



RESEARCH ARTICLE

HUMAN PHYSIOLOGY

**ESTIMATION OF PERCENT BODY FAT CONTENT BY ANTHROPOMETRY IN  
YOUNG MALES AND FEMALES****PANDURANG M. NARHARE\* AND INDLA DEVASENA**

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**ABSTRACT**

The mortality and morbidity due to obesity has increased in recent decades. So present study was done to find out percent body fat content for early detection of obesity in young age group by measuring skin fold and girth and results obtained were compared. Body density was calculated using mean of four skin fold measurements by using the equations of Durnin and Womersley. Percent body fat content was calculated from the body density by Siri's equation and prediction equations and constants presented by McArdle et al. The mean percent body fat content by skin fold method in young males was  $15.87 \pm 3.85$  and  $14.90 \pm 3.81$  by girth method. In young females the mean percent body fat content by skin fold method was  $25.03 \pm 4.54$  and  $23.74 \pm 4.59$  by girth method. 10% of young males and 16.67% young females were found to be obese. The correlation coefficient between skin fold and girth methods in young males and females was 0.98. So we conclude that girth method can also be used to estimate percent body fat content, because of its simplicity & inexpensive instruments for measurements.



## KEY WORDS

Anthropometry, Body density, Indian environment, Obesity, Percent body fat, Young age

## INTRODUCTION

Obesity has been recognized as a key risk factor for many diseases in past few decades<sup>1</sup>. Obesity is related to excessive body fat percentage rather than one's body weight. A male having percent body fat content of more than 20% and for females 30% are labeled as obese<sup>2</sup>.

The fat content of human body has both physiological and medical importance and it influences morbidity and mortality<sup>3</sup>.

Studies have shown that it is the excessive fatness, which is associated with increased risk of different diseases like diabetes mellitus<sup>4</sup>, hypertension<sup>5, 6</sup>, gall stones<sup>6</sup>, stroke<sup>6</sup>, various cancers<sup>7</sup>, osteoarthritis and degenerative joint diseases<sup>8</sup>, abnormal lipid concentration etc<sup>9</sup>. So early recognition and assessment of obesity is important.

Extra weight may be due to better bone and muscular development both heavier than adipose tissue. By anthropometry an individual with good muscle mass but little fat may be classified as obese<sup>10</sup>.

A person may be overweight without being obese. An alternative method to determine body fat percentage have to be used, stressing its validity and reliability to large population screening.

Common field method for measuring body density includes measurement of skin fold and girth anthropometrically<sup>11</sup>. A high degree of correlation exists between body density and measurements of skin fold<sup>12, 13</sup> and girth<sup>11</sup>.

**Aims and objectives of this study** – to determine the percent body fat content in

young (18-20 years) males and females by skin fold and girth methods and comparing the results obtained.

## MATERIALS AND METHODS:

### Materials:-

- 1) Skin fold Caliper (make Anand Agencies,Pune,India)
- 2) Plastic measuring tape

### Plan of study

It was a non-invasive, cross sectional study carried out in the Physiology Department at Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar-505001 (AP, India). The subjects selected for the study were 30 male and 30 female medical students of 1<sup>st</sup> M.B.B.S. in the age group of 18-20 years.

### Inclusion Criteria

1. Age between 18-20 years, non-athlete, not involved in regular physical exercises and apparently healthy.
2. The subjects selected for study varied in their body type, degree of physical activity and nutritional status.

### Exclusion Criteria:-

Not ready to participate voluntarily and any diseased state after thorough clinical examination.

**Methods**

All the skin fold and girth measurements were taken after training in the method prior to the study. The measurements were taken as follows .

- 1) The measurements were taken at four anatomical sites - biceps, triceps, sub-scapular, supra-iliac region.
- 2) The thickness of the double layer of skin and subcutaneous tissue was read directly from caliper dial and recorded in millimeters (mm) within 2-5 seconds after applying the full force of caliper.
- 3) Three measurements were taken on right side of the body with the subjects

**1) Skin fold Thickness Measurement:-**

For the measurement of skin fold thickness, recommendations published by the committee on nutritional anthropometry of the food and nutrition board of the National Research Council were followed<sup>14</sup>.

standing at each site and average of the value was taken as skin fold thickness score. Precision in estimating percent body fat by this method is  $\pm 3.5\%$  body fat.

\*Body density in gm/cc was derived from the sum of these four skin fold thickness scores using linear regression equations of Durnin & Womersley<sup>3</sup> as follows:

$$\text{Body Density} = c - m \times \log (\text{sum of skin fold thickness measurements at 4 sites in mm})$$

Where,

For males –

1) between 18-19 years  $c = 1.1620$  and  $m = 0.0630$ .

2) 20 years  $c = 1.1631$  and  $m = 0.0632$

For females –

1) between 18-19 years  $c = 1.1549$  and  $m = 0.0678$

2) 20 years  $c = 1.1599$  and  $m = 0.0717$

\* Percent body fat content was then calculated from body density values using the Siri's equation<sup>2</sup> as follows ----

Siri's Equation:

$$\% \text{ Body Fat Content} = \left( \frac{4.95}{\text{Density}} - 4.50 \right) \times 100$$

**B) Girth Measurement (Circumference):**

According to the specifications given by Mc Ardle et al<sup>2</sup>, flexible plastic measuring tape was used for measurements of girth. Measurements were taken when the person is in standing position, with exception of arm, in which the subjects were in seated position.

Duplicate measurements were taken at each site and average of two readings used as girth and measurements were rounded up to the nearest  $1/4^{\text{th}}$  inch<sup>2</sup>.

The anatomical locations selected for girth measurements for each sex were as follows:

1) **Young males** – Right upper arm (RUA), Abdomen (ABD), Right forearm (RFA)

2) **Young females** – Abdomen (ABD), Right thigh (RT), Right forearm (RFA)

% Body fat content was calculated directly by using the prediction equations and constants presented by Mc Ardle et al<sup>2</sup> First the constants were determined for corresponding girth measures from specific tables and percent body fat was calculated by substituting the appropriate constants in the following formula –



**1) For Young males,**

$$\% \text{ Body Fat Content} = \text{Constant A} + \text{Constant B} - \text{Constant C} - 10.2$$

Where, Constant A corresponds to RUA girth, Constant B corresponds to ABD girth, Constant C corresponds to RFA girth.

**2) For Young females,**

$$\% \text{ Body fat Content} = \text{Constant A} + \text{Constant B} - \text{Constant C} - 19.6$$

Where, Constant A corresponds to ABD girth, Constant B corresponds to RT girth, Constant C corresponds to RFA girth.

By this method, the error in predicting an individual's body fat is generally between  $\pm 2.5$  to  $4\%^2$ .

**Statistical analysis:**

The results of both methods in a particular group were compared by using paired *t* test and correlation coefficient was calculated.

**RESULTS**

**Table –1**

**Body measurements of subjects involved in the study presented as Mean  $\pm$  SD**

Variable	Young Males Mean $\pm$ SD	Young Females Mean $\pm$ SD
<b>Skin folds (mm)</b>		
Biceps	4.53 $\pm$ 2.22	6.97 $\pm$ 3.17
Triceps	10.70 $\pm$ 4.30	15.67 $\pm$ 4.85
Sub-scapular	11.23 $\pm$ 4.85	12.17 $\pm$ 4.37
Supra-iliac	13.73 $\pm$ 5.34	13.10 $\pm$ 5.29
Total	40.23 $\pm$ 15.59	47.90 $\pm$ 16.04
Body Density (gm/cc)	1.062 $\pm$ 0.0087	1.042 $\pm$ 0.0100
% Body fat content (Skin fold Method)	15.87 $\pm$ 3.84	25.03 $\pm$ 4.54
<b>Girths (inches)</b>		
Abdomen	29.15 $\pm$ 2.54	27.48 $\pm$ 2.94
Thigh	-	22.06 $\pm$ 1.86
Forearm	9.64 $\pm$ 0.51	9.18 $\pm$ 0.80
Upper arm	10.59 $\pm$ 0.78	-
% Body fat content (Girth Method)	14.90 $\pm$ 3.81	23.74 $\pm$ 4.59

**Table–2**

**Correlation coefficient (r) between Body Density & Body Measurements along with “t” value obtained after applying a test of significance**

Sr. No	Variable	Young Males		Young Females	
		r	t- value	r	t- value



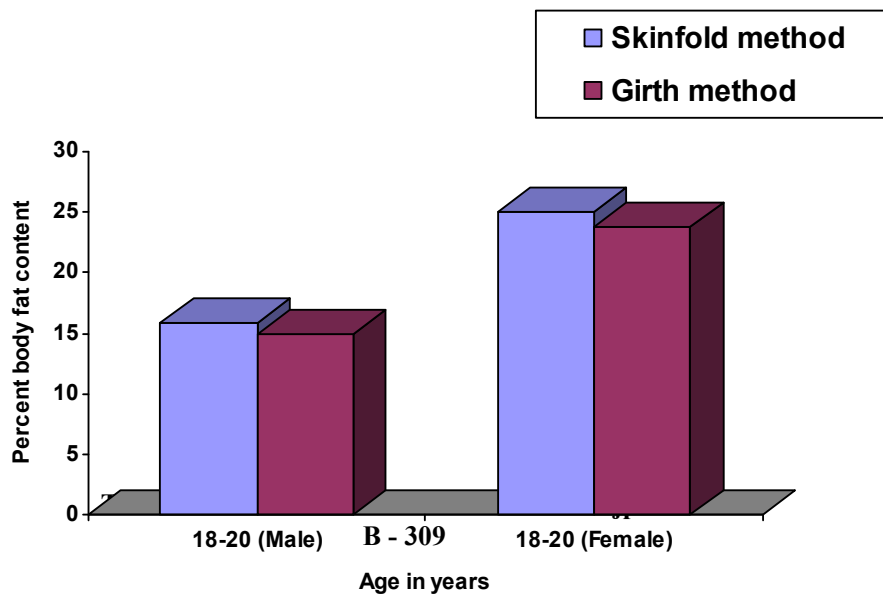
1	<b>Skin folds</b>				
a	Biceps	-0.793**	6.82	-0.791**	6.60
b	Triceps	-0.929**	7.78	-0.901**	10.33
c	Sub-scapular	-0.894**	14.58	-0.884**	9.80
d	Supra-iliac	-0.946**	14.58	-0.917**	11.60
2	<b>Girths</b>				
a	Abdomen	-0.877**	9.80	-0.737**	5.65
b	Thigh	-	-	-0.722**	5.49
c	Forearm	-0.500**	3.22	-0.335*	2.17
d	Upper arm	-0.764**	6.39	-	-

\*\*Correlation is significant at the  $p < 0.01$  & \*Correlation is significant at the  $p < 0.05$

**Table – 3**  
**Comparison of the values of % Body fat content obtained by the two methods**

Group	% Body fat content (Skin fold method)		% Body fat content (Girth method)		t-value & p value	Coefficient of correlation between the values obtained by two methods
	Mean $\pm$ SD	Range	Mean $\pm$ SD	Range		
Young males	15.87 $\pm$ 3.85	9.95 - 26.70	14.91 $\pm$ 3.82	9.66 - 25.51	8.356 = $p < 0.05$	0.986
Young females	25.03 $\pm$ 4.541	7.13 - 34.46	23.75 $\pm$ 4.59	15.38 - 34.35	10.216 = $p < 0.05$	0.989

**Graph 1**  
**Mean values of percent body fat content by two methods**



**Skin fold measurements**

- 1) In young males, maximum fat deposits were at supra-iliac area & least at the biceps area and in young females, the maximum fat deposits were at triceps & supra-iliac area and least in biceps area.
- 2) The skin fold measurements over the biceps and triceps areas were greater in females as compared to males and at sub-scapular & supra-iliac areas, the difference between males & females was insignificant ( $P > 0.05$ )
- 3) The body density was higher in males as compared to females.
- 4) According to table -2, The correlation between the body density & all the skin fold measurements were found to be statistically significant ( $p < 0.01$ ) & all correlation's were negative. In both

groups the variable which had a high correlation was skin fold thickness at the supra-iliac region.

**Girth measurements:**

According to table -2, the correlation between the body density & the various girth measurements was found to be significant ( $p < 0.01$ ) and girth measurements have a lesser correlation to body density as compared to the skin fold thickness.

**Percent body fat content:**

The % body fat content was significantly higher in case of females as compared to males as shown in table-3 and graph-1.

**Table – 4**  
**Comparison of findings of present study with other studies done in different geographical regions of the world**

Studies	Place	Age Range (years)	Body density** (gm/cc)	% Body fat content***
<b>Young males</b>				
Jackson & Pollock <sup>15</sup>	Texas (USA)	18-24	1.068	13.4
Katch <sup>16</sup>	New York (USA)	17-26	1.065	15.0
Pascale et al <sup>13</sup>	N. Carolina (USA)	17-25	1.068	13.6
<b>Present Study</b>	<b>India</b>	<b>18-20</b>	<b>1.062*</b>	<b>15.87</b>
<b>Young females</b>				
Katch & Michael <sup>17</sup>	California(USA)	19-23	1.049	21.9
MacMillan et al <sup>18</sup>	England	18-22	1.041	25.5
Nagamine <sup>19</sup>	Japan	18-23	1.047	22.70
<b>Present Study</b>	<b>India</b>	<b>18-20</b>	<b>1.042*</b>	<b>25.03</b>

\* Body density found by skin fold measurement using equations of Durnin & Womersley

\*\* Body density found by underwater weighting except in the present study and

\*\*\* Percent body fat content by Siri's equation.

**DISCUSSION**

As depicted in table - 4, young males in the present study were less dense and more fat when compared to other studies except in the

study done by Katch<sup>16</sup>, in which results are comparable.



Young females in the studies done by Katch & Michael<sup>17</sup>, Nagamine<sup>19</sup>, were less fat and more dense and in the study done by MacMillan<sup>18</sup> in which results are comparable to present study.

If we see table - 4, the difference in % body fat content between the present study and other studies is more in case of young females as compared to males. The climatic, genetic, seasonal variations are probably responsible for differences and females in western countries are more diet and exercise conscious than their Indian counterparts.

## CONCLUSION

Considering % body fat content more than 20% for males and 30% for females, then the person is said to be obese. In the present

study, 10% young males and 16.67% young females were found to be obese.

The western countries are trying hard to combat the problem of obesity by making people more diet & exercise conscious. The same thing is also required in Indian population to bring down the mortality & morbidity due to obesity.

As the results obtained by girth method are comparable to that obtained by skin fold method, it can be recommended in Indian population because of its simplicity and inexpensive instruments.

## ACKNOWLEDGEMENT

We are thankful to Dr. B.P. Subba Reddy for his guidance and final proof reading of the paper and First M.B.B.S. students for volunteering in the study.

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