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Original article

BMI AS A CENTRAL TOOL FOR INDICATING HEALTH STATUS: STUDY AMONG THE FEMALE SUNNI MUSLIMS OF BARASAT, WEST BENGAL

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ABSTRACT

Background: Body mass index (BMI) is a common, inexpensive and simple method to categorize individuals. However this method does not reflect any kind of body shape or fat distribution. But there is a close relation of BMI with different measurements like hip circumference, waist circumference, mid upper arm circumference, body fat percentage and blood pressure. This study basically pointing the correlation of BMI with WHR, MUAC, SBP, DBP, PP and % body fat. The main purpose of the study is to determine the best predictor for the BMI from above mentioned measurements.

Methods: 314 non-pregnant women who are in their premenopausal stage, and are apparently free from major diseases were examined to assess their height, weight, hip circumference, waist circumference, mid upper arm circumference, triceps, subscapular and abdominal skinfold thickness, blood pressure. The body mass index, waist hip ratio, percentage body fat and pulse pressure was calculated. The results were statistically analysed using MS excel and SPSS 16.0.

Results: Statistically significant correlation were established between almost all variables like WHR, MUAC, SBP, DBP, PP and % body fat.

Conclusions: BMI is the strong predictor of other anthropometric measurements.
Keywords : BMI, Best predictor, correlation

INTRODUCTION

BMI is a quick and relatively reliable tool to assess nutritional status and to categorize individuals. It is the international standard that measures body size in adults. It is a statistical measure of an individual's weight scaled according to his/her height. It is a common, inexpensive and simple method to categorize individuals as underweight, normal weight, overweight, obese and further subcategories.

Although other anthropometric measures are widely available for human body composition assessment. Anthropometry concerns the measurement of different parts of human body such as bone, muscle, and adipose (fat) tissue. Various anthropometric measurements such as waist circumference, waist hip ratio, waist height ratio, and various skin fold thicknesses have been studied in relation to the health and nutritional status of individuals (Mannisto et al, 1997).In addition these methods are most popular due to their simplicity and low cost.

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There is a close relation of BMI with these anthropometric measurements. So this study basically pointing the correlation of BMI with WHR, MUAC, SBP, DBP,PP and % body fat and the best predictor of BMI.

REVIEW OF LITERATURE

BMI is an important tool for indicating nutritional status and risk assessment for the general population. Therefore, several studies on different level on different aspects have been conducted by researchers and research institutes.

Deurenberg et al (1989, 1998) conducted various studies and their work demonstrated that the relationship between percent body fat and BMI differs in the ethnic groups studied for the same level of body fat, age and gender. The differences found in the body fat/BMI relationship in different ethnic groups could be due to differences in energy balance as well as the differences in body build. The results showed that the relationship between percent body fat and BMI is different among different ethnic groups. This should have public health implications for the definitions of BMI cut-off points for obesity, which would need to be population-specific.

Luke et al (1997) conducted a study and found positive strong correlation between body mass index and body fat in black populations from Nigeria.

Doll et al (2000) conducted study among 3116 adults. Their findings suggested a stable linear relation of adiposity with BP, independent of age and body fat distribution, across developed and developing countries.

Webb et al, (2002) said, SBP, DBP, RBS and WHR had positive correlation with BMI. SBP, DBP, RBS also had a positive correlation with WHR. After controlling for effects of age and sex the correlation of RBS, SBP and DBP with WHR decreased to 0.078, 0.184) and 0.166 respectively. The correlation of SBP and DBP with BMI also decreased to 0.178 and 0.123 respectively whereas the correlation between RBS and BMI slightly increased to 0.084. RBS still had no correlation with SBP (-0016) and DBP (0.009).

Bose et al (2003) conducted a study among 470 male slum dwellers of Kolkata. Their study demonstrated BMI as an independent risk factor for HT, and overweight status ($BMI \geq 23 kg/m^2$) significantly increases its risk among adult Bengalee male slum dwellers of Kolkata.

A study conducted by Canoy et al (2004) concluded waist hip ratio is independently related to blood pressure. WHR could reflect the separate and opposite relations of waist and hip circumference on blood pressure.

MATERIALS AND METHODS

Participants

Participants for the study consisted of 314 women of Bengali Sunni Muslim aged between

16 to 52 years from villages Malikapur and Kokapur (Panchayat: Nilguanj, Subdivision: Barasat-I, District: North 24 Paraganas, State: West Bengal). This study was carried out in March, 2018. A cross sectional study with judgment sampling was done.

Data Collection
Data were collected using direct measurements of height, weight, MUAC, hip-waist circumference, triceps, subscapular, abdominal skinfold thicknesses and blood pressure.

Body Weight Measurement
Body weight was measured on weighing machine with an accuracy up to 0.5 kg.Weight measurement was carried out after the participants were asked to remove shoes or heavy clothes and objects.

Height Measurement
For measuring the height participants were asked to stand straight with heels together, head oriented in the FH Plane, remove their shoes or heavy outer garments and measurement was taken from standing floor to the vertex using martin's anthropometer, to the nearest 1mm.

Calculating the Body Mass Index (BMI)
Body Mass Index was calculated using standard formula. BMI Categories were determined according to World Health Organizations (WHO) BMI classification for Asians.

MUAC Measurement
Mid upper arm circumference was measured using a measuring tape (with an accuracy of 1mm), on the left arm (non-dominant arm). It is measured at the midpoint between the tips of the shoulder and elbow (acromion and olecranon process).

Hip and Waist Measurement
For this measurement participants were asked to remove heavy outer garments and remained in tight clothing, They were asked to stand with their feet fairly close together with their weight equally distributed to each leg and were asked to breathe normally. The hip and waist circumference was taken by measuring tape with an accuracy of 1mm.

Calculating the Waist-Hip Ratio (WHR)
The Waist-hip ratio was calculated by the individual's waist measurement diving by hip measurement. WHR categories were determined according to WHO and DGSP criteria.

Skinfold Measurement
Skinfold (triceps, subscapular and abdominal) was measured according to the anthropometric procedure using skinfold caliper. Participants were asked to stand erect comfortably, site was marked and measurement was obtained to nearest millimetres. Each skinfold measurements was repeated 3 times for each participants to increase accuracy of data.

Calculating the Body Fat Percentage

The body density was calculated using Jackson and Pallock and Ward generalized equations that have been valided for both athletic and non-athletic populations. These equations for categorized women are:

D=1.089733-0.0009245 (x) + 0.0000055 (x2) -0.0000979 (y)
Where,
D= Body density
x= Sum of triceps, sub-scapular and abdominal skin folds (in mm)
y= Age in years
The percentage of body fat was calculated from body density using Siri method
Percentage fat= (495/D)-450
Body fat percentage categories were determined according to Gallagher et al.

Blood Pressure Measurement

Blood pressure was measured using standard method with sphygmomanometer and classification were determined according to WHO Classification.

Data Analysis

The data was analyzed using descriptive statistics such as means, standard deviations, standard errors, percentages and frequencies. All data analyses were performed with the help of SPSS statistical package (Version 16.0). Correlation was used for evaluating relationship between two variables and best predictor was evaluated.

Collected data were analyzed in respect with reference to WHO (2006) and DGSP (2007) and others standardized values.

RESULTS AND DISCUSSION

Descriptive statistics

The study population consisted of 314 participants. Table 1 shows the anthropometric data of the studied population.

Body mass index classification

Table 2 shows the classification of BMI among participants. Figure 1 shows distribution of Underweight, normal weight, overweight and obese participants. The highest frequency is of normal weight constituting 42.68 % of total participants. The next lies underweight (28.66%), followed by overweight (19.75%), class I obesity (7%) and class II obesity (1.91%). No participants belongs to the category obesity III.

Waist-hip ratio classification

Table 3 shows the classification of WHR among participants. Figure 2 shows distribution of normal weight, overweight and obese participants. The highest frequency is of Obese constituting 64.97 % of total participants. The next lies overweight (18.15%), followed by normal weight (16.88%)**.**

Body fat percentage classification

Table 4 shows the classification of %BF among participants. Figure 3 shows distribution of Underfat, normal, overfat and obese participant's age group wise. In the age group >39 the highest frequency is of underfat constituting 39.49 % of total participants. The next lies normal (34.71%), followed by obese (10.83%), and overfat (7.96%). In the age group 40-49 the highest frequency is of obese constituting 3.18 % of total participants. The next lies normal (2.55%), followed by overfat (0.96%), and underfat (0.32%).

Blood pressure classification

Table 5 shows the classification of BP among participants. Figure 5 shows distribution of Hypotensive, normal, prehypertensive, stage I hypertension and stage II hypertension participants. The highest frequency is of normal constituting 42.99 % of total participants. The next lies prehypertensive (39.49%), followed by stage I hypotension (15.61%), stage II hypotension (0.96%) and hypotensive (0.96%).

Correlation of different anthropometric measurements with BMI

Table 6 shows correlation of anthropometric measurements with that of BMI. All the measurements have positive correlation except the body density showing negative strong correlation (-0.879). The MUAC among all the measurements shows a significant strong positive correlation (0.928), followed by hip circumference (0.888), % body fat (0.877), WAIST CIRCUMFERENCE (0.873), ABDOMINAL skinfold thickness (0.807), subscapular skinfold thickness (0.800), triceps skinfold thickness (0.771), age (0.636), WHR (0.496), SBP (0.339), DBP (0.289) and PP (0.123).

BEST PREDICTOR OF BMI AMONG THE MEASUREMENTS

Table 7 shows the best predictor of BMI. From the table it can be concluded that among all the measurements mentioned below, body density (importance level: 0.858) is the best predictor for BMI. The other predictors are age (importance level : 0.32), MUAC (importance level : 0.134), Hip circumference(importance level : -0.010), waist circumference (importance level : 0.60),WHR (importance level : -0.029), triceps skinfold thickness (importance level : 0.016), subscapular skinfold thickness (importance level : 0.89), abdominal skinfold thickness (importance level : 0.113), SBP (importance level : 0.083), DBP (importance level : -0.054), Pulse pressure (importance level : -0.028), body fat% (importance level : -0.881).

TABLE 1: ANTHROPOMETRIC DATA OF THE STUDIED POPULATION

	N	MINIMUM	MAXIMUM	RANGE	MEAN	SD	SE
HEIGHT (cm)	314	130	163.2	33.2	150.598	5.563	0.314
WEIGHT (Kg)	314	22.5	99.7	77.2	50.1	13.278	0.749
BMI (Kg/m^2)	314	11.276	37.999	26.713	21.998	5.35	0.302
MUAC (cm)	314	15.2	34.1	18.9	23.190	4.101	0.231
HC (cm)	314	59.8	120.1	60.3	85.696	11.234	0.634
WC (cm)	314	49.9	107.1	57.2	74.689	13.656	0.771
WHR	314	0.675	1.216	0.541	0.868	0.076	0.004
TSF(mm)	314	1.5	35.8	34.3	13.872	6.347	0.358
SSF (mm)	314	4.3	69.2	64.9	17.218	9.348	0.528
ASF (mm)	314	3.3	68.9	65.6	20.609	11.128	0.628
BF (%)	314	9.732	62.294	52.563	26.188	10.694	0.603
SBP (mmHg)	314	87	174	87	118.382	14.622	0.825
DBP (mmHg)	314	41	111	70	76	12.103	0.683
PP (mmHg)	314	12	116	104	42.382	11.778	0.665

TABLE 2: BMI CLASSIFICATION FOR STUDIED PARTICIPANTS

BMI Classification	Number of Participants (%)
Underweight (< 18.5)	90 (%)
Normal weight (18.5–24.9)	134 (%)
Overweight (25.0–29.9)	62 (%)
Class I obesity (30.0–34.9)	22 (%)
Class II obesity (35.0–39.9)	6 (%)
Class III obesity (≥ 40.0)	0 (%)

TABLE 3: WHR CLASSIFICATION OF STUDIED PARTICIPANTS

WHR Classification	**Number of Participants**
Normal weight (< 0.80)	53
Overweight (0.80–0.84)	57
Obesity (> 0.85)	204

TABLE 4: PERCENTAGE BODY FAT CLASSIFICATION OF STUDIED PARTICIPANTS

Age groups	Grade			
	Underfat	Idea/Normal	Overfat	Obese
<39	124	109	25	34
40-59	1	8	3	10
TOTAL	125	117	28	44

TABLE 5: BLOOD PRESSURE CLASSIFICATION OF STUDIED PARTICIPANTS

Grade	**Number of participants**
Hypotensive (SBP: <90, and/or DBP: <60)	3
Normal (SBP:90-119 and/or DBP: 60-79)	135
Prehypertensive (SBP: 120-139and/or DBP: 80-89)	124
Stage-I Hypertension (SBP: 140-159and/or DBP: 90-99)	49
Stage-II Hypertension (SBP: >160 and/or DBP: >100)	3

TABLE 6: CORRELATION OF MEASUREMENTS WITH RESPECT TO BMI

CRITERIA	PEARSON correlation
AGE	0.636
HIP CIRCUMFERENCE	0.888
MUAC	0.928
WAIST CIRCUMFERENCE	0.873
WHR	0.496
TRICEPS SKINFOLD	0.771
SUB SCAPULAR SKINFOLD	0.800
ABDOMINAL SKINFOLD	0.807
SBP	0.339
DBP	0.289
PULSE PRESSURE	0.123
BODY DENSITY	-0.879
BODY FAT%	0.877

TABLE 7 : BEST PREDICTOR OF BMI AMONG THE MEASUREMENTS

MEASUREMENTS	IMPORTANCE LEVEL
AGE	0.32
MUAC	0.134
HIP CIRCUMFERENCE	-0.010
WAIST CIRCUMFERENCE	0.60
WHR	-0.029
TRICEPS SKINFOLD THICKNESS	0.016
SUB SCAPULAR SKINFOLD THICKNESS	0.89
ABDOMEN SKINFOLD THICKNESS	0.113
SBP	0.083
DBP	-0.054
PULSE PRESSURE	-0.028
BODY DENSITY	0.858
BODY FAT %	-0.881

CONCLUSION

BMI is the strong predictor of other anthropometric measurements. The present study mainly focuses on the BMI as a central tool to identify the physical health status depending on the anthropometric measurement like height, weight, MUAC, waist circumference, hip circumference, skinfold thickness, blood pressure.

The mean height was 150.598 cm, mean weight 50.1 kg and mean BMI was 21.998. Using the classification of BMI ranges the results reflects that 42.68 % of total participants were normal weight, 28.66% were underweight, 19.75% were overweight, 7% were of class I obesity and 1.91 % belongs to the class II obesity. And the prevalence of obesity increased with increased age.

The skinfold measurements from all sites were consistently higher by ages. Using the body fat percentage classification the distribution of normal weight, overweight and obese participants were pointed out. The majority of the participants were of category Obesity constituting 64.97 % of total participants. The next lies overweight (18.15%), followed by normal weight (16.88%).

The mean SBP and DBP was 118.3 and 76 respectively with a standard error of 0.825 and 0.683.The majority (42.99 %) of the participants were of normal blood pressure. The next lies prehypertensive (39.49%), followed by stage I hypotension (15.61%), stage II hypotension (0.96%) and hypotensive (0.96%).

The result obtained from statistical comparison of the variables showed that all the variables have positive correlation except the body density showing negative strong correlation (-0.879). The MUAC among all the measurements showed a significant strong positive correlation (0.928), followed by hip circumference (0.888), % body fat (0.877), WAIST CIRCUMFERENCE (0.873), ABDOMINAL skinfold thickness (0.807), subscapular skinfold thickness (0.800), triceps skinfold thickness (0.771), age (0.636), WHR (0.496), SBP (0.339), DBP (0.289) and PP (0.123). at a significant level less than 0.05. From the results of the study it can be concluded that among all the measurements mentioned, body density is the best predictor tool for the BMI with an importance value of 0.858(obtain through optimal

scaling regression) . Hence it can be called as best predictor .The other predictors are age (importance level : 0.32), MUAC (importance level : 0.134), Hip circumference(importance level : -0.010), waist circumference (importance level : 0.60),WHR (importance level : -0.029), triceps skinfold thickness (importance level : 0.016), subscapular skinfold thickness (importance level : 0.89), abdominal skinfold thickness (importance level : 0.113), SBP (importance level : 0.083), DBP (importance level : -0.054), Pulse pressure (importance level : -0.028), body fat% (importance level : -0.881).

In conclusion, concurrent use of several simple anthropometric assessments including BMI, may provide a more complete picture of health status. The study demonstrated that body mass index is closely associated with the anthropometric measurements mentioned before . Hence BMI can be concluded as a central tool to indicate health status. Further studies with variable population may help in determining the best marker BMI and its correlation with the anthropometric measurements.

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