtained in 2004.

Conflict of Interest

All authors declare no conflict of interest.

References

[1] Aliyu SU, Ahmad JT, Oyeyemi AY. Relationship between body mass index and blood pressure among university students in Maiduguri, Nigeria. *International Journal of Recent Advances in Multidisciplinary Research*. 2014; 10 (11): 091-096.

[2] World Health Organisation (2021). Obesity and overweight. https://www.who.int/news-room/fact-sheets/details/obesity-and-overweight

[3] Solomon OO. Emmanuel EE. Solomon OA. Oluseyiamu E. Amodu O. Association between high body mass index and high blood pressure among adolesent in Ado- Ekiti, Ekiti state, Nigeria. *Public Health Research*. 2017; 7(4): 85-90.

[4] Chesi, A., and Grant, S. F. A. (2015). The Genetics of Pediatric Obesity. *Trends in endocrinology and metabolism: TEM*, *26*(12), 711–721. https://doi.org/10.1016/j.tem.2015.08.008

[5] Isezuo KO. Jiya NM. Audu LI. Ibitoye PK. Sani UM. Yusuf, T. et al. Blood pressure pattern and the relationship with body mass index among apparently healthy secondary school students in Sokoto metropolis, Nigeria. *South African Journal of Childhealth*. 2018; 12(3): 1475.

[6] Krishna, Pushpa & PrasannaKumar, K & Desai, Nagaraj & Kandavel, Thennarasu. (2006). Blood pressure reference tables for children and adolescents of Karnataka. *Indian Pediatrics*. 43. 491-501.

[7] Shajari H. Shajari A. Akhauan M. Amin S. Mehrparvar H. Roghani R. et al. Relationship between arterial blood pressure and body mass index of school age children of southern region of Iran.*ActaMedicaIranaca*. 2011; 49(11): 737-741.

[8] Haney MO. The relationship between BMI and blood pressure in school-aged children in Izmir, Turkey. *Progress in Nutrition*. 2018; 20(3): 372-377.

[9] Eyam LE. Eyam SE. Nsan E. Type of obesity and its effect on blood pressure of secondary school students in Rural and Urban areas of cross River State, Nigeria. *Journal of Pharmacy*. 2016; 3(4): 60-66.

[10] Wu, H., Patterson, C.C., Zhang, X., Ghani, R.B.A., Magliano, D.J., Boyko, E.J., Ogle, G.D., and Luk, A.O.Y. (2022) Worldwide estimates of incidence of type 2 diabetes in

children and adolescents in 2021. *Diabetes Research and Clinical Practice*, 185 109785

[11] Cossio-Bolanos M. Vidal-Espinoza R. de Campos F.C.C. Sulla-Torres J. Cossio-Bolanos W. Andruske C.L. et al. Establishing percentiles for blood pressure based on absolute height for children and adolescents. *Biomedcentral Pediatrics*. 2021; 21:26

[12] Hagman E. Danielsson P. Elimam A. Marcus C. The effect of weight loss and weight gain on blood pressure in children and adolescent with obesity. *International Journal of Obstetrics*. 2019; 43(10): 1988-1994.

[13] Dong B. Wang H. Wang Z. Shuailu J. Ma J. *American Journal of Hypertension* 2013; 26(8): 997-1002.

[14] Liang YY. Xi B. Hu YH. Wang C. Liu JT. Yan YK. et al.. Trend in blood pressure and hypertension among Chinese children and adolescents: China health and nutrition surveys 1991-2004). *Blood Pressure*. 2011; 20: 45-53.

[15] Sanchez-Zamorano LM. Salazar-Martinez E. Anaya-Ocampo R. Lazcano-Ponce E. Body mass index associated with elevated blood pressure in Mexican school-aged adolescent. *Preventative Medicine.* 2009; 48: 543-548.

[16] Regnault N. Kleinman KP. Rifas-Shiman SL. Langenberg C. Components of height and blood pressure in childhood, *International Journal of Epidemiology*. 2014; 43(1): 149–159

[17] Sirazuddin M. Farheen N. Navley S. Blood pressure distribution in relation with age, anthropometric measurements and socio economic status among school children of Warangal city, Telangana, India. *International Journal of Contemporary Pediatrics*. 2020; 7:1566-72.