ISSN 2278-7763

Comparison of predicted body fatness from Body Mass Index and from Bioelectric Impedance Analysis among healthy females.

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Abstract

Objective: To compare the methods for assessing over weight and obesity by BMI classification and by body fat percentage using bioelectric impedance analysis.

Methods: The cross-sectional study was conducted on one hundred and three females during BMI camp arranged at PNS Shifa Hospital, Karachi. Female between the ages 20-55 years were selected using simple random sampling. They were classified into underweight, normal weight, overweight and obese groups on basis of body mass index and body fat percentage measured through bioelectrical impedance scale. Data was entered into SPSS version 21 for analysis.

Results: The age of subjects ranged between 20 - 55yr with a mean of 35.6 yr. Basic descriptive statistics for subject data were expressed as means ± standard deviations. The overall mean age was 35.60±10.32 years, BMI was 25.53 ± 1.99kg/m2,and BF% was 34.98 %± 3.82.According to BMI classification, 6% subjects were underweight, 31% normal weight, 31% overweight and 38% obese. According to BF% classification, 5%subjects were underweight, 10%normal weight,46% overweight and 41%obese. Maximum number of females belong to overweight group according to BF% and according to BMI classification maximum females fall into obese category. There is difference in terms of categorizing overweight by BMI and BF % and this difference is statistically significant($p<0.001$).Overweight and obesity calculated by both BMI and BF% was positively correlated with age.

Conclusion: Our study supported that for accurate assessment of body fat and corresponding classification f overweight and obesity , BF% should be measured along with BMI.

Keywords: Body Mass Index, Overweight, Body fat percentage, Obesity.

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Introduction:

Obesity is now recognized as one of major public health issues all over the world. WHO called urgent action to halt this global epidemic of obesity which is now labeled as "GLOBESITY".

Overweight and obesity is defined as abnormal excessive accumulation of fat within the body that impair the body functions.[1]

Excessive body fat irrespective of body weight and BMI have been linked to increase incidence of type-2 diabetes mellitus, coronary heart disease, stroke, hypertension, and various types of cancer [2] leading to excessive mortality and morbidity.[3]

South Asian countries are currently affected by obesity epidemic which is leading cause of various chronic non communicable diseases and its associated mortality and loss of life due to premature death.[4]

The prevalence of overweight and obesity in Pakistan taking Asian-specific BMI cut off levels for categorizing over weight and obesity about one quarter of Pakistani population would be classified as overweight and obese and prevalence of overweight was found to be 25% and obesity prevalence was 10.3%[5]

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Amongst other methods available for assessment of obesity BMI is most commonly used method of assessment of overweight and obesity because of its general application and feasibility.[6] However, it under estimates the prevalence of both condition.

BMI calculate obesity level in terms of height and weight of an individual and does not differentiate between muscles, bone mass and water content.[7]It may lead to misclassification of level of obesity as it is not necessary that overweight person has increased body fat as this excessive fat can be due to increase muscle mass as in athletes. It's just a mathematical calculation and not a direct estimation of adiposity.[8]It is an index for weight excess, rather than body fat composition[6].

Racial and ethnic disparities exist in distribution of body fat among different populations and ethnic subgroups[9] there is different relationship between BMI and BF% ,among different population these disparities being more pronounced among women.[10]

In Europeans ,BMI of 30kg/m^2 corresponds to 25% of body fat in males and 30% in females[11] while in South Asians of same gender ,age and BMI have increased body fat percent and less muscle mass along with increased risk of cardio metabolic disorders. These changes more pronounced in females as compared to males .[12,13]

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These ethnic disparities should be kept in consideration and instead of uniform BMI cut off population specific BMI cut offs based on %body fat and distribution of fat should be purposed.[14]

Keeping in view BMI related error in measurement of obesity, researchers are considering for some better tool for measuring the obesity. Advent of bioelectrical impedance analyzer might be another method which could provide more direct approach of assessing obesity as compared to BMI and is being widely used in clinics, epidemiological field surveys and weight reduction programs[15]

Since obesity has become growing public health issue, accurate level of estimation of obesity has become extremely important because of major health issues caused by excessive body fat. Main focus of our study is to determine the extent to which excessive body fat occur within intermediate ranges of BMI.

Methodolgy:

This cross sectional study was carried out at PNS SHIFA Wardroom mess during BMI Camp arranged by registered dietitian through official written invitation to lady wives and daughters of Residents of Shifa hospital (Doctor's Complex)

Inclusion criteria for study participants include disease free healthy females of age group 20-55years with no underlying comorbids associated with obesity. Exclusion criteria include females with syndromal obesity, polycystic ovaries and those on pharmacotherapy for obesity.

Body weight was measured to the nearest 0.1 kg in light indoor clothing without shoes, using a digital scale. Height was measured using same portable stadiometer . A correction of 0.5 kg was made for the weight of the cloths.

BF % was measured using a commercially available (HBF-352, Omron Health care Co., Kyoto, Japan). digital weight scale incorporating a bioelectric impedance analyzer. This instrument is portable and easy to use in epidemiological field surveys. The digital weight scale has hand grip and foot plate, each is equipped with two electrodes. On taking measurement, the study subject stood on the foot plate and gently grasped the two handgrips with arms held straight forward. Before taking measurement personal data and height recorded through stadiometer is entered and BF % was calculated from the impedance value and on the basis of pre entered personal data.

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Total one twenty three females visited camp out of these seven which don't full fill the inclusion criteria or not willing to give informed written consent were excluded and rest of 103 females were enrolled after taking the informed consent.

The subjects were classified for BMI and BF% as follows:

According to BMI criteria for Asian population normal weight (BMI: 18-22.9kg/m2),overweight (BMI: 23-25.9kg/m2), and obese (BMI >26kg/m2) [16]

According to the BF% scale: Females — normal weight (BF% 17-27%),overweight (BF% 27.1-32%), and obese (BF% > or=32.1).

Subjects falling below the normal values were classified as underweight for both BMI and BF%.[17]

Results:

The age of subjects ranged between 20 - 55yr with a mean of 35.6 yr. Basic descriptive statistics for subject data were expressed as means ± standard deviations. The overall mean age was 35.60±10.32 years, BMI was 25.53 ± 1.99kg/m2,and BF% was 34.98 %± 3.82 (Table 1)

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According to BMI classification, 6% subjects were underweight, 31% normal weight, 31% overweight and 38% obese. According to BF% classification, 5%subjects were underweight, 10%normal weight,46% overweight and 41%obese.(Table 2) Maximum number of females belong to overweight group according to BF% and according to BMI classification maximum females fall into obese category. There is difference in terms of categorizing overweight by BMI and BF % and this difference is statistically significant($p<0.001$) (Table3).Overweight and obesity calculated by both BMI and BF% was positively correlated with age.(Table 4)

Table 1: Physical characteristics, BMI and body fat % among study subjects

Variable	Mean	Standard Deviation	Median	Range
Age	35.60	10.32	35	20-50
Height	156.13	4.14	155	135-167
Weight	62.42	5.64	63	47-85
BMI	25.53	1.99	25	18-31
BF%	34.98	3.82	35	15-40

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Table 2:Age distribution of body weights according to body mass index and body fat percentage classification

AGE	BMI				BF%			
	Under weight N (%)	Normal weight N (%)	Over Weight N (%)	Obese N (%)	Under weight N (%)	Normal weight N (%)	Over Weight N (%)	Obese N (%)
20-30	1(1)	10(10.3)	-	-	2(2)	2(2)	-	-
31-40	3(3)	12(12.3)	4(4.1)	2(2)	1(1)	3(3)	7(7.2)	10(10.3)
41-50	2(2)	8(8.2)	11(11.3)	15(15.4)	2(2)	4(4.1)	18(18.5)	10(10.3)
≥50	-	-	15(15.4)	20(20.6)	-	1(1)	20(20.60	20(20.6)
Total	6(6.1)	30(30.9)	30(30.9)	37(38.1)	5(5.1)	10(10.3)	45(46.3)	40(41.2)

Table 3: Comparison of body weight on basis of basis of body mass index and body fat percentage classification methods

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	Underweight			Normal weight			Overweight			Obese		
	N	%	P value	N	%	P value	N	%		N	%	P value
BMI	6	6.18	>0.05	30	30.9	<0.001*	30	30.9	<0.05*	37	38.1	>0.05
BF%	5	5.15		10	10.3		45	46.3		40	41.2	

*statistically significant

Table 4: Correlation of overweight/ obese classification by BMI and BF% with age

Age (years)	No of overweight and obese		%of overweight and obese		Correlation
	BMI	BF%	BMI	BF%	
31-40	6	17	6.18	17.5	0.575
41-50	26	28	26.78	29	0.635
≥50	35	40	36	41.2	0.629
Total	67	85	69	87.7	0.735

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Discussion:

Various researches has shown that females of all ages and ethnic group have higher body fat percentage as compared to males .For equivalent BMI, women have significantly higher body fat as compared to males.[18,19]

Data from National health survey was reanalyzed using Asian specific BMI cut off has showed twice prevalence of obesity in females as compared to males with obesity prevalence 40 % in females and 20% in males with overall increase burden in urban areas as compared to rural areas [20].

According to recent report on study conducted by international consortium of researchers on prevalence of obesity from year 1980 to 2013, In Pakistan ,overall prevalence of obesity has been increased from 26% to 33%.However, there is striking gender difference with increase prevalence in male from 1980 to 2013 was found to 24% to 28% and while females within same duration prevalence has been increase from 29 % to 38 % which depicts the largest gender gap in the South Asian region[21]

The results of our study showed that 31% of the females were classified as normal weight by BMI while this figure turn out to be 10% in terms of BF% and this difference is found to be statistically significant.15% of females categorized by BMI as normal fall into category of overweight by BF% ($p<0.05$) and 6% comes under the obese category. These results showed that 21% of females previously classified as normal weight now fall into category of overweight and obese. This shows that 21% females were misclassified on basis of BMI alone and remain undiagnosed for disease risk if BF% is not measured simultaneously.

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Study conducted by SP Singh[22]on multiethnic Indian population detected the obesity prevalence of 20.66% on the basis of BMI and 47.11% on basis of body fat % and recommends low level of BMI cut offs should be used to define overweight and obesity and incorporation of assessment of level of BF % for more accurate assessment and categorization of level of obesity.

Another study in India also supported the use of BF% rather than BMI for more accurate and precise estimation of level of obesity and its associated disease risk[22] Moreover, various researches also showed increase risk of cardio metabolic factor at BMI within the normal range[23,24]

Results of our study showed that BMI misclassification is more pronounced within overweight group having BMI within intermediate ranges and difference was found to be statistically significant ($P<0.05$). This finding is also supported by results of previous studies, which showed increase risk of cardio metabolic diseases within the range categorized as normal by BMI.

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Study conducted on Indian adult showed 44 % of males within the BMI range 24-24.99 kg/m^2 showed higher BF% than normal. This study also proved increased risk of disease risk factors stratification for various chronic diseases including Diabetes and Hypertension within normal limits of BMI by International classifiacation(24-24.99) .Similar results were also evident from previous studies. [25-27]

WHO Expert Consultation proposed a new BMI cut-off for public health action in Asia. According to this BMI of 18.5 to 23 kg/m^2 is associated with moderate disease risk, 23 to 27.5 kg/m^2 is associated with considerable increased risk. This proposal was based because Asian have increase risk of chronic disease and its associated mortality within range considered as normal by International BMI classification. [28]

Three specific factors specific factors that led WHO to reclassifying BMI include 1.There is increase evidence of development of risk factors for cardiovascular disorder and type 2 diabetes at BMI below 25 kg/m^2 in Asian. Second, association between BMI, BF% and fat distribution differ across different population .Third, two previous attempts to classify BMI cut offs in Asians contributed to debate on purposing different BMI cut offs among different ethnic populations[28]

Our study result proved that for accurate assessment of adiposity and corresponding disease risk, BMI should be assessed along with body fat%. A considerable number of individuals both males and females cannot be classified on basis of BMI alone. It is proved by evidence that approximately one-third of obese men and women are misclassified according to BMI ,thus care should be taken while using BMI as reference in clinical practice and research.[29,30]

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Keeping in consideration the increase prevalence of overweight and obesity among Pakistani females and along with progressive increase in gender gap and limitation in assessment of disease risk associated with excessive adiposity by BMI . Bioelectrical impedance analyzer is another method for assesment of body fat % which can prove to be effective as it take into account age ,sex and allows more allows more accurate, reliable and direct estimation of body fat% as compared to BMI.[31]

Conclusion :

Our study supported that for accurate assessment of body fat measurement and corresponding disease risk, BF% should be measured along with BMI.

Limitation:

This study is only conducted only on females, this limit the ability to study the effect of gender on % fat distribution. Body fat% calculated by BIA is effected by various factors including recent physical activity, hydration status, body position. These underlying factors must be kept in consideration before carrying out measurement

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Recommendation :

It's a high time to create awareness among health care professionals regarding importance of assessment of body fat % in conjunction with BMI for early detection of disease risk and its associated co morbidities, this will help in the long run to reduce burden of obesity in our country.

Awareness should be created at population level at school colleges universities through awareness lectures and health education program in order to halt effectively with this epidemic .

Clinical trials and epidemiological studies should be conducted on large scale with increased sample size in order to enhance the generalizibility.

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