Original Article

Anthropometric measurements as a predictor of metabolic syndrome among young adults aged 18-24 years in Mumbai city

Abstract

Aim: The aim was to identify the risk factors in developing metabolic syndrome among boys and girls aged 18-24 years in Mumbai city. **Materials and Methods:** A total of 200 samples were taken from different areas of Mumbai city. A lifestyle questionnaire was given containing questions like personal background and anthropometric measurements such as weight, height, body mass index (BMI), waist circumference and neck circumference were noted. **Results and Discussions:** The mean anthropometric measurements of 200 samples (100 boys and 100 girls) are as follows the mean age of the males in the study was found to be 21.26 ± 0.204 years and of females 21.31 ± 0.206 years. The mean differences in weight, height, and ideal body weight between males and females are as follows 75.3 ± 0.848 kg and 63.7 ± 0.735 kg, 171.37 ± 0.577 cm and 159.88 ± 0.552 cm, 71.39 ± 0.577 kg and 54.94 ± 0.544 kg. The mean waist circumference and neck circumference are as follows 87.88 ± 0.526 cm for males and 87.09 ± 0.559 cm for females and 37 ± 0.432 cm for males and 33.8 ± 0.456 cm for females. **Conclusion:** From the results, it can be concluded that BMI, neck circumference and waist circumference values are very higher than that of normal and this proves a basis that anthropometric measurements can be used to predict metabolic syndrome among young adults aged 18–24 years in Mumbai city.

Key words: Abdominal obesity, anthropometric measurements, metabolic syndrome, Mumbai city, neck circumference, young adults

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INTRODUCTION

Metabolic syndrome is highly age dependent.[1] The prevalence increases as the age increases. Metabolic syndrome is a disorder of energy utilization and storage, diagnosed by a co-occurrence of 3 out of five of the following medical conditions: Abdominal (central) obesity, elevated blood pressure, elevated fasting plasma glucose, high serum triglycerides, and low high-density cholesterol lipoprotein levels.[2] In the last decade, the rates for obesity among the 18-29 years old population with some college education have increased significantly.[3,4] Young adults are the building blocks of the country's economy as well as country's health. It is very important to ensure their proper healthy health status for a productive population. In the growing economic world, many worldly things affect the health status of populations. Young adults are at an increased risk of developing metabolic syndrome due to family history of disease, irregular eating patterns, and childhood obesity leading to adult obesity, peer pressure, existing diabetes or cardiovascular disease in an individual or family and lifestyle habits like smoking, alcohol, sedentary lifestyle and less of physical activity. As the present generation is showing signs of developing metabolic syndrome at a very young age it would be interesting to know the factors leading to it so the present study was carried out with an aim of finding the risk factors, which may lead to development of metabolic syndrome among boys and girls aged 18-24 years in Mumbai city.

MATERIALS AND METHODS

Samples of 200 male and female subjects were selected from the age group of 18-24 years on a purposive randomized sampling technique. Samples were taken from areas like Byculla, Dadar, Andheri, Vasai, Thane, Dombivli and Ulhasnagar of Mumbai city. Healthy samples are belonging to age group of 18-24 years were included in the study. Subjects suffering from any disease condition, pregnant and lactating

women were excluded from the study. A questionnaire was given seeking personal background like name, age, gender, religion, type of family, family income, occupational status of the samples were taken.

Anthropometric measurements like height, weight, ideal body weight (IBW), body mass index (BMI) and neck circumference were taken using a standardized tool to predict metabolic syndrome. BMI was calculated using weight in kg divided by height in m^2. Height, waist circumference, and neck circumference was measured using standard measuring tape close to 0.1 cm.

Statistical analysis

The data's were collected and coded, and these codes were entered in a Excel Sheet and analyzed using SPSS statistical analysis package. Pearson's Chi-square tests and nonparametric independent *t*-test were used to analyze the prevalence of metabolic syndrome criteria per BMI category. Significance was set at $P \leq 0.05$ for all tests. Sensitivity of neck circumference and its specificity was assessed with the use of receiver's output curve estimation.

RESULTS AND DISCUSSION

Background information

Of 200 samples, 100 were girls, and 100 were boys. The samples were from the age group of 18-24 years. 40% participants were from the age of 24 years, followed by 33% participants from 22 years then 26% of participants were from 18 years and so on. Majority of samples belonged to Catholic community, followed by Maharashtrians, Muslims, Gujarati's, South Indians and Jains. Maximum samples were from Thane, followed by Andheri then Ulhasnagar and so on. Majority of samples were from the nuclear family when compared to joint family type. 50% of the samples in the study were students studying in college followed by 30% of the samples were employed and so on. 70% of the samples belonged to the middle-class range of the society.

Anthropometric measurements

Table 1 represents the anthropometric measurements of the samples. *t*-test statistics was calculated to find out the difference between anthropometric measurements between boys and girls. The mean age of the males in the study was found to be 21.26 ± 0.204 years and of females 21.31 ± 0.206 years. The mean differences in weight, height, and IBW between males and females are as follows 75.3 ± 0.848 kg and 63.7 ± 0.735 kg, 171.37 ± 0.577 cm and 159.88 ± 0.552 cm, 71.39 ± 0.577 kg and 54.94 ± 0.544 kg. The *P* values were found to be <0.05. The mean values for weight were found to be higher than that of mean ideal weight measurements for males and females in the study. That means that the samples in the study are healthier than that of their IBW.

Table 2 represents the gender-wise distribution of samples that fall below and above the reference values for waist and neck circumference. About 65% of female samples were seen to have waist circumference

Table 1: Anthropometric statistics of the samples

Variables	Gender	*n*	Mean	SD	SEM
Age	Female	100	21.31	2.063	0.206
	Male	100	21.26	2.038	0.204
Weight (kg)	Female	100	63.740	7.3562	0.7356
	Male	100	75.359	8.4863	0.8486
Height (cm)	Female	100	159.880	5.5200	0.5520
	Male	100	171.370	5.7746	0.5775
IBW (kg)	Female	100	54.9400	5.44360	0.54436
	Male	100	71.3900	5.77332	0.57733
Independent samples test					
			T-test for equality of means		
	T		df	Significant (two-tailed)	
Age	0.172		198	0.863	
Weight (kg)	−10.346		194.089	0.000	
Height (cm)	−14.383		198	0.000	
IBW (kg)	−20.731		198	0.000	
Waist circumference (cm)	−1.028		198	0.305	
Neck circumference (cm)	2.831		198	0.00.00	

IBW = Ideal body weight, SD = Standard deviation, SEM = Standard error of the mean

Table 2: Gender wise distribution of samples below and above reference waist and neck circumference values

Variables	Gender	*n*	Mean (cm)	Reference values (cm)	Below reference value %	Above reference value %
Waist circumference	Female	100	87	80 and more	35	65
	Male	100	87	90 and more	70	30
Neck circumference	Female	100	33.8	33 and more	45	55
	Male	100	37	35 and more	32	68

values higher than reference value of 80 cm and more whereas only 30% of male samples were seen to have higher waist circumference values than the reference value of 90 cm and more. These 65% of females and 30% of males who have higher waist circumference values are at increased risk of developing metabolic syndrome. This fat patterning in females shows that females tend to store fat in the lower region of the body when compared to males.

About 68% of male samples were seen to have higher neck circumference values than the reference values of 35 cm and more whereas 55% of female samples were seen to have neck circumference values higher than the reference values of 33 cm and more. From the neck circumference values suggest that males tend to store fat more in the upper region of body when compared to females and 68% males are at increased risk to develop metabolic syndrome as compared to 32% males who have values below reference values.

These values tell us about the increased and adverse fat patterning among young adults at an early age like 18-24 years. This fat pattern can be a result of genetic predisposition of fat or unhealthy eating patterns of young adults.

Body mass index classification for predicting obesity

The BMI of the participants were classified using the Indian standards given by the Health Ministry, the Diabetes Foundation of India, the All-India Institute of Medical Science (AIIMS), Indian Council of Medical Research, the National Institute of Nutrition in the year 2008. The classification is as follows [Table 3].

Table 3: BMI classification for predicting obesity for Indians[5]

BMI in kg/m²	Classification
<16	Severely underweight
16-16.9	Moderately underweight
17-18.4	Underweight
18-22.9	Normal/healthy
23-24.9	Overweight
25-30	Obese
30-34.9	Obese grade I
40>	Obese grade II

BMI = Body mass index

The guidelines were released jointly by the Health Ministry, the Diabetes Foundation of India, the AIIMS, Indian Council of Medical Research, the National Institute of Nutrition and 20 other health organizations. A person with a BMI of 23 kg/m² will now be considered overweight and below that as one with normal BMI – unlike the cut-off limit of 25 kg/m² earlier. Those with BMI of 25 kg/m² will be clinically termed obese (as opposed to 30 kg/m² at the international level) and those with BMI of 32.5 kg/m² will require bariatric surgery to eliminate excess flab. According to guidelines, cut-offs for waist circumstances will now be 90 cm for Indian men (as opposed to 102 cm globally) and 80 cm for Indian women (as opposed to 88 cm at the international level).[5]

It can be observed from Figure 1 that major participants in the study were obese followed by over-weight and normal BMI values. Very few participants were classified as obese grade I and II and under-weight. The main criteria for metabolic syndrome are abdominal obesity and hence purposive randomized sampling technique was used to include more of over-weight and obese samples in the study to find out better results. The anthropometric measurements of the samples like mean height, weight and waist circumference, were also

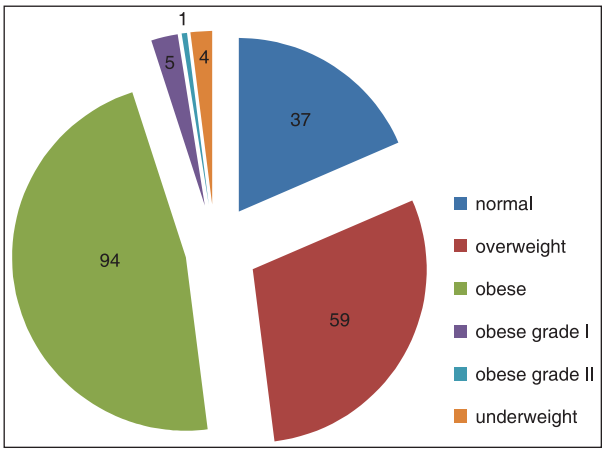

Figure 1: Body mass index classification of the samples in the study

Table 4: Co-ordinates of curves of neck circumference of the samples in the study

Nc in cm	Frequency	Sensitivity	Specificity	Sensitivity + specificity	Accuracy
33.5	2.000	1.000	0.000	1.000	0.625
34.5	5.000	0.900	0.167	1.067	0.625
35	6.000	0.800	0.167	0.967	0.563
35.5	9.000	0.700	0.167	0.867	0.500
36	10.000	0.600	0.167	0.767	0.438
36.5	11.000	0.500	0.167	0.667	0.375
37	12.000	0.300	0.167	0.467	0.250
37.5	15.000	0.300	0.500	0.800	0.375
38	16.000	0.100	0.500	0.600	0.250
38.5	22.000	0.000	0.500	0.500	0.188
39	24.000	0.000	0.667	0.667	0.250
39.5	28.000	0.000	0.833	0.833	0.313

found to be higher and serve as a reason for more obese samples in the study. The major population of the study was students, the high BMI can be a result of their sedentary lifestyle, unhealthy eating practices, peer pressure and social gatherings. Obesity can also be heredity effect that also leads to high BMI values.

Comparing college student population with general population a study by Wadhwa *et al*.,[6] with 548 subjects, on a population-based survey in Mumbai, showed a mean BMI of 25.68 in males and 26.95 in females with a 95% confidence interval of (25.27-26.09 in males) and (26.3-27.6 in females). Another study reported the highest occurrence rate (74%) for obesity (BMI >25 kg/m^2) on college students.[7]

These higher values of BMI and abdominal obesity in females can be risk factors which may lead to various other problems like polycystic ovarian disease, hormonal imbalance, low fertility, etc. and in males it can lead to infertility, hormonal imbalance leading to excessive facial and hairs over body, low muscle built up etc [Figures 2 and 3].

Predicting obesity from neck circumference

From Table 4, the best cut-off found for predicting obesity from neck circumference is 34.5 cm at 0.900 sensitivity and 0.167 specificity for all samples. The graphs explain the receiver operating characteristic curve and specificity and sensitivity of neck circumference values.

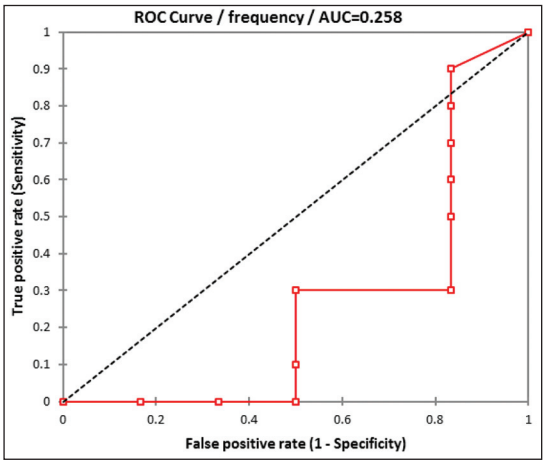

Figure 2: Receiver operating characteristic curve of neck circumference of the samples for predicting obesity

The mean value of neck circumference in girls was found to be 33.8 cm and 37 cm in boys.

The results of study done by Anuradha Shekhar and Sakina Ratlamwala on "Neck circumference as a marker of Obesity among the young girls (18-22 years) of Dawoodi Bohra community in Central Mumbai are 33.35 cm to predict obesity.[8] In a study, higher neck circumference (>35 for men and 33 for women) is positively related with BMI, waist circumference, and metabolic syndrome in Chinese individuals with type 2 diabetes aged 19-30 years.[9] In another study done on 350 diabetic and nondiabetic individuals of 20-40 years it was found out that, NC of >36 cm in diabetics and >37 cm in nondiabetics was the best cut-off value to determine subjects with central obesity.[10] Another study reports that large NC is related to the presence of sleep apnea, diabetes, and hypertension.[11] In a study done to correlate the neck circumference with visceral adiposity and insulin resistance among grade III obese individuals as classified by WHO (BMI >40 kg/m^2), it was seen that neck circumference value of 37 cm and higher strongly associated in proving visceral adiposity and insulin resistance at $P \leq 0.001$, whereas waist circumference only correlated with visceral adiposity at $P = 0.001$.[12]

SUMMARY AND CONCLUSION

The anthropometric measurements are major criteria to find out the metabolic syndrome risk in any person along with the clinical

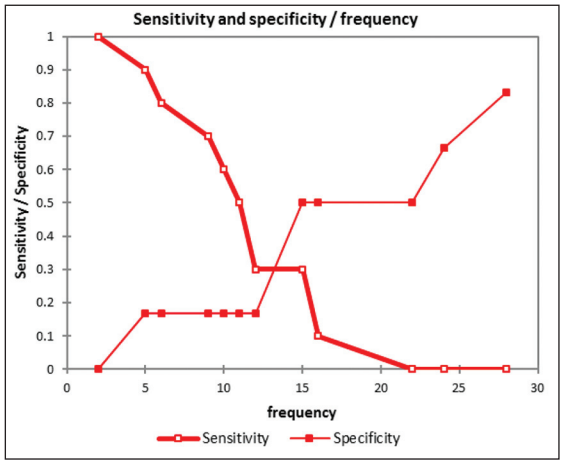

Figure 3: Frequency of specificity and sensitivity of neck circumference to predict obesity among samples in the study

parameters of metabolic syndrome. The mean waist circumference of girls was found out to be higher as per the standard value. The mean neck circumference of both girls and boys were found to be higher than the standard values. The BMI of 25 kg/m^2 and higher served as a marker to find out the obesity in the young adults and these adults are further needed to be examined thoroughly to find out the other risk factors leading to metabolic syndrome.

Ethical clearance

The research was started only after getting proper institutional ethical clearance committee. The research work was sanctioned by Seva Mandal Educational Society Institutional Ethical Committee on October 12, 2013.

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