The association of ABSI with biochemical and clinical indices in undergraduates of a Nigerian South-southern University

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Abstract

A Body Shape Index (ABSI) is a new adiposity metric that has been linked with chronic metabolic diseases such as diabetes mellitus, type 2, cardiovascular diseases, and cancer risk in some studies. ABSI is an anthropometric index that takes into account waist circumference (WC), body mass index (BMI), and height. The aim of this study was to determine the relationship of ABSI with clinical and biochemical indices in undergraduates. This cross-sectional study involved 97 undergraduate students of Edo State University Uzairue, Edo State, Nigeria (16–26 years old). They comprised 65 females and 32 males. Information on socio-demography was obtained from administered semi-pretest questionnaire. Anthropometric indices; body weight, height, waist circumference, hip circumference and mid-upper arm circumference were determined using standard methods. BMI, ABSI, waist hip ratio and waist height ratio were calculated. Blood pressure, pulse rate, pulse pressure, saturation of peripheral oxygen (SPO_2), and body composition including lean body mass, body water, metabolism and so on. as well as plasma glucose and total cholesterol were determined by standard methods. Age, body weight, height, mid-upper arm circumference, systolic blood pressure, lean body mass, metabolism were significantly higher in males, while body age, SPO_2 and fat were significantly higher in females than males ($p<0.05$). ABSI positively correlated with height, waist circumference, pulse rate, visceral fat, metabolism, and lean body mass ($p<0.05$). Observations in this study show that ABSI could be a good index of assessing abdominal obesity, hence, its recommendation for obesity screening in studies is suggested.

Keywords**:** A body shape index, Biochemical indices, Body mass index, Clinical indices, Obesity, Waist circumference

1.0 Introduction

Obesity is a global health predicament with mounting prevalence. A threefold increase in prevalence has been observed in the last three decades (Lee *et al.*, 2022). Adolescence is a critical phase of life marked with swift growth rate accompanied with alteration in body composition contingent on tissue maturation (Nicolucci and Maffeis, 2022). Therefore, obesity in this phase of life strongly predicts obesity in adulthood and a high death rate (Nicolucci and Maffeis, 2022). Diabetes mellitus type 2 (DMT2), cardiovascular diseases and cancers are some pathologies associated with obesity (Lee *et al.*, 2022).

There is variation in the outcomes of obesity as a function of definite body fat depot. Abdominal obesity usually results in metabolic complications while gluteofemoral obesity is inversely associated with metabolic complications (Hill *et al*., 2018). General obesity is assessed by BMI as recommended by World Health Organization (WHO), there is still no agreement on the best means of assessing abdominal obesity (Christakoudi *et al*., 2020). A body shape index has been reported to be more effective than other anthropometric indices i.e. waist circumference and waist hip ratio in determining abdominal obesity (Christakoudi *et al*., 2020). This information is expected to be verified in adolescents.

A report showed the relationship of ABSI with elevated blood pressure, DMT2 and cardiovascular diseases (Ji *et al*., 2018). In that report, it was also found to be strongly associated with death than either WC or BMI. Its applicability to a variety of populations irrespective of demographics has been suggested also as a merit (Lee *et al*., 2022).

Studies on the use of ABSI in predicting obesity in adolescents are sparse. This study was designed to ascertain the relationship of ABSI with clinical and biochemical parameters in undergraduates students of Edo State University Uzairue, Edo State, Nigeria

2. Materials and Methods

This cross-sectional study involved 97 apparently healthy Edo State University Uzairue undergraduate students aged between 16 and 26 years old. They included 65 female and 32 male participants drawn from the faculties in the University who gave written consent in participating in the study. Participants with reported chronic ailment were excluded from the study. Participant's socio-demographic information was obtained using pre-test questionnaire. Anthropometric, clinical and biochemical indices were obtained as described below.

2.1. Anthropometric measurement

The following anthropometric indices were taken from each study participant; Height, body weight, middle-upper arm circumference, hip circumference, waist circumference. The following anthropometric indices where calculated; BMI, waist hip ratio, body mass index, waist height ratio and ABSI.

BMI: This was determined manually using the formula Wt/H^2 and calculated by the automatic scale and reported in kg/m^2.

Weight: While each participant wore light outdoor clothing without shoes or a head covering, two scales were utilized for measurement: one manual and one automatic. Before each use, the manual scale was reset to zero. Two sets of readings were taken from each study participant while standing on the scale. After prior entry of height data, the automatic scale was utilized in conjunction with a phone app that tracks body age, weight, water, protein, muscle, bone mass, metabolism, lean body mass (LBM), fat, visceral fat, obesity and BMI. The participant stood barefooted on the scale, which was connected to a phone via Bluetooth using the OKOK app, and readings were shown on the phone and reported in kilograms. Since there was no difference in the readings obtained using the scales, readings from the manual scale was reported in this manuscript.

Height: Every participant's height was measured using an available cement floor level and a mobile standiometer. The participants were measured by standing erect on a flat solid surface without shoes or headgear, arms hanging by their sides, and ankles and knees together. A ruler was placed firmly on the subject's head to determine the exact height on the wall, a point was marked on the wall, and the standiometer was used to measure the distance between the designated point in the wall and the floor. Readings were taken to the closest two decimal places in metres. The measurements were made twice.

Waist circumference: Participants' waist circumferences were measured in cm with a tape rule. The participant's waist was wrapped in a tape rule, and measurements were obtained and recorded to two decimal places.

Hip circumference: A tape rule in cm was used to measure the participant's hip circumference. The participant's hip was wrapped in a tape rule, and measurements were obtained and recorded.

Middle upper arm circumference: The circumference of the subjects' central upper arms was measured in cm using a tape rule. Measurements were taken and recorded while the tape rule was wrapped around the participant's middle upper arm.

A Body Shape Index (ABSI): This was calculated using the formula below

$$\text{ABSI} = \frac{\text{Waist Circumference}}{\text{BMI}^{2}\ \text{Height}^{1/2}}$$

2.2 Body composition

This includes fat (%), muscle (kg), water (%), visceral fat, bone mass (kg), protein (%), metabolism, obesity (%), body age (years) and lean body mass (kg). Each participant was made to stand barefooted on the sensitive pores of an automatic weighing scale connected via Bluetooth with a pre-installed app (OKOK) on an android phone. Readings were taken according to manufacturer's instruction

2.3 Clinical data

Saturation of peripheral oxygen (SPO_2) and Pulse rate: The heart rate and SPO_2 were measured using an oximeter. The oximeter was turned on and placed on the participant's middle or index finger while seated, after it had rested for about 2 minutes. Readings were taken in accordance with manufacturer's instruction.

Pulse pressure and Blood pressure: The pulse pressure and systolic and diastolic blood pressures were measured with a sphygmomanometer. The subject was seated and asked to rest for 5 minutes before the test. The cuff was placed on the subject's bare left upper arm one inch above the bend of the elbow and wrapped around it until only two fingers could slide under the cuff's top edge. The participant was instructed not to move or speak, after which the machine was turned on and readings were taken.

2.4 Biochemical indices

Participant's plasma glucose was determined using a glucose meter (Accu-Chek). Sterile lancet was used to prick the finger tip of each participant previously cleansed with cotton wool soaked in ethanol. A drop of blood was thereafter placed in the appropriate place on the meter after which the reading was displayed on the meter's screen. Plasma total cholesterol was also determined using a lipid estimation meter (SpeedGUC Multifunctional Analyzer, Changasha Zealson Biotech, China). A drop of blood was obtained from each participant as previously described for plasma glucose and placed on the designated area of the meter, the reading was subsequently displayed on the meter's screen. Both glucose and total cholesterol were expressed in mg/dl.

2.5 Ethical considerations

The ethical approval for this study was obtained from the Faculty of Basic Medical Sciences' Ethical Committee of Edo State University Uzairue, Edo State, Nigeria. (ERC/FBM/007/2021).

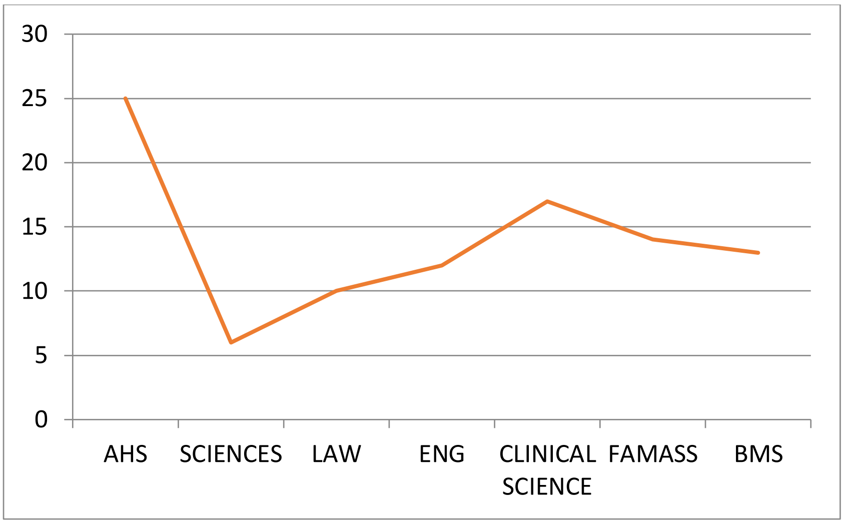
2.6 Statistical Analysis

Microsoft excel and Statistical package for social sciences (SPSS 18.0) were used for the analysis of the data. Distribution of gender, Department of participants and age population age were determined using Microsoft excel. Comparison of the quantitative variables was done using Student's t-test. Association among variables was determined by Pearson correlation coefficient. Data was considered statistically significant at ($p<0.05$).

3.0. Results

In Figure 1, the distribution of participant's Faculties is represented. The Faculty with the highest population of participant was Applied Health Science (AHS), while Faculty of Science had the least number of participants**.** As shown in Figure 2, female participants accounted for the majority of study participants. There were 65 females (67%) and 32 males (33%). Participants aged 18 and 26 years accounted for the highest and least percentage of study participants, respectively as shown in Figure 3

Table 1 shows the comparison of variables in male and female participants. Significant difference was observed in the age, body age, weight, height, middle upper arm circumference, systolic blood pressure, SPO2, fat, LBM, Muscle, body water and metabolism ($p<0.05$). There was however no significant difference in other parameters. In table 2, ABSI was found to be associated with height, waist circumference, pulse rate, visceral fat, metabolism, and lean body mass ($p<0.05$).



AHS: Applied Health Sciences

Figure 1- The Distribution of Participants Faculty

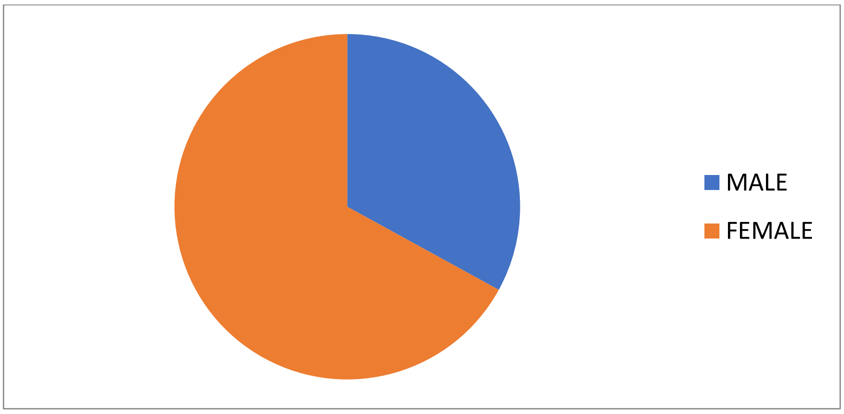


Figure 2- The Gender Population of Participants

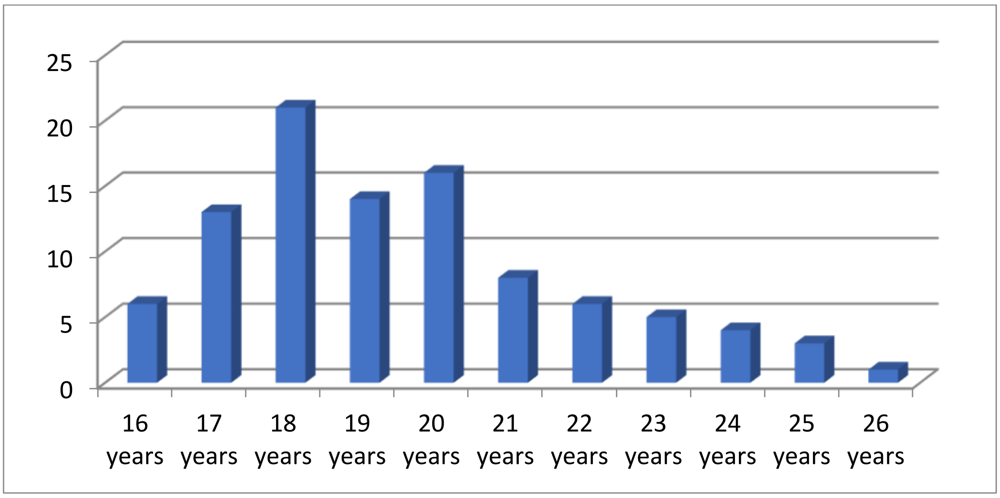


Figure 3- The Population Age of Participants

Table 1: Comparisons of Age, Body Composition, Anthropometric, Biochemical and Clinical Indices in Male and Female Participants

Index	Male (n=32)	Female (n=65)	t	p
Age and Anthropometric Indices				
Age (years)	19.88±2.54	18.88±1.57	2.386	0.019*
Body age (years)	22.28±5.05	25.79±4.77	-3.224	0.002*
Weight (Kg)	73.25±14.12	65.04±14.85	2.602	0.011*
Height (m)	1.79±0.09	1.64±0.07	9.135	0.000*
BMI (kg/m^2)	23.12±4.43	24.81±6.71	-1.280	0.204
Waist circumference (cm)	78.78±11.13	76.05±12.33	1.056	0.293
Hip circumference (cm)	96.63±10.54	97.56±11.19	-0.395	0.694
MUAC (cm)	29.34±3.80	27.35±4.04	2.326	0.022*
ABSI	0.07±0.01	0.07±0.01	1.834	0.070
Clinical Parameters				
SBP (mmHg)	120.75±9.42	108.48±10.45	5.613	0.000*
DBP (mmHg)	77.47±8.98	76.80±6.66	0.413	0.681
Pulse rate	86.31±30.17	91.41±23.89	-0.905	0.368
Pulse Pressure	85.78±20.26	87.20±11.27	-0.443	0.658
SPO_2	96.00±2.44	97.08±1.84	-2.428	0.017*
Body Composition				
Fat (%)	20.76±8.39	30.61±8.44	-5.415	0.000*
Visceral Fat	7.42±6.69	5.57±4.00	1.516	0.134
Obesity	11.33±22.24	18.05±27.90	-1.190	0.237
LBM (kg)	58.85±8.80	44.02±5.98	9.778	0.000*
Muscle (kg)	66.21±11.25	60.28±13.03	2.202	0.030*
Water (%)	52.56±10.15	48.11±3.84	2.787	0.007*
Bone mass (kg)	2.88±0.59	4.72±16.17	-0.643	0.522
Metabolism	1725.37±258.08	1370.68±175.80	7.962	0.000*
Protein (%)	27.80±19.38	25.33±21.95	0.519	0.605
Biochemical Parameters				
Random Glucose (mg/dl)	107.36±19.10	108.37±24.13	-0.166	0.869
Random Total Cholesterol (mg/dl)	243.71±33.13	231.22±38.16	0.687	0.503

Values are mean±SD, LBM: Lean Body Mass. SBP: Systolic Blood Pressure. DBP: Diastolic Blood Pressure. *Significant at P<0.05. MUAC: Middle upper arm circumference. t: Student's t-test value. p: Probability value

Table 2: Correlation of ABSI with Age, Body Composition, Anthropometric, Clinical and Biochemical Indices

Index	Index	R	p
ABSI	Body age	-0.016	0.883
	Weight	0.183	0.073
	Height	0.251	0.013*
	BMI	-0.041	0.693
	Waist circumference	0.400	0.000*
	Hip circumference	0.132	0.197
	MUAC	0.116	0.256
	Pulse rate	0.261	0.010*
	SBP	0.171	0.094
	DBP	0.156	0.128
	SPO2	-0.011	0.913
	Pulse pressure	0.068	0.507
	Fat	-0.093	0.364
	Muscle	0.171	0.094
	Water	-0.068	0.556
	Visceral fat	0.352	0.002*
	Bone mass	0.088	0.390
	Metabolism	0.338	0.001*
	Protein	0.049	0.643
	Obesity	0.016	0.879
	LBM	0.318	0.002*
	Random Glucose	0.245	0.067
	Random Total cholesterol	0.359	0.173

r=Pearson correlation coefficient. * Significant at $p<0.05$. LBM: Lean body mass, SBP: Systolic Blood Pressure. DBP: Diastolic Blood Pressure. MUAC: Middle upper arm circumference

4.0 Discussion

In this study, males were significantly older than females. There is an increased interest in the role of biological (body) age in health and diseases recently. Biological age is developed from several adjustable factors that informs about body aging. It gives a better prediction of death when compared with chronological age (Husted *et al.*, 2020). Body (biological) age was significantly higher in females in comparison with the males in this study. This may appear physiological, but requires further studies.

Body weight and muscle were significantly higher in male than female participants in this study. Generally, males are more muscular than females, which could be attributed to genetic and hormonal factors. Similar observation of higher weight in males was made in a reported study that determined body changes in both male and female fresh undergraduates (Beaudry *et al*., 2019). It is pertinent to know that the contribution of muscle to total daily energy expenditure (TDEE) is about 20% as against the contribution of fat reported as 5% (Kinucan and Kravitz, 2022).

Height was also significantly higher in male than female participants. This could be attributed to the role of sex hormones, particularly, androgens in growth. Testosterone mediates growth by stimulating the secretion of growth hormone-insulin-like growth factor 1 (GH-IGF1). This is via a reaction process involving aromatase that catalyzes the conversion of androgens to oestrogens which binds to oestrogen receptor-alpha and beta. Furthermore, testosterone and oestrogen bind to their respective receptors that are situated in the growth plate cartilage (Stancampiano *et al*., 2019).

The utility of MUAC in nutritional status assessment has been reported. This is because of its correlation with BMI in a lot of studies. Emerging report suggests the merits of MUAC over BMI including; the ability of MUAC to determine muscle atrophy, a better indicator of chronic under-nutrition as well as its strong predictive ability of all-cause mortality (Thorup *et al*., 2020). The observation of a wilder middle upper arm circumference in males than females in this study could be attributed to their muscle mass.

Fat was significantly higher in female than male participants in this study. Our observation is in tandem with the report of Kirchengast (2010). It however contradicts the report of Karastergiou *et al* (2012) in which a higher fat mass was noticed in males in comparison with females. Females normally have a higher percentage of body fat than males. Also, women store more fat in the gluteal-femoral region, whereas more fat is stored in the visceral (abdominal) depot in men. Our observation of significantly reduced lean body mass in females relative to males contradicts the above report of Kirchengast (2010).

The significantly higher metabolism in males than females in this study appears physiological (Arciero *et al*., 1993; Lazzer *et al*., 2009). Proper hydration is important for the maintenance of body functions and appropriate fluid distribution in the various compartments is associated with health. Hypo-hydration has been implicated in the risk of hypoglycaemia, urinary and cardiovascular diseases (Zhang *et al*., 2021). There are indications of variable hydration status according to gender. In this study, water was significantly higher in males than females. This could be explained by higher rate of metabolism and less body fat in the male in comparison to the female gender.

Systolic blood pressure was significantly higher in males than females. Studies have shown the protective effect of oestrogens in the female gender against cardiovascular diseases, thus indicating that males are less protected against cardiovascular diseases (Reckelhoff *et al*., 1999; Choi *et al*., 2017). In a study, both systolic and diastolic blood pressures were reportedly higher in undergraduate males than females (Alhawari *et al*., 2018). Similar significantly higher blood pressure was also reported in a study involving undergraduates of a Nigerian South Eastern University (Nwachkwu *et al*., 2020). Blood oxygen saturation level was significantly higher in females than males in this study. This observation is in tandem with the report of Levental *et al.* (2018).

ABSI correlated positively with height in this study. Height alongside WC and weight is a component of ABSI. ABSI was also found to be positively correlated with WC in this study. ABSI being an autonomous transformation of WC gives an enhanced involvement of WC in abdominal obesity and its associated clinical outcomes. The intimate link of WC with visceral adiposity as well as its increased risk of metabolic pathologies and mortality has been previously reported (Christakoudi *et al*., 2020). An elevated ABSI therefore indicates an elevated WC than envisaged for a particular height and weight as well as its correlation with central adiposity (Gomez-Peralta *et al*., 2018). It has therefore been associated with cardiovascular diseases and death rate (Bertoli *et al*., 2017).

The positive correlation of ABSI with visceral obesity in this study further supports previous studies with such an observation. Various studies have implicated visceral obesity in the aetiology of metabolic diseases including type 2 diabetes mellitus, cardiovascular diseases among others (Ji *et al*., 2018). The determination of visceral fat using more complex procedures; magnetic resonance imaging, dual-energy X ray absorptiometry and bioelectrical impedance analysis could be costly (Liu *et al*., 2022). Therefore, ABSI is an easier, non-invasive and cheaper alternative. The positive correlation of ABSI with pulse rate also suggests its role in cardiovascular events. Furthermore, the correlation of ABSI with lean body mass and metabolism in this study requires additional studies.

5.0 Conclusion

Observations in this study show that ABSI is associated with height, waist circumference, metabolism, visceral fat, pulse rate and lean body mass. It could be a good index of assessing abdominal obesity and cardiovascular disease risk.

Acknowledgement

The study participants are acknowledged

Conflicts of interest

Authors declare that they have no competing interests.

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