Challenges of Body Mass Index Classification: New Criteria for Young Adult Nigerians

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ABSTRACT

Background: There are evidences to suggest that the World Health Organization (WHO) general cutoff points for body mass index (BMI) may not be the most appropriate for young adults globally irrespective of racial and ethnic considerations.
Objective: This study assessed body anthropometric parameters in healthy population of young adult Nigerians with a view to determining race and gender-specific criteria (Ife criteria) for BMI classification.
Methods: Four hundred and eighty-four (242 males and 242 females) healthy subjects aged between 18 and 41 years (inclusive) were recruited for the study. The participants were age- and sex-matched (mean age: 22.81 ± 3.83 years). The weight and height of the subjects were obtained using standard techniques while BMI was calculated as derivatives of height and weight. The BMI was classified using 5th, 85th, and 95th percentiles and delineated into underweight (<5th percentile), normal (5–85th percentile), overweight (85–95th percentile), and obese (>95th percentile).
Results: The result showed that the general BMI cutoff values for underweight, normal, overweight, and obesity were <17.8, 17.8–24.7, 24.8–27.8, and ≥27.9, respectively. The sex-specific BMI cutoff values for underweight, normal, overweight, and obesity in males and females were < 17.8 and < 17.8; 17.8–23.6 and 17.8–25.6; 23.7–26.8 and 25.7–28.7; and ≥26.9 and ≥28.8, respectively.
Conclusions: The cutoff values for the new criteria for BMI classification were lower than the WHO defined values and sex differences were demonstrated in BMI. Therefore, WHO criteria may not be universally applicable.

Key words: Body mass index, challenges, classification, new criteria

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INTRODUCTION

Body mass index (BMI) is an estimation of the proportion of body weight that is accounted for by fat. BMI is calculated as body mass in kilograms divided by square of height in meters.[1] Hence, BMI is derivative of weight and height. According to World Health Organization (WHO) general cutoff points, BMI could be used to classify individuals into four major categories; underweight (<18.5 kg/m²), normal (18.5–24.9 kg/m²), overweight (25–29.9 kg/m²), and obese (≥30 kg/m²).[2] BMI as defined simply applies to people with "normal body frame." It is less useful for fat estimation among athletes and weightlifters. This is because these individuals have their body frame mostly contributed by bone and muscle rather than increased fat accumulation. BMI measures and quantifies the degree of excess body weight and not strictly excess body fat. Hence, athletes and many muscular or "physically fit" individuals can be overweight without significant accumulation of body fat.[3] BMI is slightly increased in the elderly and to a lesser extent in children.[4,5]

The world is diverse in population and various regions of the world are made up of many and different ethnic groups with distinct genetic constitutions. Therefore, different ethnic groups have different physiological responses to fat storage.[6] BMI cutoff points have been fixed by the WHO based on classifications in a number of past studies based on mortality and morbidity outcomes and body build in the USA and Europe.[6] There were evidences to support the fact that the BMI and body fat accumulation differs among ethnic populations.[7]

As far back as the year 2000, the Regional Office for Western Pacific of WHO (WPRO), the International Association for the Study of Obesity, and the International Obesity Task Force jointly put forward a separate classification for

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obesity among Asian populations.[7] In their classifications, overweight was specified as a BMI over 23.0 and obesity as a BMI over 25.0. Sequel to what the WPRO put forward, the Examination Committee of the Japan Society for the study of obesity followed with a new guideline for diagnosing "obesity" and set obesity as a BMI >25.[8] Moreover, the new BMI criteria for Asians by the Western Pacific Region of the WHO have since being in use for medical clinical screening within the Asian populations. The suitability of the WPRO criteria in the screening for overweight to prevent metabolic syndrome in elderly Japanese workers had been established.[9] Issues regarding BMI criteria and its cutoff points should, therefore, be of public health concern globally. To date, there has been little or no reported study, or attempt geared toward the categorization of BMI cutoff points by the African Regional Office of the WHO among indigenous Africans. Our goal therefore was to determine the BMI cutoff points among Nigerian young adults as well as determining gender differences in the criteria among the study population. This study assessed the body anthropometric parameters in healthy population with a view to defining race specific new BMI criteria called Ife BMI Criteria for young adults.

METHODS

Participants

Four hundred and eighty-four (242 males and 242 females) subjects aged between 18 and 41 years were recruited for the study. They were selected according to their age and sex. They were grouped into four age group categories; 18–23 years (69.0%), 24–29 years (24.4%), 30–35 years (4.5%), and 36–41 years (2.1%). The study population was drawn from people within Ilé-Ifẹ̀, an ancient Yoruba town in South-Western Nigeria. Only healthy volunteers (absence of systemic diseases) after initial screening process participated in the study. The screenings include clinical evaluation and blood pressure assessment. Exclusion criteria were symptomatic diseases, pedal edema, pregnancy, athlete, and arterial blood pressure ≥140/90 mmHg. The volunteers were assessed for anthropometric parameters, height and weight while their BMI calculated.

Ethical consideration

Participation in the study was completely voluntary based on informed consent from the participants. Ethical clearance was sought and obtained from the Ethics and Research Committee of Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, as anthropometry component of the study of young adult electrocardiogram.

Height and weight measurements

The standing heights were measured using a stadiometer (ZT-120 Health Scale). Each participant was assessed while in good standing posture on the foot rest of the device with minimal clothing without shoes but with the head facing forward, shoulders relaxed, arms hanging loosely on both sides, palms facing forwards, feet together, and knees straight.

The height for each subject was taken when the movable headboard was lowered to touch the crown of the head. The measurements were taken to the nearest 0.5 cm. The weighing scale was checked for zero balance before each use. Subjects were instructed to empty pockets and remove shoes and any apparel that could interfere with weight measurements. Only light clothing was permitted. The subjects then stood on the scale looking straight ahead, relaxed, and motionless without leaning on any object or the wall. Weight measurements were taken when the scale stabilized and recorded to the nearest 0.5 kg.

Calculation of body mass index

BMI was calculated as weight in kilograms divided by the square of height (in meters). BMI was expressed in kg/m^2.

Statistical analysis

The data obtained during the investigation were analyzed using SPSS® IBM Corporation Software Package. The descriptive statistics were expressed as a mean ± standard deviation for each variable. Student's *t*-test was carried out to detect the gender differences for each parameter: Height, weight, and BMI. A $P < 0.05$ was considered statistically significant. The BMI was classified using 5th, 85th, and 95th percentiles and delineated into underweight (<5th percentile), normal (5–85th percentile), overweight (85–95th percentile), and obese (>95th percentile).

RESULTS

Body anthropometric parameters

Four hundred and eighty-four young adults participated in the study. The age range of the participant was 18–41 years. Among all participants ($n = 484$), the mean values (normal limits) for height, weight, and BMI were 1.67 ± 0.09 m (1.54–1.82 m), 60.94 ± 9.60 kg (47.00–79.75 kg), and 21.82 ± 3.02 kg/m^2 (17.80–4.83 kg/m^2), respectively. In anthropometric parameters, men had significantly higher values for height and weight, but they had a significantly lower value for BMI. Among male participants (242), the mean values for height, weight, and BMI were 1.72 ± 0.07 m, 63.43 ± 9.1 kg, and 21.43 ± 2.63 kg/m^2, respectively. Among female participants (242), the mean values for height, weight, and BMI were 1.62 ± 0.07 m, 58.46 ± 9.45 kg, and 22.21 ± 3.33 kg/m^2, respectively [Table I].

Comparison between new body mass index criteria and World Health Organization criteria

The new BMI classes of participants from our study were presented in Table II side-by-side with WHO and WPRO classifications. The cutoff point for underweight (<17.8 kg/m^2) was lower than the WHO and WPRO classification of <18.5 kg/m^2. The normal range from this study was 17.8–24.7 kg/m^2 compared to the WHO higher values of 18.5–24.9 kg/m^2 and WPRO of 18.5–22.9 kg/m^2, respectively [Table II]. Overweight was determined to be in the range of 24.8–27.8 kg/m^2 and was lower compared to WHO values

of 25.0–29.9 kg/m² but was higher, compared to WPRO values of 23.0–24.9 kg/m². Obesity was determined to be ≥27.9 kg/m².

Sex-specific new body mass index cutoff points

The BMI classes of participants by gender were presented in Table III. Men had lower cutoff values for BMI than women. Men and women were classified <17.8 kg/m² as "underweight," 17.8–23.6 kg/m² and 17.8–25.6 kg/m² as "normal," 23.7–26.8 kg/m² and 25.7–28.7 kg/m² as "overweight," ≥26.9 kg/m² and ≥28.8 kg/m² as "obese," respectively based on the new criteria [Table III].

DISCUSSION

Our study revealed that the current general cutoff points of BMI (30 kg/m² or above) recommended by the WHO might exceed proper limits. We found this to be higher and tends to misclassify those who at high risk to be either normal or at low risk. In the general population, the WHO classifies an individual to be overweight if the BMI is calculated to be within 25–29.9 kg/m² and obese if the BMI is ≥30 kg/m². The results

Table I: Sex differences in age, anthropometry, and body mass index

Variables	Mean±SD		t	P
	Male (n=242)	Female (n=242)		
Age (years)	22.81±3.88	22.81±3.88	0.000	1.000
Height (m)	1.72±0.07	1.62±0.07	5.901	<0.001
Weight (kg)	63.43±9.11	58.46±9.45	15.032	<0.001
BMI (kg/m²)	21.43±2.63	22.21±3.33	−2.830	0.005

P<0.05 is taken as statistically significant. Significant sex differences exist in height, weight, and BMI. BMI: Body mass index, SD: Standard deviation

Table II: Body mass index classification according to Regional Office for Western Pacific of World Health Organization, New (Ife) and World Health Organization criteria

Category	WPRO	New (Ife) criteria*	WHO
Underweight	<18.5	<17.8	<18.5
Normal	18.5-22.9	17.8-24.7	18.5-24.9
Overweight	23.0-24.9	24.8-27.8	25.0-29.9
Obesity	≥25.0	≥27.9	≥30.0

*New (Ife) criteria for both sexes. WHO: World Health Organization, WPRO: Regional Office for Western Pacific of WHO, BMI: Body mass index

Table III: New (Ife) body mass index criteria sex-specific cutoff points for young adults

Category	Male	Female
Underweight	<17.8	<17.8
Normal	17.8-23.6	17.8-25.6
Overweight	23.7-26.8	25.7-28.7
Obesity	≥26.9	≥28.8

The cut-off points for various categories of BMI were lower in males than females except for the underweight category. BMI: Body mass index

of this study indicated that the BMI cutoff value was lower in the population from which our study was carried out. An individual is overweight if the BMI is within 24.8–27.8 kg/m² and obese if the BMI is above 27.9 kg/m². For instance, some individuals classified as overweight according to WHO cutoffs actually falls within the obese class.

Evidence abound against using a single universal cutoff value worldwide to define obesity is widespread.[10-12] For example, WHO recommended BMI values of 23 kg/m² and 25 kg/m² as the cutoff points for overweight and obesity for Asians, respectively which is lower when compared with the cutoff values from our study.[7] This may explained in part because BMI is established to be skewed by height, BMI will be higher for some Black ethnic groups, and lower for Asian groups.[7] Furthermore, several Asian countries have also recommended using lower cutoff values to identify overweight and obesity.[13-20] Our findings suggest adequate grounds for the proposition of separate criteria among Africans of Yoruba speaking people of South-Western Nigeria. By comparison, the BMI criteria determined from our study are higher than WPRO criteria for Asians and lower than the WHO criteria for the general population.

Gatineau and Mathrani[6] postulated that the estimated burden of obesity-related disease among minority ethnic groups in the United Kingdom may be greatly underestimated and that using revised thresholds for some ethnic groups could greatly increase these estimates. This agrees with our findings with regards to public health, the estimated burden of obesity-related diseases among Nigerian ethnic groups may have been seriously underestimated.

We also established from our findings, the existence of sex differences in the BMI cutoff points. Even though the WHO classification did not take gender differences into account, our result defines overweight among female participants to be 25.7–28.7 kg/m² and obesity to be ≥28.8 kg/m². This is higher than in males from our study population which was 23.7–26.8 kg/m² for overweight category and ≥26.9 kg/m² for obesity. The observation that BMI cutoff values are higher in the female is supported by the findings of Hedley *et al.*,[21] which posited that reproductive-aged women are more likely to be obese than similarly aged men, which may make them vulnerable to cardiovascular disease risk factors and other obesity-related diseases. This is in consonance with the age group (18–41 years) of the female participants in our study.

Our results on gender-specific BMI cutoff values to define obesity among women agree with certain studies carried out even in the US. Rahman and Berenson[22] showed obesity as those with BMI greater or equal to 28.7 kg/m². This value was almost same with the cutoff value of 28.8 kg/m² in this study. This is also similar to the data of Evans *et al.*,[23] whose cutoff values for obesity was 28.4 kg/m² all among black American women. Moreover, White and Hispanic women have been shown to demonstrate significantly higher percent body fat for a given BMI than black women.[24] This suggests that the

BMI cutoff values should not only be lower than the value currently used but also it should differ by gender and race or ethnicity, to better assess an individual's risk of obesity-related morbidity and mortality. Other studies have indicated that in some populations there might be differences in BMI across ethnic lines which support our findings.[2,17,25,26] For example, a study on Asian American anthropometric measurements found that reducing the cut-point for obesity from 30 kg/m^2 to 27 kg/m^2 could increase the prevalence of obesity in a population by as much as 14% points.[27] These differences may require different cut-points for evaluating obesity using BMI among different ethnic groups. It appears that when using BMI to classify individuals into no risk, low risk, and high-risk categories, the gender and ethnic backgrounds should be taken into consideration.[3] Moreover, it had been justified that WHO universal cutoff point for obesity increases the numbers of people at risk for type 2 diabetes mellitus among Asian American and that a lower BMI cutoff points had been considered far more appropriate for Asian population to reduce overweight-associated disease burdens.[28]

CONCLUSIONS

In conclusion, the cutoff values for the new criteria for BMI classification were lower than the WHO defined values and sex differences were demonstrated in BMI. Therefore, WHO criteria may not be universally applicable. Hence, race, age, and gender should be taken into consideration in determining the cutoff values for BMI.

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Conflicts of interest

There are no conflicts of interest.

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