

## ORIGINAL ARTICLE

**Obesity Related Indices for Screening of Obesity in Adolescents**Amit Sohani<sup>1</sup>, Sanjeev Chincholikar<sup>2</sup>, Bandana Patnaik<sup>3</sup>, Swati Raje<sup>4</sup><sup>1</sup>Assistant Professor, <sup>2</sup>Professor, <sup>3</sup>Professor and Head, <sup>4</sup>Assistant Professor (Statistician), Department of Community Medicine, Maharashtra Institute of Medical Education and Research Center, Medical College, Talegaon Dabhade, Pune 410507.

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E Mail ID: [aruna@mitmimer.com](mailto:aruna@mitmimer.com)**Citation**

Sohani A, Chincholikar S, Patnaik B, Raje S. Obesity Related Indices for Screening of Obesity in Adolescents. Indian J Comm Health. 2015; 27, 3: 304-310.

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**Background:** Obesity is a fast growing problem in the developing countries like India and is now known to be associated with increased health risk. Realizing the fact that the obesity in adolescent age group does not receive the deserved attention in the prevention and control programme, the present study was undertaken on 585 adolescent subjects studying in one college and three schools. **Aims and Objectives:** 1. To study the prevalence of overweight and obesity in adolescent population. 2. To find the association of body mass index (BMI) with important parameters like skin fold thickness, waist circumference and waist to hip ratio. **Methods:** It was a cross sectional observational study. The study population was school and college going adolescents in the age group of 11-19 years. The estimated sample size for present study is 585 students. The subjects were screened by body mass index, skin fold thickness, waist circumference and waist to hip ratio. **Results:** The prevalence of overweight and obesity was 19.14% and 4.44% respectively. It was found that there was strong association between the waist circumference with overweight and obesity. Similarly a strong association between waist to hip ratio with overweight and obesity has been found. Also it was found that there was a strong association between skin fold thickness with overweight and obesity. Skin-fold thickness has more sensitivity as compared to waist circumference and waist to hip ratio. Waist to hip ratio has got maximum specificity amongst all but when both sensitivity and specificity criteria are considered together waist circumference stands out. **Conclusion:** It was found that the prevalence of overweight and obesity was 19.14% and 4.44% respectively. Skin-fold thickness has more sensitivity as compared waist circumference and waist to hip ratio. Waist to hip ratio has got maximum specificity. When sensitivity and specificity criteria are considered together waist circumference can be effectively used as screening tool

**Key Words**

Overweight and obesity; BMI; Waist circumference; Waist to hip ratio; Skin fold thickness

**Introduction**

Obesity is a fast growing problem in the developing countries like India and is now known to be associated with increased health risk. Obesity is a risk factor in the development of hypertension, diabetes, gall bladder disease and coronary heart diseases and certain type of cancers. Other morbid conditions

associated with obesity are varicose vein, abdominal hernia, osteoarthritis of weight bearing joints and psychological stress.(1)

Childhood obesity is a fast emerging problem. Effective prevention of adult obesity will require prevention and management of childhood obesity. WHO has also emphasized on urgent need of

understanding the prevalence trend, factors contributing and developing strategies for effective intervention. With this background in mind, present study was undertaken in semi-urban area of Maharashtra to compare obesity related parameters with BMI for screening out obesity.

Body mass index (BMI) is commonly used to classify overweight and obesity. It is defined as persons weight in kilogram divided by square root of his height in meters ( $\text{kg}/\text{m}^2$ ). Khadilkar's age specific BMI cut-off values were used to classify overweight and obesity in adolescents.(2)

Waist circumference and waist to hip ratio are the approximate indices of intra-abdominal fat mass and total body fat. There is an increased risk of metabolic complications for men with a waist circumference more than or equal to 102cm and women with waist circumference more than or equal to 88cm.High waist to hip ratio more than (1) in men and more than 0.85 in women indicates abdominal fat accumulation (1). Measurement of skin fold thickness is a rapid and non-invasive method of assessing body fat. The measurement may be taken at all the four sites mid triceps, biceps, sub-scapular and supra-iliac regions. The sum of the measurements should be less than 40mm in boys and 50 mm in girls.<sup>1</sup> Skin fold thickness measurements are better predictors of body fat percentage than BMI. (3)

### Aims & Objectives

1. To study the prevalence of overweight and obesity in adolescent population.
2. To find the association of body mass index (BMI) with important parameters like skin fold thickness, waist circumference and waist to hip ratio.

### Material and Methods

The study was carried out in four institutions (3 schools and 1 college) of semi-urban area of Maharashtra from Jan 2013 to Jan 2014.Ethical committee of parent institute approved the study. Permission for the study was obtained from respective in-charges of schools and colleges.

It was a cross sectional observational study. A pilot study of 100 adolescents was carried out for determining sample size and validating the questionnaire. It was found that the prevalence of obesity was 15%.Prevalence of obesity is between 10 to 30% in India as reported by various studies (4-7). Finding of pilot study confirm the prevalence as 15%

in the reference population also. Therefore considering prevalence of obesity in adolescent as 15%, with 95% confidence interval ( $\alpha =0.05$ ) power of test=80% ( $\beta=0.2$ ), estimated sample size for adolescent population including 5% non-responsive error was 575. Though the estimated sample size for present study is 575, actual study was carried out on 585 students. Thus, reference population consisted of 17 schools and 3 colleges. Three schools and one college were selected by simple random sampling. All adolescent school going boys and girls in the age group between 11 to 19 years were included as per definition of adolescent. All students were selected by systematic sample. A pretested standardized questionnaire was used.

Height and weight of each individual was measured with the help of fiber plastic measuring tape up to the nearest millimeters and weighing scale up to the 0.5 kg respectively. Body mass index was calculated by dividing the weight in kilogram by square of height in meter. Khadilkar's age specific BMI cut-off values were used to classify overweight and obesity in adolescents. (2)

Waist circumference and hip circumference was measured using fiber plastic tape up to the nearest millimeter. Cut off values for risk of central obesity is with waist circumference 71 centimeters or more in children. Waist to hip ratio was calculated by simply dividing the waist circumference by the hip circumference. Waist to hip ratio more than 0.9 is indicative of central obesity in children. (8)

Skin-fold thickness was measured with the help of Harpenden skin-fold calliper.

#### The measurement sites were

1. Biceps - The front of the upper arm.
2. Mid-triceps - The back of the upper arm.
3. Sub-scapular - Beneath the edge of the shoulder blade.
4. Supra-iliac - Just above the iliac crest of hip bone.

All the above four measurements were summed up to get total skin fold thickness.

The sum of measurements, 40 millimeters in boys and 50 millimeters in girls was considered as cut off point for skin fold thickness to classify obesity. (1)

### Results

The study sample consisted of 585 adolescents in the age group of 11 to 19 years. It can be observed from [table I](#) that Prevalence of obesity was 4.5% while there were 20% overweight subjects.

As mentioned in materials and methods, 40 millimeters was considered as cut off point for skin fold thickness to classify obesity in boys. It was found that there was a strong association between skin fold thickness with prevalence of overweight and obesity in boys as shown in [table II](#).

It can be seen that eighty four boys either with overweight or obesity (as classified by BMI) had skin fold thickness more than 40 millimeters.

Similarly 50 millimeters was considered as cut off point for skin fold thickness to classify obesity in girls. As revealed in [table III](#), when skin fold thickness was compared with overweight and obesity (as per classification of BMI) it was found that there was a strong association between skin-fold thickness (more than 50 millimeters) and prevalence of overweight and obesity in girls.

It can be seen that 50 girls either with overweight or obesity (as classified by BMI) had skin fold thickness more than 50 millimeters. At the same time, only one overweight subject had skin fold thickness less than 50 millimeters.

As mentioned in materials and methods, 71 centimeters was considered as cut off point for waist circumference to classify obesity. It was found that there was a strong association between waist circumferences with prevalence of overweight and obesity as per classification of BMI as shown in [table IV](#). It means that as waist circumference increases, likelihood of overweight and obesity is more.

As mentioned in materials and methods, 0.9 was considered as cut off point for waist to hip ratio to classify obesity in adolescents. It was found that there was a strong association between waist to hip ratio with overweight and obesity as per classification of BMI as revealed in [table V](#). It appears that more the chances of overweight and obesity if waist hip ratio is more than 0.9.

When skin fold thickness, waist circumference and waist to hip ratio compared with BMI As shown in [table VI](#), it was found that skin fold thickness has more sensitivity to detect obesity as compared to waist circumference and waist to hip ratio. It can also be seen that waist to hip ratio has got maximum specificity amongst all, indicating that those identified as normal weight and below almost likely to be normal weight and below. However, when both sensitivity and specificity criteria are considered together waist circumference stands out. It means that waist circumference can be effectively used as screening tool.

## Discussion

### Prevalence of overweight and obesity

As revealed in [table I & Que 1](#), overall Prevalence of obesity was 4.44% while overweight was 19.14%.

Marie Ng *et al* 9 in their systematic analysis from 1980–2013, reported that prevalence of overweight and obesity in different parts of India ranges from 3% to 29% in childhood and adolescent population. Similar prevalence was observed in our study.

Kotian MS *et al* (10) in their study in 2010, reported that, the prevalence of overweight among adolescents was 9.9% and obesity was 4.8% which is comparable to our study.

In a recently conducted study by Tabassum Nawab *et al* (11), it was found that prevalence of overweight and obesity was 9.8% and 4.8%, respectively which is also comparable to our study.

Few studies have reported prevalence of overweight in the range of 22–25% and that of obesity 2–6% in children and young adolescents of Delhi. 12-14 However, these studies are based on urban adolescent population as against semi-urban population considered in our study.

### Skin fold thickness and BMI

As mentioned in materials and methods, 40 millimeters in boys and 50 millimeters in girls was considered as cut off point for skin fold thickness to classify obesity in subjects. It was found that there was a strong association between skin fold thickness with prevalence of overweight and obesity as per classification of BMI as revealed in [table II](#) and [table III](#).

BMI measures total body mass distributed per unit height. Obesity, however, is defined as an excess of body fat, and it is the amount of this fatness that is associated with morbidities, (12) Because BMI does not distinguish between fat mass and lean body mass, a high tracking of BMI from adolescence to adulthood can also represent a high tracking of body build rather than fatness. (13) Therefore, the assessment of obesity should ideally be based on measurement of body fatness. (14, 15)

According to Sarria A *et al* (16) Skin fold thickness measurements are better predictors of body fat percentage than BMI in adolescent and children.

### Waist circumference and BMI

From [table IV](#), It was found that there was a strong association between waist circumferences with overweight and obesity as per classification of BMI. It means that waist circumference was more than 71

centimeters, likelihood of overweight and obesity is more.

In adolescents, the accumulation of abdominal fat has been identified as a risk factor for the occurrence of cardiovascular and metabolic diseases. (17)

Patterns of fat distribution have shown to influence cardiovascular disease risk, and abdominal obesity predicts cardiovascular disease risk better than overall obesity. Thus waist circumference has been suggested as the most useful simple measure of fat distribution in children and adolescents as it has shown strong association with risk for coronary heart disease, adverse lipid profile and hyperinsulinemia in children. (18, 19)

Savva SC *et al*. In their study also observed a strong association between risk for coronary heart disease and waist circumference more than 71 centimeters in children. (20)

Harish BR *et al* (21) in their study have opined that the use of Waist Circumference to measure obesity in children can be considered to be an alternate tool to BMI.

#### **Waist to hip ratio and BMI**

From [table V](#), it was found that there was a strong association between waist to hip ratio with overweight and obesity as per classification of BMI. It appears that more the chances of overweight and obesity if waist hip ratio is more than 0.9.

According to Ojofeitimi *et al* (22), in their study revealed that waist to hip ratio technique identified more respondents to be overweight and obese than BMI technique.

According to Inter heart study (23) this it was very clear that out of different anthropometric measures waist hip ratio shows the strongest relation with the risk of myocardial infarction. More over this ratio was the strongest predictor of myocardial infarction irrespective of age, sex, smoking status, diabetes, lipid levels and blood pressure.

Though waist to hip ratio and body mass index have similar associations with obesity for knowing the incidence of obesity, further research is needed to determine usefulness of waist to hip ratio over BMI in children and adolescents Skin fold thickness, waist circumference, waist to hip ratio and BMI.

As shown in [table VI](#), when skin fold thickness, waist circumference and waist to hip ratio compared with BMI, it was found that skin fold thickness has more sensitivity to detect obesity as compared to waist circumference and waist to hip ratio. It can also be seen that waist to hip ratio has got maximum

specificity amongst all, indicating that those identified as normal weight and below almost likely to be normal weight and below. However, when both sensitivity and specificity criteria are considered together waist circumference stands out. It means that waist circumference can be effectively used as screening tool.

In a study done by Taylor RW (24) found that 80th percentile for waist circumference correctly identified 89% of girls and 87% of boys with high trunk fat mass (sensitivity) and 94% of girls and 92% boys with low trunk fat mass (specificity). Waist circumference performed significantly better as an index of trunk fat mass than did waist hip ratio and provided yet effective measure of truncal adiposity in children and adolescents.

Sunita Simon Kurpadet *al* (25) in their study concluded that waist circumference correlated better with body mass index than waist-to-hip ratio. The prevalence of abdominal obesity using waist circumference was higher than that with waist-to-hip ratio.

#### **Conclusion**

The prevalence of overweight and obesity was 19.14% and 4.44% respectively.

It can be revealed that skin-fold thickness has more sensitivity as compared to other two parameters waist circumference and waist to hip ratio. It can also be seen that waist to hip ratio has got maximum specificity amongst all but when both sensitivity and specificity criteria are considered together waist circumference stands out. It means that waist circumference can be effectively used as screening tool.

#### **Recommendation**

1. All schools and colleges should be persuaded to incorporate screening of secondary and higher secondary school children for obesity before starting their schedule. Proformas including demographic information and screening methods like BMI, skin fold, waist circumference and waist to hip ratio should be used to determine the exact burden of overweight and obesity.
2. The adolescent population found to be obese by screening instruments should be referred to clinician for reduction of obesity. They should be clinically examined, investigated and treated by the clinician.

3. Obese students should be counselled for nutrition, psychological changes, behavioural changes, pharmacological management and surgical intervention if necessary

### Limitation of the study

1. All the schools and colleges which provided education up to 10th standard or above 10th standard were considered as reference population. As there were no government schools or colleges providing teaching up to 10th standard or above, only private schools and colleges were considered for said study.
2. Community based studies on a larger representative sample of adolescent children, will be needed to study obesity related indices for screening of obesity in adolescent age group.

### Authors Contribution

All authors have contributed significantly in the study.

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**Tables**

**TABLE 1 PREVALENCE OF OVERWEIGHT AND OBESITY IN STUDY SUBJECTS**

BMI	Number of students	Percentage
<b>Obese</b>	26	4.44
<b>Overweight</b>	112	19.14
<b>Normal range &amp; below</b>	447	76.41
<b>Total</b>	585	100

**TABLE 2 ASSOCIATION OF SKIN FOLD THICKNESS WITH PREVALENCE OF OVERWEIGHT AND OBESITY IN BOYS**

Skin fold thickness → BMI ↓	< 40 Millimetre No. (%)	≥ 40 Millimetre No. (%)	Total No. (%)
<b>Students with normal weight and below</b>	93 (86.87)	151 (64.26)	244 (73.72)
<b>Students with overweight and obesity</b>	3 (3.13)	84 (35.74)	87 (20.08)
<b>Total</b>	96 (100)	235 (100)	331 (100)

$\chi^2 = 27.59594, \quad df = 1, \quad p < 0.001$

**TABLE 3 SKIN FOLD THICKNESS WITH PREVALENCE OF OVERWEIGHT AND OBESITY IN GIRLS**

Skin fold thickness → BMI ↓	< 50 Millimetre No. (%)	≥ 50 Millimetre No. (%)	Total No. (%)
<b>Students with normal weight and below</b>	43 (97.73)	160 (76.19)	203 (79.92)
<b>Students with overweight and obesity</b>	1 (2.27)	50 (23.81)	51 (20.08)
<b>Total</b>	44 (100)	210 (100)	254 (100)

$\chi^2 = 8.403047, \quad df = 1, \quad p < 0.001$

**TABLE 4 WAIST CIRCUMFERENCES WITH PREVALENCE OF OVERWEIGHT AND OBESITY**

Waist circumference → BMI ↓	< 71 Centimetre No. (%)	≥ 71 Centimetre No. (%)	Total No. (%)
<b>Students with normal weight and below</b>	350 (93.58)	97(40.76)	447 (76.41)

<b>Students with overweight and obesity</b>	24 (6.42)	114(59.24)	138(23.59)
<b>Total</b>	374 (100)	211 (100)	585(100)
$\chi^2 = 129.6256, \quad df = 1, \quad p < 0.001$			

**TABLE 5 WAIST TO HIP RATIO WITH PREVALENCE OF OVERWEIGHT AND OBESITY**

Waist to hip ratio → BMI ↓	< 0.9 No. (%)	≥ 0.9 No. (%)	Total No. (%)
<b>Students with normal weight and below</b>	385 (80.54)	62 (57.94)	447 (76.41)
<b>Students with overweight and obesity</b>	93 (19.46)	45 (42.06)	138 (23.59)
<b>Total</b>	478 (100)	107 (100)	585 (100)
$\chi^2 = 18.92976, \quad df = 1, \quad p < 0.05$			

**TABLE 6 COMPARISONS OF VARIOUS PARAMETERS LIKE SKIN FOLD THICKNESS, WAIST CIRCUMFERENCE AND WAIST TO HIP RATIO WITH BMI IN TERMS OF SENSITIVITY, SPECIFICITY, FALSE NEGATIVE AND FALSE POSITIVE**

Indicators	Skin fold thickness	Waist circumference	Waist to hip ratio
<b>Sensitivity</b>	97.10%	82.61%	32.61%
<b>Specificity</b>	30.43%	78.30%	86.13%
<b>False negative</b>	2.90%	17.39%	67.39%
<b>False positive</b>	69.57%	21.70%	13.87%

**Figures**

**FIGURE 1 PREVALENCE OF OVERWEIGHT AND OBESITY IN STUDY SUBJECTS.**

