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Baseline anthropometric measurements and Obesity among students in Sagamu, Ogun State, southwest, Nigeria

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Abstract
Objectives: This study was designed to determine the anthropometric characteristics and prevalence of obesity among secondary and undergraduate students in Sagamu.
Methods: This cross-sectional study involved a selection of 260 students aged 10 to 33 years in Sagamu using a convenience sampling method. The weight, height, and waist and hip circumferences of each subject were measured. The body mass index was then calculated. Data were analyzed using SPSS version 25.0 and p-values< 0.05 were considered statistically significant.
Results: The age ranges were 1o to 17 years (Secondary school (SS) students) and 14 to 33 years (undergraduate students). There were 130 students in each group, comprising 52.7% males and 47.4% females. Underweight was commoner among the SS students (20.8% versus 6.2%). Most of the subjects were of normal weight 52.3% in SS and 68.5% in undergraduates. Only 3.1% of SS students were obese compared to 4.6% of undergraduate students. The mean BMI of SS students (22.2± 0.39 versus 23.24±0.34) was statistically lower (p=0.019). The mean waist circumference of SS students (66.92±0.44 versus 74.64±0.67) was also statistically lower (p=0.000). The mean BMI of SS students was higher in females than in male subjects (23.14±0.62 versus 20.86±0.42). The mean waist and hip circumferences and BMI were lower in female subjects for both study groups.
Conclusions: The mean BMI and hip circumferences were higher in female subjects while the mean waist circumferences were lower in females than males in both study groups.

Keywords: BMI, Weight, Waist circumference, Thigh circumference, Obesity, Students

Plain English Summary
This study was designed to determine the anthropometric characteristics and prevalence of obesity among secondary and undergraduate students in Sagamu. This cross-sectional study involved a selection of 260 students aged 10 to 33 years in Sagamu using a convenience sampling method. The weight in kilogram and height in meters of each subject were measured. The waist circumference (WC) in centimeter (cm) and hip circumference (HC) (cm) of each subject was measured using a flexible tape. The body mass index (kg/m2) (B.M.I) was calculated. The ages of the secondary school students (SS) were between 10 and 17 years while that of the undergraduate students was between 14 and 33years. There were 130 students in each group comprising 52.7% males and 47.4% females. Mean BMI among students (22.2± 0.39 versus 23.24±0.34). The mean waist circumference was 66.92±0.44 in SS Students versus 74.64±0.67 in undergraduate students). The study shows that the mean waist circumference was lower in female subjects for both study groups. Mean BMI was higher while the mean hip circumferences were lower in females than males in both study groups.

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Introduction

One of the many ways by which health status can be assessed is through measurement of the anthropometric indices of an individual; other ways include measurement of the biochemical parameters such as cholesterol, evaluation of physical appearance, and assessment of the presence or absence of diseases or conditions[1]. Anthropometrics provide information on body mass index (BMI), height (ht) weight (wt), and Mid Upper Arm Circumference (MUAC), among others. Anthropometrics is the scientific study of the measurement and proportions of human body parts or the whole body. Moreover, it is the science that defines the physical measurement of a person's size, form, and functional capacities. Functional capacities are a function of wellness (1, 2). Anthropometrics provide indices of growth and development and therefore health status (3, 4). Anthropometry is an important determinant of nutritional status and health; "poor nutritional status during the period of growth is an important determinant of health" (5).

Anthropometric indices can be divided into body size and body composition (6). In the hospital, anthropometric indices of body size (i.e., mid-upper-arm circumference, weight, height, and body mass index) are used primarily to distinguish between under- and over-nutrition and to monitor changes after a nutrition intervention (7). Weight and length/height are also critical as a basis for calculating dietary requirements (7). The indices of height, weight, body mass index, waist circumference, and hip circumference were used in this study because they were cheap and easy to measure. Other anthropometric parameters (though not used in this study) are mid-parental height, waist-hip ratio, skin fold measurement, head circumference, and bioelectrical impendence analysis.

It has been stated, "The measurement of height is important for calculating certain indices such as height-for-age, weight-for-height, BMI, the creatinine height index and estimating basal energy expenditure[6]. BMI can be used to determine nutritional status and widely accepted measures for body fat, although it is influenced by age, gender, and race (6).

Overweight and obesity are predictors of morbidity and mortality from cardiovascular diseases (CVD), diabetes, musculoskeletal disorders, and some cancers (8, 9). In addition, excess abdominal obesity is associated with a range of metabolic abnormalities and CVD (10, 11). Body mass index (BMI) is widely used in the diagnosis of overweight and obesity, whereas waist circumference (WC) and indices based on WC–such as waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR)–are employed as surrogate indicators of visceral obesity to predict morbidity and mortality at the population level (12, 13, 14). These anthropometric indices are used in epidemiological studies for population surveillance of risk factors for chronic disease because they can be easily measured and at a low cost (15, 16).

There is a paucity of published work on anthropometric measurements concerning gender differences in students in our environments. Therefore this study was intended to determine the prevalence of obesity as well as anthropometric parameters among selected students in Sagamu, Ogun state.

Methods

This cross-sectional study involved a selection of 260 subjects using a convenience sampling method of students in Sagamu, Ogun State, South-West, Nigeria, aged between 10 and 33 years. Two secondary schools were selected from Sagamu Local Government Area. The undergraduate students were from the Faculty of Basic Medical Sciences of Olabisi Onabanjo University, Sagamu.

Sample size determination method using the formula

This was performed using Cochran's formula $(Z_{1-\alpha}/2)^2 \times SD^2/d^2$ where Z= normal variant d= 3%. Type 1 error. SD=25 unit(s) from a previous study. 2.5% attrition since human subjects are involved (6).

This is equal to $\dfrac{1.96^2(25)^2}{(0.03)^2}$

= 266 (260 + 6).

The weight in kg of the subjects was recorded in kilograms (to the nearest 1.0 kg) without them wearing any heavy clothing like a coat, jacket, shoes, or agbada, using a calibrated bathroom scale (Soehnle Waagen GmbH and Co. KG,D 71540 Murrhardt /Germany) positioned on a firm horizontal surface. Height in meters of subjects was measured (to the nearest 0.1m) using a stadiometer. Subjects stood erect, without shoes and headgears, on a flat surface with the heels and occiput in contact with the stadiometer. The body mass index (B.M.I) was subsequently calculated using the

formula: weight (kg)/ height^2 (metres^2). Underweight, normal weight, overweight, and obesity were defined by WHO as BMI < 18.5, 18.5-24.9, 25.0-29.9, and ≥ 30.0 respectively. Overweight and/or obesity was defined as BMI ≥ 25. The waist circumference of each subject was measured using a flexible tape measure to the nearest 1cm at the level of the umbilicus with the subject standing and breathing normally. The hip circumference of each subject was measured with the same tape measure to the nearest 1cm at the level of the greater trochanter. All measurements were taken by the researcher with the aid of an assistant to cross-check that the tape measure did not slant.

Statistical analysis
The student t-test was used to compare the variability of numerical variables between males and females. The data obtained were analyzed using the computer statistical program package SPSS version 25.0 Probability value of p less than 0.05 was considered statistically significant.

Results
The total number of subjects was 260. The ages of the secondary school students were between 10 and 17 years while that of the OOU students were between 14 and 33years. There were 137(52.7%) males and 123 (47.4%) females comprising 130 students in each group or category of students (Table 1).

Table 1: Demographic characteristics of the participants

Variable	Category	Total 0 (0.0)	SS 0 (0.0)	OOU 0 (0.0)
Age(years)	10-13	62 (23.8%)	62 (47.7%)	
	14-17	90 (34.6%)	68 (52.3%)	22 (16.9%)
	18-21	46 (17.7%)		46 (35.4%)
	22-25	47 (18.1%)		47 (36.2%)
	26-29	9 (3.5%)		9 (6.9%)
	30-33	6 (2.3%)		6 (4.6%)
Gender	Male	137 (52.7%)	64 (49.2%)	73 (56.2%)
	Female	123 (47.3%)	66 (50.8%)	57 (43.8%)

Underweight was more common among the SS students 20.8% against 6.2%. Most of the subjects are of normal weight 52.3% in SS students and 68.5% in OOU students. Only 3.1% of SS students were obese compared to 4.6% of OOU students (Table2).

Table 2: BMI of the Study Groups

BMI Category	Total	SS Students	OOU
Underweight	35 (13.5%)	27 (20.8%)	8 (6.2%)
Normal weight	157 (60.4%)	68 (52.3%)	89 (68.5%)
Overweight	58 (22.3%)	31 (23.8%)	27 (20.8%)
Obese	10 (3.8%)	4 (3.1%)	6 (4.6%)

The mean BMI is 22.2 ± 0.39 in SS students and 22.24 ± 0.34 in OOU students. The mean waist circumference is 66.92 ± 0.44 in SS students and 74.64 ± 0.67 in OOU students (table3).

Table 3: Anthropometric measurements of the study groups

Variable	SS students (n=130)	OOU students (n=130)	T-test	P value
Mean weight(kg)	45.31±0.73	63.71±1.10	13.959	0.000*
Mean height(m)	1.45±0.02	1.66±0.01	11.113	0.000*
Mean BMI(kg/m^2)	22.02±0.39	23.24±0.34	2.358	0.019*
Mean waist circumference(cm)	66.92±o.44	74.64±0.67	9.631	0.000*
Mean hip circumference(cm)	80.67±0.43	94.58±0.78	15.665	0.000*

*Significant at p<0.05

The mean BMI is higher in females (23.14 ± 0.62) than in males (20.86 ± 0.42) among the SS students. The mean waist circumference is lower in female subjects for both study groups. Mean BMI was higher while the mean hip circumferences were lower in females than males in both study groups (Tables 4).

Table 4: Sex distribution of the study groups

Variable	SS (n=64)	OOU (n=73)	T-test	P value
Male				
Mean weight(kg)	45.93±0.97	66.21±1.30	12.215	0.000*
Mean height(m)	1.49±0.02	1.71±0.01	9.927	0.000*
Mean BMI(kg/m^2)	20.86±0.42	22.67±0.37	3.218	0.002*
Mean waist circumference(cm)	67.16±0.56	75.24±0.81	7.956	0.000*
Mean Hip circumference(cm)	80.58±0.53	93.75±0.85	12.745	0.000*
Females	(n=66)	(n=57)	T-test	P value
Mean weight(kg)	44.70±1.09	60.51±1.79	7.756	0.000*
Mean height(m)	1.41±0.02	1.59±0.01	6.417	0.000*
Mean BMI(kg/m^2)	23.14±0.63	23.96±0.59	0.946	0.346
Mean waist circumference(cm)	66.69±0.67	73.87±1.12	5.661	0.000*
Mean hip circumference(cm)	80.75±0.68	95.63±1.39	10.003	0.000*

*Significant at p<0.05

Discussion:

This study demonstrates that undergraduate students have a higher mean Body Mass Index (BMI), mean hip circumference (HP), and waist circumference (WC) when compared with secondary school subjects. The progressive increase in the waist and hip circumferences may be due to an age increase among SS to University students. The progression from puberty and the elaboration of estrogen in the blood in adulthood may be responsible for the higher preponderance of values in females (17). More SS students are underweight than undergraduate students, this may be due to the nutritional status of children in the country. The poor economic status of the developing country of which Nigeria is one cannot be over-emphasized. The affordability of a balanced diet may be responsible for the obesity we saw in both the SS and Undergraduate students. Besides nutrition, obesity may be due to hormonal factors (14).

The anthropometric parameters (BMI, WC, HC) in the study group followed a progressive increase in the age of both SS students and undergraduate students, this is similar to the study done by Taiwo and Sofola, 2020 (18) where anthropometric parameters were measured in motor park workers where there was a progressive increase in the BMI, WC, and HC measured (18).

Fidelis et al, 2019 (19) in their study stratified the population according to gender and age. Across all age groups; males had higher mean values for both HC and BMI except the hip circumference which was found to be higher in females than in males (19)·

In a population-based study done by Ibrahin Mohmond and Nabil Sulaimon in 2021 (20) on the significance and agreement between obesity anthropometric parameters and indices in adults, the prevalence of obesity/overweight was 66.4% based on body mass index (BMI), 61.7% based on waist circumference (WC), A lower prevalence 3.8% of obesity was seen in this study. Obesity was higher in undergraduate students than in SS students. This may be due to the level of affluence experienced in the United Emirates compared with young adults in developing countries like Nigeria.

BMI was calculated in all the participants. BMI is used to diagnose obesity as it correlates with body fats. It indirectly measures body fat and has limitations when used in isolation as seen in a study where the percentage of body fat varies with age and gender (6). Clinically, anthropometric measurements have roles in assessing physical fitness and providing data for a wide variety of the population from children to athletes and the elderly (9). This study showed that there is a high prevalence of overweight among undergraduates and SS students, whether measured by BMI or WC. Obesity remains a major contributor to the burden of ill-health in Sub-Saharan Africa, particularly among urban populations. The similar pattern of increase or decrease with age of the indices of overall and central obesity highly suggests an association between increased overall obesity (as measured by BMI) with increased visceral fat (WC). Similar results were reported in the urban female population of Morocco by Belahsen *et al* (21) and by Sargeant *et al.* in the urban adult population of Jamaica (22). It is likely therefore that BMI provides different measures of almost the same phenomenon. In the study done by Belahsen et al, 2004 clinically, visceral fat is more metabolically active than subcutaneous fat and hence may be more deleterious to health (22, 23). Several studies have found a strong association between visceral fat and cardiovascular risk factors (24, 25, 26). However, WC is a practical measure of

intra-abdominal fat mass (25) and recommendations have been formulated to use it in the identification of people in need of intervention for cardiovascular risk reduction (27, 28, 29). Hans et al, 1995, suggested that defining obesity on the base of WC may be a more valid and useful method in epidemiological research and clinical practice, though further research is needed to demonstrate this unequivocally (29). The study done by Montague and Rahilly, 2000 provided insights into the relationship between age, sex, and overweight, using a range of anthropometric parameters. Based on BMI alone, the study showed a high prevalence of overweight and provides evidence to support the establishment of intervention programs to prevent further increases in obesity-related disorders such as diabetes and hypertension in urban Sub-Saharan African populations (23). Meanwhile, further studies need to be carried out to provide appropriate cut-off points and identify which anthropometric parameter has the highest predictive value in the identification of subjects at risk of obesity-related disorders.

Conclusion
The Mean BMI and hip circumferences were higher in female subjects while the mean waist circumferences were lower in females than males in both study groups. The hip circumference and waist circumference which are indicators of anthropometric parameters circumferences were higher in senior students. All these parameters measured can be a baseline for future studies.

List of abbreviations
OOUTH:	Olabisi Onabanjo Teaching Hospital
SS students:	Secondary School Students
OOU Students:	Olabisi Onabanjo University Students
BMI:	Body Mass Index
MUAC:	Mid Upper Arm Circumference
CVD:	Cardiovascular Disease
WHR:	Waist Hip Ratio
WHtR:	Waist to height Ratio
HREC:	Health Research Ethics Committee
HP:	Hip Circumference
WC:	Waist Circumference

Declarations
Ethics approval, and Consent to Participate
Ethics clearance for the study was obtained from the Health Research Ethics Committee (HREC) of Olabisi Onabanjo University Teaching Hospital (OOUTH), Sagamu (HREC/OOU/019/2019). All participants (260) of this study signed an informed consent form before answering the questionnaire and taking their anthropometric measurements.

Authors' Contributions
Conceptualization:	TOE
Study design:	TOE
Drafting of the manuscript:	TOE
Data collection:	TOE
Data analysis:	TOE, TLOA
Manuscript review:	TLOA

Both authors read and approved the final manuscript.

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