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Pattern of BMI Percentiles among Adolescents in a Semi-Urban Community in South-Western Nigeria

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Abstract: Obesity in children and adolescents is increasing globally with attendant consequences on health and mortality. Over the past two decades there has been increase in type 2 diabetes mellitus (T2DM) in children, hence the need to regularly assess the body mass indices of adolescents in rapidly growing populations with the aim of early detection and management through lifestyle modification so as to prevent debilitating morbidity in adulthood. This was a cross sectional study involving 628 adolescents from two public schools and one private school in Ado Ekiti, Nigeria over four month period. With parental consent, volunteers completed a questionnaire, had their weight and height measured; body mass index calculated and BMI percentile plotted on BMI percentile charts for age and gender by Centre for Disease Control and Prevention (CDC). The BMI percentile of 552 (87.9%) of the 628 studied subjects was within normal limits, 42 (6.7%) were overweight, 5 (0.8%) were obese and 29 (4.6%) were underweight using WHO definition. The proportion, 39 (13.8%), of the studied 282 female adolescents who were overweight/ obese was significantly higher than 8 (2.3%) of 346 male participants; this difference was statistically significant $\chi^2 = 29.767$, df = 1, p = <0.001). This study showed that the prevalence of overweight/obesity among secondary school adolescents in Ado-Ekiti, Nigeria is lower than findings in other parts of Nigeria and also different compared to other parts of the world. Overweight/obesity is more common among females in the early adolescent age group.

Key words: BMI percentile, obesity, semi-urban community, Nigeria

INTRODUCTION

There is rising incidence of non-communicable diseases like diabetes, hypertension and coronary heart diseases globally (WHO, 2012; Slimane Mehdad *et al*., 2012; Akinpelu *et al*., 2008). Obesity in adolescents has been found to be associated with increased risk of impaired glucose tolerance, insulin resistance and type 2 diabetes (T2DM) (Whitlock *et al*., 2005). Overweight adolescents are also at risk of developing one or more risk factors for cardiovascular disease, such as hypertension and high cholesterol as well as other chronic medical conditions such as premature puberty/ adrenarche, hypovitaminosis D and osteopenia/ osteoporosis, which need to be attended to early (Freedman *et al*., 2007; Lobstein *et al*., 2004; Arisa *et al*., 2001; Oduwole *et al*., 2012). The Bogalusa study among obese children and adolescents showed that 70% of them had at least one risk factor for cardiovascular disease while 39% had two or more risk factors (Freedman *et al*., 2007). Adolescents are a dependent population and development of diabetes mellitus or other non-communicable diseases will pose a burden to parents and future society at large; hence the need to continually assess the burden of obesity and its co-morbidities among adolescents even in non-Western nations like Nigeria. This will help in early detection and hopefully control through potential early education and lifestyle modification.

Obesity means excessive body fatness (Barlow, 2007) and has been defined as a body mass index (BMI) at or above the 95th percentile for children and teenagers (Barlow, 2007). In 1996, the Body Mass Index (BMI) was considered as an important metric and in 1997 the World Health Organization (WHO) formally recognized obesity as a global epidemic (Caballero, 2007). In fact, childhood obesity has more than doubled in children and tripled in adolescents in the past three decades (Ogden, 2012; National Center for Health Statistics, US, 2012).

The fundamental cause of obesity is a chronic imbalance between the amount of energy intake as food and energy expended by the body in daily activities (Bray, 2004). Much research continues to better understand the pathogenesis of obesity, the contribution of genetics and also the contribution of environment factors promoting obesity. Leptin is a peptide hormone discovered in 1994, that is involved in a complex circuit of hormones and neurotransmitters to control appetite (Bray, 2004; Speiser *et al*., 2005). Absence of leptin, because of rare genetic defects, causes failure of coupling between energy intake and energy expenditure, resulting in obesity (Bray, 2004). Analysis of global prevalence of childhood overweight and obesity from 144 countries, in cross-sectional surveys by de Onis *et al*. (2010) found an estimated 42 million obese children under the age of five in the world of which close

to 35 million lived in developing countries. Additional findings included worldwide prevalence of childhood overweight and obesity increasing from 4.2% in 1990 to 6.7% in 2010 and expecting to further increase to 9.1%, an estimated 60 million overweight and obese children, by 2020 (de Onis *et al*., 2010). In Nigeria recently, the same thing is taking place and the prevalence of obesity and overweight (defined as BMI between 85th and <95th percentile for age, sex and height) among high school adolescents in Lagos was 9.4 and 13.8%, respectively (Oduwole *et al*., 2012). Ado-Ekiti, the state capital of Ekiti State Nigeria, is a rapidly developing city in Nigeria with very dynamic changes in the life style of the populace. Baseline data is needed to assess the impact of increased urbanization on a previously more rural community.

MATERIALS AND METHODS

This was a cross sectional study carried out among a convenience sample secondary school adolescents in Ado-Ekiti, Ekiti State, Nigeria over a period of four months. Ethical clearance was obtained from the Research and Ethical Committee of the Ekiti State University Teaching Hospital, Ado-Ekiti. Permission to enter the secondary schools was secured from the Ministry of Education, Ekiti State who also selected and provided a letter of permission to the school authorities concerned. Informed consent was obtained from the parents or legal guardians and assent from the volunteer secondary school adolescents who participated in the study after explaining the study objective and protocol. Secondary school adolescents of both sexes who satisfied the inclusion criteria were recruited for the study from three different schools. A structured questionnaire was administered to obtain socio-demographic data and information relevant to the study. Body weight was measured to the nearest 0.1 kg using a portable weighing scale with minimal clothing and no shoes; belts and other accessories were removed and pockets emptied. Height was measured to the nearest 0.1 cm using a portable stadiometer with the subjects standing erect, barefoot, heels together and looking straight ahead in the Frankfurt plane. The lower edge of the eye socket was in the same horizontal plane as the external auditory meatus, with the heels and back against the height rule (Marfell-Jones, 2006). BMI was calculated as weight in kilogram divided by the square of height in meter (kg/m^2). Using these measurements and BMI-for-age percentiles charts by the US Centers for Disease Control and Prevention (CDC), the weight status of each subject was categorized as follows: obese (≥95th percentile); overweight (85th to <95th percentile); normal weight (5th to <85th percentile); underweight (<5th percentile) (Ogden, 2000).

Data was entered and analyzed using SPSS 16.0 for Windows (SPSS Inc, Chicago, USA). Numerical values was given as number of cases (n); mean (standard deviations), median, proportions and percentage. Subjects were grouped based on their age, gender, socio-economic status and BMI percentile. Students were also grouped based on some lifestyle/activities (for example, eating pattern, snacking between meals, daily television viewing duration, exercise, family size, family history of diabetes and type of school). These lifestyle/activities were cross-tabulated with their BMI percentile. Test for association with chi square (χ^2) was done and p-values less than 0.05 was regarded as significant.

RESULTS

A total of 628 adolescents were studied in three different secondary schools in Ado-Ekiti. There were 346 males and 282 females giving a male to female ratio of 1.2: 1. The mean age (SD) of participants was 14.2 (1.7) years; ranging from 10 to 19 years. The prevalence of overweight/ obesity (47 out of 628) was 7.5% in the studied population. The greatest proportion, 31 (66%), of the overweight/obese adolescents were in the 10-14 years age group while the remaining 16 (34%) were in the 15-19 years age group. The majority, 508 (80.9%), of the studied adolescents were from a high social class, 104 (16.6%) were from middle class and 16 (2.5%) were from low socio-economic class. Of the 49 overweight/obese adolescents 39 (83%) were from upper social class, 8 (17%) from middle social class and none (0%) from low socio-economic class. Table 1 shows the BMI percentile grading of the studied adolescents according to age group and gender.

Female gender was the only factor found to significantly influence obesity in the studied population ($p<0.001$). Other factors such as age, type of school, small family size, exercise, family history of obesity, snacking and watching television for more than 5 hours a day were not significantly associated with obesity ($p>0.05$).

The distribution pattern of body mass indices of the 628 studied adolescents from three secondary schools in Ado-Ekiti is shown in Fig. 1. The mean (SD) BMI was 19.8 (2.53), median was 19.5 kg/m^2 and it ranged from 13.6 to 30.1 kg/m^2. Figure 2 is a box plot comparing the BMI pattern in male and female adolescents: it shows that the BMI pattern in males is more evenly distributed than females and that the females have higher variability in their BMI than the males. 346 males were studied and their mean (SD) BMI was 19.3 (2.2), whereas there were 282 females and their mean (SD) BMI was 20.4 (2.8).

DISCUSSION

The prevalence of overweight among secondary school adolescents in Ado-Ekiti was 6.7% while that of obesity was 0.8%; combined overweight/obesity had a prevalence of 7.5%. The prevalence of obesity among secondary school adolescents (0.8%) in this study is

Table 1: Body mass index percentile grading according to age group and gender

	BMI percentile grading				
Age group	Normal	Overweight	Obese	Underweight	Total
10-14 years	317	29	2	9	357
15-19 years	235	13	3	20	271
Total (%)	552 (87.9)	42 (6.7)	5 (0.8)	29 (4.6)	628 (100)
Sex					
Male	315 (57.1)	7 (16.7)	1 (20.0)	23 (79.3)	346
Female	237 (42.9)	35 (83.3)	4 (80.0)	6 (20.7)	228

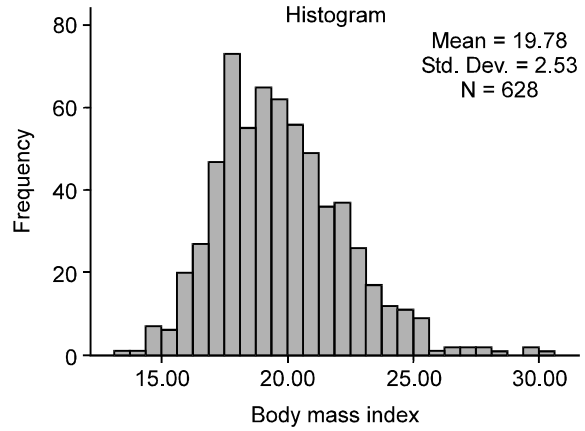

Fig. 1: Pattern of distribution of BMI (kg/m^2) of secondary school adolescents in Ado-Ekiti

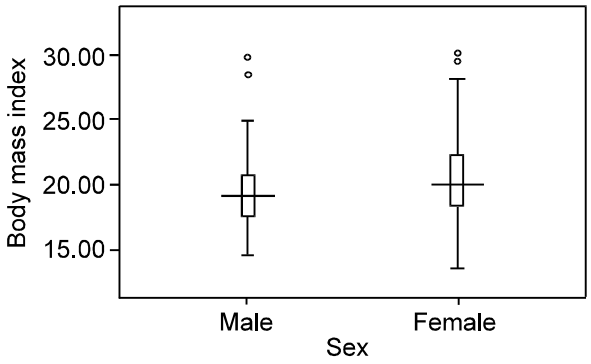

Fig. 2: Box plot comparison of the BMI in male and female adolescents

much lower than 9.4% reported among adolescents in Lagos, Nigeria (Oduwole *et al*., 2012); 18% in US (Ogden, 2012; National Center for Health Statistics, US, 2012); 14.6% in Kuwait (El-Bayoumy *et al*., 2009), 4.2% in Ile-Ife, Nigeria (Sabageh and Ojofeitmi, 2013), 2.1% in Enugu, Nigeria (Ani *et al*., 2013), 4.1% in Tunisia (Aounallah-Skhiri *et al*., 2008) and 5.3% in South Africa (Reddy *et al*., 2008). Also the prevalence of overweight among secondary school adolescents in Ado-Ekiti (6.7%) is lower than 13.8% reported from Lagos (Oduwole *et al*., 2012), 7.5% from Enugu (Ani *et al*., 2013), 30.7% from Kuwait (El-Bayoumy *et al*., 2009), 17.4% from Tunisia (Aounallah-Skhiri, 2008) and 19.7% from South Africa (Reddy *et al*., 2008). Furthermore, when compared to adolescents of similar age groups from rural communities of South Africa (Kimani-Murage *et al*., 2010), 10-14 years and 15-20 years the prevalence of overweight and obesity 8.1%, 0.6%, 4.8% and 1.1% in Ado-Ekiti compared to 6%, 8%, 2% and 4% in rural South Africa (Kimani-Murage *et al*., 2010), respectively is still lower except for prevalence of overweight in age group 10-14 years which was 8.1% in Ado-Ekiti compared to 6% in rural South Africa (Kimani-Murage *et al*., 2010). This difference could be due to different factors prominent among which is socio-economic status of these adolescents. Ekiti State is among the poorest in Nigeria where earning power is lower in comparison to Lagos State where there is also more prevalence of overweight and obesity, perhaps reflecting the amount and/or type of food available for the adolescents. There are also increased physical activities among the adolescents in Ado-Ekiti within and outside the school environment. Many of them trek long distances to school daily and there are large expanses of land for sport activities in most schools so this too may explain differences with a larger city such as Lagos. There are variations in the prevalence of overweight and obesity based on the gender of the adolescents: this study showed that female adolescents (13.8%) were more overweight/ obese compared to males (2.3%) and this was statistically significant (p = <0.001). This agrees with findings in most other studies within and outside Nigeria (Slimane Mehdad *et al*., 2012; Arisa *et al*., 2001; Oduwole *et al*., 2012; Sabageh *et al*., 2013; Aounallah-Skhiri *et al*., 2008; Reddy *et al*., 2010; Kimani-Murage *et al*., 2010; Bibiloni *et al*., 2013; Tharkar and Visvanathan, 2009) but there are a few studies reporting a higher prevalence among male (Ani *et al*., 2013; Bibiloni *et al*., 2013). Earlier puberty and early growth spurts in females versus males is normal and to be expected but this may be a confounding factor and contribute to this difference since there is increased accumulation of relative adipose tissue in females during puberty followed by a reduction in adipose tissue accumulation after puberty (Kimani-Murage *et al*., 2010; Tharkar *et al*., 2009). This could partly explain the two peaks observed in the BMI of the adolescents at 12 and 17 years of age in this study which roughly correspond to the time for early and late phase of puberty respectively in the mixed population of male and female adolescents (Kimani-Murage *et al*., 2010; Tharkar *et al*., 2009).

The prevalence of overweight and obesity among secondary school adolescents in our study in Ado-Ekiti, though low compared to findings from other communities/countries, is higher than "ideal" so a recommendation to medical, public health, government and school authorities should take heed of this information. There is established evidence that non communicable diseases are associated with overweight and obesity (Whitlock *et al*., 2005; Freedman *et al*., 2007; Lobstein *et al*., 2004; Caballero, 2007) and measures must be put in place to prevent it in every adolescent (Barlow, 2007). Overall, the BMI percentile of majority (87.9%) of the secondary school adolescents studied for this project in Ado-Ekiti was within normal range while 4.6% of the studied population were underweight (BMI percentile <5%). This is consistent with finding from other studies (Oduwole *et al*., 2012; Ani *et al*., 2013; Aounallah-Skhiri *et al*., 2008; Reddy *et al*., 2010; Kimani-Murage *et al*., 2010).

Conclusion: The present study showed that the BMI percentile of 9 out of every 10 secondary school adolescents in Ado-Ekiti is within normal range; One out of every fifteen (6.7%) secondary school adolescents is overweight; the prevalence of obesity is relatively low (0.8%) among adolescents in Ado-Ekiti; overweight and obesity is more common among female adolescents; overweight is more prevalent in the early adolescent (10-14 years) age group while obesity is more common in the older adolescents (15-19 years) and 4.6% of the adolescents were underweight.

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Conflict of interest: The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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