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Body mass index or body fat! which is a better obesity scale for Pakistani population?

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ORIGINAL ARTICLE

Body Mass Index or body fat! Which is a better obesity scale for Pakistani population?

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Abstract

Objective: To compare two methods of classifying obesity based on body mass index and body fat percentage.

Methods: The cross-sectional study was conducted from November 2012 to August 2013 at Jinnah Postgraduate Medical Centre, Karachi.

Male and female volunteers between the ages 15-65 years were selected using simple random sampling. They were classified into different groups for body mass index and body fat percentage measured through bioelectrical impedance scale. The subjects were sub-grouped into underweight, normal weight, overweight and obese. SPSS 11 was used for statistical analysis.

Results: The mean age of the 828 healthy volunteers was 25.67±10.10 years. A total of 552(66.6%) subjects had a higher body fat percentage and were misclassified by body mass index. Only 276(33.3%) subjects had body fat percentage values corresponding to the body mass index classification. The difference in terms of categorising obesity was highly significant ($p<0.001$).Both body mass index and body fat percentage showed positive correlation with age ($r=0.144$; $p=0.001$) ($r=0.261$; $p=0.001$) and weight ($r=0.578$; $p=0.001$) ($r=0.444$; $p=0.001$) respectively. Moreover body fat percentage showed a significant positive association with gender ($r=0.109$; $p=0.027$) whereas BMI did not.

Conclusions: Body fat percentage should be incorporated for a better understanding as well as categorising of obesity.

Keywords: BMI, Overweight, Body fat percentage, Obesity. (JPMA 64: 1225; 2014)

Introduction

Obesity is acknowledged as one of the burning public health problems reducing life expectancy and quality of life.[1] Many factors influence the obesity epidemic, including genetic susceptibility, socioeconomic, cultural, behavioural, environmental factors, imbalance between food intake and lack of physical activity.[2] Adiposity, however, irrespective of weight and or body mass index (BMI) value, is believed to be a primary risk factor for diabetes and cardiovascular disease,[3] providing a rationale for the use of methods which measure body fat directly. The frequently used anthropometric measures such as BMI, waist circumference (WC), waist-to-hip ratio (WHR), hip circumference (HC) have been anticipated to define obesity. However, their limitation to assess degree of fatness in individuals with difference in muscular build is well recognised.[4]

The Quetelet's index is used far more commonly as a surrogate measure of fatness than body fat percentage (BF%) to define obesity[5] whereas it is not a measurement of adiposity, but merely an imprecise mathematical estimate.[6] Use of BMI alone to classify individuals may result in misclassification because of the varying contributions of bone mass, muscle mass, and fluid to body weight.[7] In Europeans, a BMI of 30 correlates with about 25% body fat in males and 30% body fat in females,[8] while for the same age, gender and BMI, South Asians have an increased per cent body fat, lesser lean mass, skeletal muscle and bone mineral content along with a higher risk for cardiovascular diseases.[9,10]

Debate over the value of BMI for the estimation of body fat has recently led investigators to recommend the use of new technologies for the direct measurement of body fat, especially in epidemiological research,[11] to account for the differences in body weight. It has been found that amount of body fat rather than excess weight determines health-associated risks.[6]

The commonly used methods for classifying obesity and overweight fail to appropriately identify the burden of underlying disease, especially in Pakistani population. This study was planned to relate the misclassification of obesity by BMI in contrast with BF%. This might help to provide a working approach to incorporating body fat measurement as a proper obesity indicator.

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Subjects and Methods

The cross-sectional study was conducted from November 2012 till August 2013 at Jinnah Postgraduate Medical

Centre, Karachi.

In order to achieve 80% power with a 15% estimated prevalence of disease in project area and a two-sided 5% level of significance, the minimum sample size calculated for the study was 260.[12] We recruited828 male and female volunteers between the ages 15-65 years by simple random sampling.

All the participants were asked to sign written, informed consent. Subjects were excluded if they had a history of recent acute illness (e.g, pneumonia, myocardial infarction or dehydration), had a chronic condition (e.g, cancer, uncontrolled high blood pressure, or collagen vascular disease), pregnancy and/or menstrual period and vigorous activity (12 hours before) body fat estimation. The study was approved by the ethics review committee of Jinnah Postgraduate Medical Centre's Basic Medical Sciences Institute in Karachi.

BMI of the study subjects was calculated by dividing weight with height squared (kg/m^2).[5] The BF% was measured using Diagnostic Scale BG55 (Beurer Germany) through bioelectrical impedance analysis.

The subjects were classified for BMI and BF% as follows: according to BMI criteria for South Asian population as normal weight (BMI: 18-22.9 kg/m^2), overweight (BMI: 23-25.9kg/m^2), and obese (BMI $\geq$26kg/m^2) subjects[13] and according to the BF% scale: Males — normal weight (BF%: 12-22%), overweight (BF%: 22.1-27 %), and obese (BF%: = 27.1); Females — normal weight (BF% 17-27%), overweight (BF% 27.1-32%), and obese (BF% > or=32.1).[14] Subjects falling below the normal values were classified as underweight for both BMI and BF%.

A descriptive statistical analysis of continuous variables was performed using SPSS 11. Statistical comparisons of categorical variables (BMI and BF%) were computed using Pearson chi square test. Pearson correlation coefficient was applied to check the correlation of BMI and BF% with study parameters. Continuous variables were presented as Mean±SD and percentages and compared by student's t-test. In all statistical analysis, $p<0.05$ was considered significant.

Results

Of the 828 subjects in the study, 426(51.44%) were females and 402(48.55%) were males. The overall mean age was 25.67±10.10 years, BMI was 27.79±8.57kg/m^2, and BF% was 24.61%±7.61. According to BMI classification, 42(5%) subjects were underweight, 238(29%) normal weight, 150(18%) overweight and 398(48%) obese. According to BF% classification, 68(8%) subjects were underweight, 160(19%) normal weight, 242(29%) overweight and 358(43%) obese. However, only 276(33%) participants could be correctly identified in similar categories by both the BMI and BF% criteria (Table-1). The difference in terms of categorising obesity between the two was highly significant (2 df(1)=9/43.47; $p<0.001$).

Table-1: Comparison of Weight and body fat percentage on the basis of body mass index and body fat percentage classification methods.

	Under weight		Normal weight		Overweight		Obese	
	Count	Mean±SD	Count	Mean±SD	Count	Mean±SD	Count	Mean±SD
Weight (kg)								
BMI Group	42(5.0%)	44.72±4.30	238(28.7%)	54.16±7.35	150(18.1%)	64.39±10.23	398(48.0%)	68.21±17.01
Body fat Group	68 (8.2%)	56.16±8.01	160(19.3%)	56.78± 13.15	242(29.2%)	58.33± 10.71	358(43.2%)	68.59±16.98
Body Fat %								
BMI Group	42(5.0%)	19.20±4.62	238(28.7%)	22.25±5.83	150(18.1%)	24.33±5.87	398(48.0%)	26.70±8.68
Body fat Group	68(8.2%)	13.10±1.99	160(19.3%)	17.66±2.67	242(29.2%)	23.02±2.16	358(43.2%)	30.98±6.18

BF%: Body fat percentage
BMI: Body mass index.

Table-2: Comparison of classification of obese: gender stratification.

	Underweight		P value	Normal Weight		P value	Overweight		P value	Obese		P value
	BMI	BF%		BMI	BF%		BMI	BF%		BMI	BF%	
Males (n=402)	16 (4%)	32 (8%)	>0.05	122 (30%)	60 (15%)**	<0.001	88 (22%)	86 (21%)	>0.05	176(43%)	224 (56%)**	<0.001
Females (n=426)	48 (11%)	64 (15%)	>0.05	114 (27%)	102 (24%)	>0.05	66 (14%)	118 (27%)**	<0.001	198 (47%)	142 (33%)	>0.05

BMI: Body mass index
BF%: Body fat percentage
SD: Standard deviation.

Both BMI and BF% showed positive correlation with age (r=0.144; p=0.001) (r=0.261; p=0.001) and weight (r=0.578; p=0.001) (r=0.444; p=0.001) respectively. Moreover, BF% showed a significant positive association with gender (r=0.109; p=0.027) whereas BMI did not (Table-2).

Discussion

The prevalence of overweight and obesity in developing countries, especially in Pakistani population, has been reported to be 25% and 10% respectively[13] with an increased trend of obesity in youngsters. The recognition of true obesity is thus important to identify potential threats of associated health disorder that bear out economic burden on society.[15-18]

BMI in this regards is considered to be a gauge of obesity and fitness in various cultures andnarrates incidence and prevalence of obesity with regard to mortality and morbidity rates in ethnic populations.[19] The BMI cut-off values for the detection of obese, however, have changed from $\geq$30kg/m^2 to $\geq$26 kg/m^2 for South Asian population specifically,[20] with fewer risks at BMI less than 18·5kg/m^2 and increased risk with BMI 23-27·5kg/m^2, and maximum risks when values exceed 27·5kg/m^2. Besides, the classification of obesity on the basis of BMI is subjective to diversity with respect to the variation of population. Here we propose and agree that Asian populations need to be evaluated by their own cut-off values in terms of BMI, BF%, and associated health risks.[13]

The results of this study showed 29% subjects to be normal weight by BMI category. However, lesser number of individuals, 19%, fell into the same category by BF%. Only 14% subjects were deemed normal weight by both. An interesting finding was that in this group of normal weight for BMI individuals, 3% turned out to be under-weight, 12% as overweight and 9% were obese when their body fat was measured. This indicated a false positive result for 28% subjects who may be left unnoticed for detection of disorders, if BF% was not measured simultaneously. This means that in order to define normal weight, both criteria should be taken into account. A recent large-scale study[21] on UK adults has shown that the association between BMI and BF% is not applicable, particularly when BMI is less than 25kg/m^2. Studies[22] found that high BF% was associated with increased cardiovascular risk regardless of BMI whose categorisation resulted in an underestimation of subjects with cardiovascular risk factors.[23,24]

Identification of true underweight is nonetheless important to recognise nutritional deficiencies, immune disorders, brittle bones, arthritic changes and compromised fertility. In this study, true underweight when both criteria were taken into account were 3%, while 5% were underweight by BMI and 8% by BF%. This shows that BF% is also a better predictor of underweight who were misclassified by BMI alone. People with BMI below 18.5kg/m^2 are found to be associated with the above-mentioned risks along with higher death rates.[19]

Maximum number of subjects in our study were declared obese by both methods of estimation. The true obese declared by both BMI and BF% were 72%. Among them, 48%had a BMI $\geq$26kg/m^2. However, when BF% was measured, the number decreased to 43%; concurring with our hypothesis that by taking BMI alone into consideration, more individuals can be marked obese erroneously since BMI is not a measuring factor for the muscle mass.

Another interesting finding in our study was that greater proportion of subjects 29% were declared overweight by BF% compared to 18% by BMI (p=<0.001). Interestingly, the misclassification of obesity on the basis of BMI was found to affect males more, which is contradictory to the results of an earlier study[3] which found that BMI-defined obesity (BMI >30kg/m^2) was present in 21% of men and 31% of women, but BF%-defined obesity was found in 50% of men and 62% of women. It also found that BMI failed to discriminate between BF% and lean mass in the overweight, or intermediate, range of BMI (25-29.9kg/m^2).We believe that the more serious complications from increased adiposity are implicated early in South Asian men and hence detection of extent of adiposity is extremely important for them.

These findings support our concerns that typically normal BMI may conceal underlying excess adiposity characterised by an increased percentage of fat mass and reduced muscle mass. Thus we suggest that the accuracy of BMI in diagnosing obesity is limited, particularly for individuals in the intermediate BMI ranges.

The study emphasises the need to measure BF% together with BMI and catalogue misclassified persons especially for categorisation. Early detection of obesity by simple, quick, safe, low-cost measures of body fatness by bioelectrical impedance analysis (BIA) is thus required to address the related metabolic risk association with underlying disease burden. There is also a need to develop provisional, population based cut-off values for BF% in order to fill information gap because no comparable percentage body fat ranges that exist for evaluation of potentially misclassified subjects referred to body-composition analysis. The limitation of the current study is that since this is the first study conducted in local population, it could not verify the validity of the sampled population.

We recommend that awareness about the impact of higher BMI and BF% as risk factors with early commencement of disease and disorders should be generated among the masses and periodic assessment of body weight and BF% in schools, colleges, universities and workplaces should be reinforced to prevent obesity.

Conclusion

To limit the discrepancy among classification of false negative and false positive values in our population, body fat measurement should be incorporated for a better understanding and classification of obesity. This would be helpful in lowering the disease burden.

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