

## **Assessment of Anthropometric Profile of adolescents (13-15 Yrs) in two different states of South India**

**K Hemamalin,**

Assistant Professor, Department of Food Technology, KLEF, Vaddeswaram 522302, Guntur  
District, Andhra Pradesh, India

**B Babitha,**

Assistant Professor, Department of Food Nutritional Sciences, Acharya Nagarjuna  
University, Guntur, Andhra Pradesh, India.

### **Abstract:**

The study aims at ascertaining the most appropriate communication media to be used to bringing about improvement in nutritional status, attitudinal change in children for sustainable development. 300 school going children (13-15 years), 300 boys' were selected randomly from Vijayawada (AP) and Chennai (TN) further grouped as normal weight, over weight and underweight based on BMI for age percentile. Questionnaire as the tool framed to collect data from respondents. The present findings reflect the existence of overweight and obesity in males (16.00%/18.51%) and females (31.03%/45.94%), respectively. The highest triceps was observed in Overweight girls' (36.18) of Chennai. The lowest results were obtained in normal weight girls' (13.28) of Vijayawada. The standard error of triceps varies from 1.46 to 0.58 of girls' and 1.26 to 0.65 of boys' in Vijayawada city whereas in Chennai for boys' the SE was between 0.79 to 1.26 to and in girls' it varies from 1.37 to 0.69. In all the categories the adolescents of Vijayawada, the SE observed was 0.26 to 0.79, however in Chennai children it was observed to be between 0.25 – 0.81. Which if continued in future, can have long lasting effect on improvement of nutritional status and healthy life style.

**Key Words:** Anthropometric measurements, Biceps, Triceps, BMI etc.

### **Introduction:**

Adolescence is a decisive period in human life in which important body composition changes occur. Increase of total body mass and its relative distribution are mainly related to gender and pubertal development.

The adolescence period in girls' starts from puberty that is around 13 to 15 years of age. For boys' it starts later by 9 years and ends by 18 years. Hormonal changes regulate the development of sex characteristics. In girls, there is an increase in subcutaneous fat around abdominal area and increased bone development around pelvic region. The growth in boys' is slow but they beat girls' in height and weight since they put on more muscle mass and there is growth in long bones. The sweat glands are more active thus acne on the face and back is a common problem in this age group (Joshi, 2000).

Adult size measured by height and weight also reflects an entire range of physiological measurements that determine work capacity, safety and ease of childbirth, decreased obstetric risk to mother and decreased incidence of low birth weight. During adolescence the relatively uniform growth of childhood is suddenly altered by an increase in the velocity of growth, there are major changes in height, weight and body composition has been reported by (WHO, 2006).

World health organization (WHO) defines a BMI above and equivalent to 25 considered as overweight and a BMI above and equivalent to 30 as obesity. NFHS 3-data state that overweight and obesity are emerging problems in India - 13% of women and 9% of men are overweight and obese. In the age group 15-19 nearly half of the females (47%) and nearly three-fifths of the males (58%) are thin. At the same time 24% of females and 2% of males in the age group of 15-19 suffer from obesity reflecting the changes in dietary and lifestyle patterns among the young. Young people in rural areas are more likely than youth in urban areas to be abnormally thin and less likely to be overweight or obese (National Family Health Survey, 2007).

A study conducted with 5664 school-going adolescents in the 12-18 year age group indicated that age adjusted prevalence of overweight was higher among boys' than girls' that is 14% among boys' and 9% among girls', whereas obesity was 2.9% among boys' and 1.5% among girls' (Goyal *et al.*, 2010). The authors stated that the rise in the occurrence of overweight and obesity occurred at the age of 12 years and thereafter decreased with age. On the other hand (Deshmukh *et al.*, 2006) found that the prevalence of thinness was significantly higher in early adolescence than in late adolescence in rural Wardha. They also reported that the prevalence of thinness was significantly higher (69.8%) in girls' than in boys' (40.7%). Current trend in India indicates that obesity is increasing in children as well as in adults. The

urban prevalence of obesity has increased alarmingly. Almost 50% of adult urban Indians in Delhi fulfill criteria for either obesity or abdominal obesity. The prevalence of overweight/obesity in children has increased from 16% in 2002-2004 to 29% in 2006 (Misra *et al.*, 2006).

A study with 223 adolescent girls' in an urban slum area of Andhra Pradesh reported an overall prevalence of stunting at 28.3% (Indian standard) underweight at 22.9% and thinness at 20.6%. The paper highlighted the fact that an urban slum adolescent girl is subjected to more physical and mental challenges compared to a rural adolescent girl (Prashant and Chandan, 2009).

Good nutrition and dietary behavior are important during adolescence to achieve full growth potential and appropriate body composition and to promote health and wellbeing. There is an immediate need to address the high burden of under nutrition in adolescents of both sexes in schools by routine annual monitoring of nutritional status, appropriate management of affected child and providing nutritional counseling for underweight adolescents (Anantha Narayana Gowda *et al.*, 2018).

Recently much research is conducted to explore how each sedentary activity is associated with body mass index (BMI) dietary behaviors and leisure time physical activity. The data collected from project EAT (Eating Among Teens) a school-based survey (Utter, 2003) examining personal behavioral and socio-environmental factors that are associated with nutritional intake among adolescents reported that high television/video use among boys' and girls' was associated with more unhealthful dietary behaviors like increased consumption of soft drinks, fried foods and snacks.

## **Materials and Methods:**

### **Anthropometric measurements and techniques**

Nutritional anthropometry is measurement of human body at various ages and levels of nutritional status. It is based on the concept that an appropriate measurement should reflect any morphological variation occurring due to significant functional physiological changes. For example, significant reduction in fat fold measurement reflects a shift in the individuals energy balance Mahtab Bamji *et al.*, (1996).

Anthropometric parameters were used for assessing the nutritional status of children and then the data was compared with the standards to reflect the present health status. Under

this height, weight, skinfold (biceps and triceps), BMI, waist to hip circumference ratio (WHR) and mid upper arm circumference were assessed for each subject.

### **Height and weight measurement:**

For the measurements of both height and weight, all precautions outlined by Jelliffe (1966) in his work were strictly followed.

### **Height**

Height measurement is an important parameter to assess the growth and nutritional status of growing children. In present study the standing height of the respondents were measured with the help of a portable and easy to wall-mount Stadiometer. The tool was purchased from the market and was calibrated to have authentic results it did not include tapes, yardsticks or graphics attached to the wall. Student was asked to remove shoes, hat, and hair ornaments /buns/braids to extent possible. They stand on the uncarpeted floor with back against wall, bring legs together (in contact at some point, whatever touches first). It was assured that student's legs were straight, arms at sides, and shoulders were relaxed and body was in a straight line. Then lowering the headpiece until it touches the crown of the head firmly, compressing the hair and finally recorded the nearest centimeters.

### **Weight**

The actual body weight is the weight measurement taken at the time of examination. Weight measurement is directly related to nutritional adequacy and thus reflects the nutrient intake of respondents. In present study actual body weight of the children were measured with the help of ISI marked weighing scale measuring up to a maximum of 125 kg with increments of 100 gm. It was properly calibrated before use, the scale was set at zero reading students were asked to remove shoes and stand erect in the center of the scale. It was ensured that students did not see their readings or values so as to avoid the error.

Before each measurement, the scale was adjusted to read 0.0kg to ensure accuracy. Fig: 3 shows the weighing scale which was used for the study depicts the method to take weight.

### **Body mass index**

The Body Mass Index (BMI) is a method of comparing a child's build to those of other children with the same age and gender. It's widely used because it only requires height

and weight measurements, which are easily obtained. Body mass index of each subject was calculated by using a formula. The BMI values recommended for adults are not applicable for growing age like adolescent. BMI for Age percentile chart was used.

Body mass index calculated from weight (kg) and height (cm). It was calculated from the equation  $wt (kg) / ht (m^2)$ . Khosla (1967) explained that BMI gives a measure of weight for height that is highly independent of actual height FAO/WHO/UNU, (1985).

### **BMI percentile chart**

Each gender has a separate BMI chart. The horizontal axis shows the child's age, the vertical axis shows the child's BMI, usually in metric units. The chart contains various curves that show BMI percentile rankings over age. The child's BMI and age are cross-referenced on the chart and that point is compared to the percentile curves to obtain the child's BMI percentile ranking. The percentile ranking indicates the percentage of children with the same age and gender that have a lower BMI than the test subject.

**Table: 1 BMI Percentile**

<b>Condition</b>	<b>Percentile Cut – off</b>
Underweight	< 5th percentile
Healthy weight	5th to <85th percentile
Overweight	85th <95th percentile
Obese	>95th percentile

The Weight and height of adolescent was compared with the reference data ICMR (2009) was calculated. The malnutrition status of adolescent was analyzed using IAP (Indian Academy of Pediatrics) growth monitoring guidelines proposed by Khadilkar *et al.*, (2007) growth charts.

### **Waist circumference:**

The WHO protocol for measuring waist circumference instructs that the measurement was made at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest WHO, (2008). Waist measurement should be made at the level of the umbilicus or navel. However, published reports indicate that measurements of waist circumference made at the level of the umbilicus may underestimate the true waist circumference Croft *et al.*, (1995). It was measured by palpating the lower rib of the client and iliac crest, in between these two areas midpoint was taken and measured by keeping tape around the waist starting point is at zero.

**Hip circumference:**

The hip circumference measurement should be taken around the widest portion of the buttocks WHO, (2008). It was measured by drawing an imaginary line from symphysis pubis and measure the fullest part of your subjects hip area.

**Waist to hip ratio**

The method of measuring waist and hip circumference exist Cashdan, (2008), World Health Organization, (2011), the one applied here allows a direct comparison between the obtained WHR. The formula for calculating waist to hip ratio is as given below,

$$\text{WHR} = \text{Waist}/\text{Hip}$$

In current study to calculate waist to hip ratio, first the measurements were taken for hip and waist then for each student calculation was done separately using the above formula, after that mean was taken as per their weight wise category for further statistical analysis.

**Chest circumferences**

Chest Circumference was measured at the level of nipple on the anterior aspect of the thorax which correspondence approximately to the fourth inters coastal space. The fourth inter coastal space is just inferior of the fourth costosternal joints; the measurement was made in horizontal plane by standing in front of subject but slight to left side Kankana De, (2017).

**Mid upper arm circumference (MUAC)**

The subject was asked to hang the hand freely, and with inch tape from acromion process to olecranon process length was measured, made it half way and round length measurement was taken as mid upper arm circumference WHO/UNICEF, (2009).

**Biceps:**

Biceps skinfold is measured as thickness of a vertical fold in the front of the upper left arm, directly above the center of the cubital fossa at the same level as the triceps skinfold Weiner, (1969).

The measurement was taken approximately over the center of the biceps of the muscle of the left upper arm. The arm of the subject was in a relaxed state and loosely hung. The skinfold was lifted about a cm below the midpoint along the long areas of the muscles. The caliper, in a horizontal position was allowed to compress the skinfold about the point where the thumb and finger grasped the skinfold.

**Triceps skinfold:**

Triceps skinfold is measured at the midpoint of the back of the upper left arm Weiner, (1969).

As the fat deposition in the upper arm is not uniform in thickness, the site selected was the left mid upper arm between the tip of acromial process the scapula and the olecranon process of the ulna. The measurement was made with elbow slightly flexed and the site on the triceps was marked. The thickness of the fat fold was measured with the hand hanging freely at the side. The fat fold thickness was noted to the nearest 0.2 mm.

**Results and Discussion:**

Anthropometry is a tool to measure body dimensions. It helps in describing the nutritional condition of an individual or the group. It is important, as the adolescent is the transactional phase from childhood to adulthood. Thus a lot of changes and variation is observed in body proportions. The peculiarity of anthropometry during adolescent age helps in identifying the pathological findings nutritional risks or future diseases. The growth charts are normally plotted in terms of distance that is height and weight in relation to age. The growth is the product of continuous and complex interactions between hereditary and environmental factors David and Pat Preedy, (2006).

**General appearance**

General appearance was categorized as normal, lean, well-built and sickly (Table 2). From Vijayawada 38.66% boys' and 55.33% girls' were looking normal, 32.66% boys' and 17.33% girls' were lean, 20% boys' and 20.66% girls' were well built and 8.66% boys' and 6.66% girls' were observed sickly. From Chennai 40% boys' and 41.33% girls' were normal appearance, 34% and 22.66% boys' and girls' were looking lean, 20.66% boys' and 28.66% girls' were well-built and 5.33% and 7.33% were observed to be sickly.

Thus, in the current data it can be observed that maximum girls' from Vijayawada adolescents showed normal appearance than Chennai. Whereas maximum look well built, lean and sickly in Chennai as compared to Vijayawada. Among boys' were looking normal, well-built and lean more in the count in Chennai as compared to Vijayawada. Underweight boys' and girls' from Vijayawada looked sick in appearance were compared to Chennai.

**Table: 2 Distribution of adolescents according to general appearance**

S. No	General Appearance	N		O		U	
		Vijayawada	Chennai	Vijayawada	Chennai	Vijayawada	Chennai
1	Boys'						
	Normal	41(59.42)	37 (45.67)	4 (16.00)	9(33.33)	13 (23.21)	14(33.33)
	Lean	17 (24-63)	25 (30.86)	0(0.00)	0 (0.00)	32(57.14)	26(61.90)
	Well built	9 (13.04)	13 (16.04)	21 (84.00)	18 (66.66)	0(0.00)	0(0.00)
	Sickly	2(2.89)	6(7.40)	0 (0.00)	0(0.00)	11(19.64)	2(4.76)
	Total	69 (46.00)	81 (54.00)	25 (16.66)	27 (18.00)	56 (37.33)	42 (28.00)
2	Girls'						
	Normal	66(74.15)	48 (57.14)	10 (34.48)	10 (27.02)	7 (21.87)	4 (13.79)
	Lean	8(8.98)	14 (16.66)	0 (0.00)	0(0.00)	18 (56.25)	20 (68.96)
	Well built	12 (13.48)	18 (21.42)	19 (65.51)	25 (67.56)	0(0.00)	0(0.00)
	Sickly	3 (3.37)	4(4.76)	0 (0.00)	2(5.40)	7(21.87)	5(17.24)
	Total	89 (59.33)	84(56.00)	29 (19.33)	37 (24.66)	32 (21.33)	29 (19.33)

Note: Figures in parenthesis indicate percentages

### Height and body weight status of the subjects

The height of subjects was measured in cm and weight in kg, which was tabulated in Table 02. The average height of boys' (160.6cm) and girls' (162.97cm) of Chennai was more than the average height of boys' (153.94cm) and girls' (153.17cm) from Vijayawada. The minimum average height was observed in normal weight girls' of Vijayawada (151.72cm). Chennai boys' showed the highest Standard error of 1.34 and least error of 0.78 had been observed in schoolgirls' of Vijayawada (Table 3).



**Table 3 Mean height, current body weight and BMI of adolescents of Vijayawada and Chennai**

S N o	Cate gory	Height (cm)			Weight (Kgs)			BMI (Kg/Mt2)					
		Mean± SD	Range	SE	Mean ±SD	Range	SE	Mean ±SD	Range	S E			
<b>VIJAYAWADA</b>													
1	VN B	152.71 ± 13.30 1.99*	1 8 1	131	1.6 0	41.80 ± 7.06 2.46*	56 9 9	9 0.8 5	0.8 5	17.9 ± 1.69	21. 6	15. 3	0. 2 0
2	VO B	158.65 ± 14.88 0.07	1 7 9. 2	124	2.9 7	63.04 ± 14.22 0.39	89 3 4	3 2.8 4	2.8 4	24.61 ± 2.46	30. 8	21. 9	0. 4 9
3	VU B	153.36 ± 13.09 5.65**	1 9 0	123	7.4 8	34.02 ± 6.88 4.73* *	48 1 9	1 0.9 1	0.9 1	14.36 ± 1.32	18. 8	11. 8	0. 1 7
Total		153.94 ± 13.57	1 9 0	123	1.1 0	42.44 ±13.0 7	89 1 9	1 1.0 6	1.0 6	17.70 ± 3.89	30. 8	11. 8	0. 3 1
1	VNG	151.72 ± 7.41 9.44--	1 7 0	134. 6	0.7 8	43.09 ± 6.87 6.74* *	63 3 0	3 0.7 3	0.7 3	18.58 ± 1.80	22. 5	15. 4	0. 1 9
2	VOG	152.30 ± 8.02 3.92**	1 7 0	138	1.4 9	57.72 ± 8.67 2.93*	82 4 5	4 1.6 1	1.6 1	24.75 ± 1.93	30. 5	22. 3	0. 3 5

						*							
3	VUG	157.99 ± 14.28 2.18*	1 8 3	138	2.5 2	33.59 ± 6.76 2.16*	48	2 4	1.1 9	13.37 ± 1.16	15. 7	10. 9	0. 2 0
Total		153.17 ± 9.66	1 8 3	134. 62	0.7 8	43.89 ±10.5 8	82	2 4	0.8 6	43.89 ±10.5 8	30. 5	10. 9	0. 3 2
CHENNAI													
1	CNB	157.69 ± 17.30	1 8 8 8	131	1.9 2	45.47 ±11.0 0	81	2 9	1.2 2	17.99 ± 1.66	23. 2	15. 6	0. 1 8
2	COB	158.99 ± 18.03	1 8 5. 5	124	3.4 7	64.77 ±17.5 4	97	3 4	3.3 7	25.14 ± 2.62	31. 1	21. 9	0 5 0
3	CUB	167.26 ± 11.23	1 8 9. 5	133. 5	1.7 3	40.92 ± 7.32	59	2 6	1.1 2	14.47 ± 1.12	16. 7	11. 5	0. 1 7
Total		160.6 ± 16.42	1 8 9. 5	124	1.3 4	47.67 ±14.2 1	97	2 6	1.1 6	18.29 ± 3.96	31. 1	11. 5	0. 3 2
1	CN G	163.05 ± 10.04	1 8 7	148	1.0 9	50.78 ± 8.83	80	3 4	0.9 6	19.03 ± 2.12	22. 9	15 3	0. 2 3
2	CO G	160.94 ±	1 8	141. 5	1.6 2	65.64	12 0	4 5	2.1 6	25.06 ±	35. 8	22. 3	0. 4

		9.88	3			±13.1				2.88			7
						8							
3	CU	165.31	1	139	2.2	37.45	48	2	1.3	13.65	15.	9.5	0.
	G	±	8		1	±		4	2	±	2		2
		11.91	2			7.12				1.41			6
Total		162.97	1	139	0.8	51.87	12	2	1.1	19.47	35.	9.5	0.
		±	8		5		0	4	0	±	8		3
		10.42	7			±13.5				4.40			5
						4							

CR Values compared between two cities (two states) Table Value for 1%, 5% reported in Appendix-IX \*\* p<0.01, \*p<0.05

Weight increases as adolescent grow and develop; this was reflected in both fat-free mass and fat mass. In males, the velocity of weight gain coincides with peak height velocity (PHV), whereas in girls' it occurs few months after PHV is reached. The total mean weight was highest in Chennai boys' (47.67kg) and girls' (51.87kg) as compared to the total mean weight of Vijayawada boys' (42.44kg) and girls' (43.89kg).

The statistical analysis was done applying critical ratio test on height and weight of school going boys' -boys' and girls' -girls' of Vijayawada and Chennai. Thus, p<0.05, p<0.01 in underweight and normal weight boys'- boys', overweight girls'-girls' showing a significant difference in height and body weight within the above-mentioned groups. As p<0.05 of normal weight boys'- boys' and underweight girls'-girls' the hypothesis (H<sub>1</sub>) was rejected showing a significant difference in height and weight between the groups.

### Body mass index (BMI)

Mean BMI for normal weight boys' from both the city was same as 17.9 and standard deviation 1.69 (Table 03). The average BMI of overweight boys' from Chennai was highest as 25.14 and lowest mean BMI was of underweight girls' of Vijayawada (13.37). The maximum Standard error was observed in Chennai overweight boys' (0.50). The range of BMI varies from 35.8 to 9.5 this was observed among overweight boys' and underweight girls' of Chennai.

### Percentiles of body mass index

The percentile indicates the relative position of the child's BMI number amongst children of the same sex and age. The growth charts show the weight Status categories used for children and teens underweight, healthy weight, overweight and obese.

The BMI percentile of adolescents in Vijayawada and Chennai are shown in Table 4 and Fig 9. Out of 150 boys' of Vijayawada 46% fall under healthy weight (5<sup>th</sup> percentile - 85<sup>th</sup> percentile) category 11.33% were overweight (85<sup>th</sup> - less than the 95<sup>th</sup> percentile) 5.33% were obese (equal to or greater than the 95<sup>th</sup> percentile) and 37.33 % were underweight category (<5<sup>th</sup> percentile). Among 150 girls' 59.33% were a healthy weight, 16.66% overweight, 2.66% obese and 21.33 underweight.

In Chennai (54% and 56%) boys' and girls' were healthy weight, (28% and 19.33%) of boys' and girls' were underweight. In overweight category boys' were (12%) whereas girls' were (20%) and in obese boys' were more i.e. (6%) than girls' (4.66%).

Thus the study reveals that maximum children were of healthy weight percentile from both the places, overweight and obese children were more in Chennai when compared to Vijayawada. The number of children in underweight percentile was more in Vijayawada.

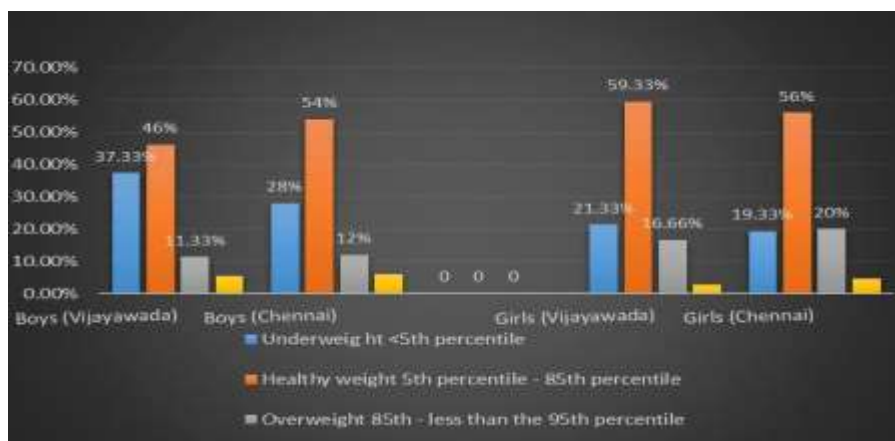
**Table: 4 BMI for the age percentiles of adolescents in Vijayawada and Chennai**

Sl.No	Category	Weight Status Category and Percentile Range			
		Underweight <5th percentile	Healthy weight 5th percentile – 85th percentile	Overweight 85th - less than the 95 <sup>th</sup> percentile	Obese Equal to or greater than the 95th percentile
Vijayawada					
1	VB	56(37.33)	69 (46.00)	17(11.33)	8 (5.33)
2	VG	32(21.33)	89(59.33)	25(16.66)	4 (2.66)
	Total	88(29.33)	158(52.66)	42(14.00)	12 (4.00)
Chennai					
1	CB	42 (28.00)	81 (54.00)	18(12.00)	9 (6.00)
2	CG	29(19.33)	84 (56.00)	30(20.00)	7 (4.66)

	Total	71 (23.66)	165(55.00)	48(16.00)	16(5.33)
	Grand Total	159(26.5)	323(53.83)	90(15.00)	28 (4.66)

Note: Figures in parenthesis indicate percentages

**Fig: 9 BMI percentile for adolescent boys’ and girls’ from Vijayawada and Chennai**



**Chest circumference of the subjects**

The mean chest circumference values are shown in table 04. The highest mean chest circumference in Vijayawada was 86.51 of overweight girls’ and 82.48 cm for overweight boys’. In normal weight girls’ the circumference was 75.80 and boys’ 70.87cm, for underweight it was 65.28 and 64.17cm of girls’ and boys’ respectively. In Chennai, the maximum mean was 92.20 of overweight girls’ followed by 87.51cm overweight boys’. The chest circumference normal weight girls’ were 81.34cm followed by 72.79cm for normal weight boys’. The standard error for Vijayawada was 1.72 and for Chennai it was 2 which were the highest values.

**Table: 5 Mean values of chest circumference and MUAC of adolescents**

S.No	Category	Vijayawada			Chennai				
		Mean ±SD	Range	SE	Mean ±SD	Range	SE		
Vijayawada									
1	VNB	70.87 ± 6.09	93.5	63	0.73	21.77 ± 2.64	30	19	0.31
2	VOB	82.48 ± 8.62	108	79	1.72	26.48 ± 3.99	35	23	0.79

3	VUB	64.17 ±4.98	74	50	0.66	19.25 ±2.08	25	15	0.27
	Total	70.85 ±9.60	108	50	0.78	21.79 ±3.91	35	15	0.31
1	VNG	75.80 ±7.90	92	63	0.83	22.64 ±2.53	28	20	0.26
2	VOG	86.51 ±5.20	101	77	0.96	26.45 ±2.21	32	24	0.41
3	VUG	65.28 ±6.20	80	58	1.09	19.09 ±1.49	22	20	0.26
	Total	75.62 ±9.80	101	58	0.80	22.62 ±3.27	32	24	0.26
Chennai									
1	CNB	72.79 ±7.83	88.7	63	0.87	22.62 ±3.22	29	19	0.35
2	COB	87.51 ±10.44	108	71	2	28.00 ±4.22	31	22.5	0.81
3	CUB	68.96 ±5.20	72	59	0.8	20.61 ±1.67	22	18	0.25
	Total	74.37 ±10.01	108	59	0.81	23.02 ±3.95	31	18	0.32
1	CNG	81.34 ±7.18	94	69	0.78	24.36 ±2.66	31.5	20	0.29
2	COG	92.20 ±7.68	114	80	1.26	28.62 ±3.30	42	24	0.54
3	CUG	69.79 ±5.09	80	63	0.94	20.14 ±1.96	22.5	18.35	0.36
	Total	81.79 ±10.14	114	63	0.82	24.59 ±3.90	42	18.35	0.31

### Mid upper arm circumference

Table 5 showed that mean MUAC values of adolescents. The maximum average value of 28.62 cm and 28.00 was observed in schoolgirls' and boys' of Chennai. Whereas, the minimum average value of 19.09 cm was observed in underweight girls' of Vijayawada. In all the categories the adolescents of Vijayawada, the SE observed was 0.26 to 0.79, however in Chennai children it was observed to be between 0.25 to 0.81.

### Waist circumference of the subjects

In Children and adolescent, body fat distribution can be described by WC (waist circumference). It is positively associated with high risk of metabolic complications and morbidity, in most of the intervention programs and research WC is used as an

anthropometric tool. In the current study table 6 shows the highest mean and SD for WC in Vijayawada was 86.22 cm of overweight girls' and minimum was 58.81 cm of underweight boys'. In Chennai overweight girls' 91.00 cm was the maximum average of WC and the minimum was 64.05 cm of underweight boys'. The highest SE observed in Chennai was 2.45 however, in Vijayawada children it was observed between 2.36 to 0.74.

### Hip circumference of the subjects

Hip Circumference was measured to calculate waist to hip ratio. The average HC of overweight boys' and girls' from Vijayawada was 89.15 and 95.67 respectively. In Chennai the average overweight boys' 95.27 and girls' 100.95 was higher than Vijayawada. It was observed that among the entire category the HC of Chennai subjects was higher than Vijayawada. The standard error varies from 2.17 to 0.81 of boys' and 1.19 to 0.64 of girls' in Vijayawada city whereas in Chennai for boys' the SE was between 2.14 to 0.84 and in girls' it varies from 1.28 to 0.76.

**Table 6 The mean waist circumference, hip in cm and waist to hip ratio values of the subjects**

S No	Cate gory	Waist (cm)			Hip (cm)			WHR				
		Mea n±S D	Range	S E	Mea n±S D	Rang e	S E	Me an± SD	Range	S E		
<b>VIJAYAWADA</b>												
1	VNB	67.2 8 ± 7.48	94 56	0. 9	78.89 ± 6.75	1 0 3	6 8 81	0. 8 1	0.8 5 ±0. 040	0. 94	0. 74	0
2	VOB	85.0 8± 11.8 1	11 5	70 2. 36	89.15 ±10. 87	1 2 3	8 4 17	2. 17	0.9 1 ±0. 030	0. 97	0. 83	0
3	VUB	58.8 1 ± 5.63	74 45	0. 75	72.39 ± 6.68	8 9	5 5 89	0. 89	0.8 1± 0.0 2	0. 89	0. 75	0

										1.8			
										7			
	Total	67.0 8 ±11. 82	11 5	45	0. 96	78.77 ±10. 21	1 2 3	5 5 3	0. 83	0.8 4± 0.0 5	0. 97	0. 74	0
1	VNG	72.6 6± 7.00	88	57	0. 74	84.68 ± 6.12	9 8	7 5	0. 64	0.8 5± 0.0 3 1.8 5	0. 94	0. 73	0
2	VOG	86.2 2 ±7.6 4	98	71	1. 41	95.67 ± 6.07	1 0 6	8 5 .	1. 12	0.9 0 ±0. 040	0. 98	0. 8	0
3	VUG	62.1 8 ±6.1 8	73 .5	53	1. 09	75.15 ± 6.77	8 3. 5	6 9	1. 19	0.8 2± 0.0 4 1.8 3	0. 9	0. 71	0
	Total	73.0 5± 10.3 4	98	53	0. 84	84.77 ± 9.03	1 0 6	6 9 73	0. 73	0.8 5± 0.0 4	0. 98	0. 71	0
CHENNAI													
1	CNB	69.8 2± 9.68	93 .5	55 .5	1. 07	81.00 ± 8.43	1 0 5	6 8	0. 98	0.8 5± 0.0 4	0. 74	0. 95	0
2	COB	87.0	10	71	2.	95.27	1	7	2.	0.9	0.	0.	0



		3 ± 12.7 7	5		45	±11. 16	1 0	8	14	1 ± 0.0 4	97	81	
3	CUB	64.0 5 ± 5.34	69	53	0. 82	77.34 ± 5.47	8 6	6 3	0. 84	0.8 2 ± 0.0 3	0. 89	0. 75	0
Total		71.3 1 ± 12.1 4	10 6	53	0. 99	82.54 ±10. 31	1 0 5. 5	7 8	0. 84	0.8 6 ± 0.0 5	0. 97	0. 95	0
1	CNG	78.2 4 ± 7.55	90	65 .5	0. 82	90.07 ± 6.98	1 1 3	7 9 .	0. 76	0.8 6 ± 0.0 4	0. 97	0. 71	0
2	COG	91.0 0 ± 8.35	11 5. 5	71	1. 37	100.9 5 ±7.8 4	1 3 0	8 5 .	1. 28	0.9 0 ± 0.0 4	1	0. 81	0
3	CUG	66.6 9 ± 5.41	74	60	1	79.41 ± 6.45	8 3. 5	7 1	1. 19	0.8 4 ± 0.0 5	0. 92	0. 7	0 .0 1
Total		79.1 5 ± 10.9 4	11 5. 5	60	0. 89	90.69 ±10. 05	1 3 0	7 1 2	08	0.8 7 ± 0.0 5	1	0. 7	0

CR Values Compared between two cities (two states) for WHR Table Value for 1%,  
5% reported in Appendix-IX  $p < 0.01$ ,  $p > 0.05$

### Waist to hip ratio

The table 7 details the waist to Hip ratio to assess the fatness in adolescents. Thus it was observed that the mean of WHR for both the places for overweight boys' and girls' was

same as 0.91 and 0.90. The minimum average of WHR was of underweight boys' 0.81 from Vijayawada. The SE among all the categories was 0.00 whereas only underweight girls' of Chennai was observed 0.01

### Summary and Conclusion:

Anthropometry assessments are important for the improvement of their nutrition and health status, thereby overall development of the community concerned, where use of anthropometric measurements plays a pivotal role in the assessment of nutritional status WHO, (1995), Mondal and Sen (2010). The statistical analysis was done on height and weight of adolescent boys' -boys' and girls' -girls' of Vijayawada and Chennai. Underweight and normal weight boys' and overweight girls' show a significant difference in height and body weight. The maximum Standard error was observed in Chennai overweight boys' (0.50).

However, the findings from this study showed that based on BMI, 10.90% of girls' and 11.80% in boys' of Vijayawada and only 9.50% in girls' and 11.50% in boys' of Chennai adolescents were undernourished, having a Chronic Energy Deficiency (CED) Grade I, (BMI<16.00). Whereas 22.50% of girls' and 21.60% in boys' of Vijayawada and 22.90% in girls' and 23.20% in boys' of Chennai adolescents were moderate, having a Chronic Energy Deficiency (CED) Grade II, (BMI= 16.00- 16.99). The range of BMI varies from 35.8 to 9.5 this was observed among overweight boys' and underweight girls' of Chennai.

The chest circumference normal weight girls' were 81.34 cm followed by 72.79 cm for normal weight boys'. The standard error for Vijayawada was 1.72 and for Chennai it was 2 which were the highest values. In all the categories the adolescents of Vijayawada, the SE observed was 0.26 to 0.79, however in Chennai children it was observed to be between 0.25 – 0.81. The waist circumference observed in Chennai was 2.45 however, in Vijayawada children it was observed between 2.36 to 0.74. The hip circumference varies from 2.17 to 0.81 of boys' and 1.19 to 0.64 of girls' in Vijayawada city whereas in Chennai for boys' the significance between was 2.14 to 0.84 and in girls' it varies from 1.28 to 0.76.

The minimum average of WHR was of underweight boys' 0.81 from Vijayawada. The SE among all the categories was 0.00 whereas only underweight girls' of Chennai were observed 0.01. The highest triceps was observed in Overweight girls' (36.18) of Chennai. The lowest results were obtained in normal weight girls' (13.28) of Vijayawada. The standard error of triceps varies from 1.46 to 0.58 of girls' and 1.26 to 0.65 of boys' in

Vijayawada city whereas in Chennai for boys' the SE was between 1.26 to 0.79 and in girls' it varies from 1.37 to 0.69.

There is a paucity of well-conducted studies, and lack of uniformity in the age and sex specific cut-off points used to define overweight and obesity nationally. As a result, the magnitude of overweight and obesity problem in India especially between 5 - 18 years of age is relatively unclear Khadilkar *et al.*, (2015). Therefore, examining our children using the nationally collected growth data sets must become a mandatory practice as the BMI calculation based on WHO/NCHS recommendations may mislead the veracity of problem. Khadilkar, *et al.*, (2009) and Parthasarathy, (2007).

Especially when the BMI cut-off defines overweight and obesity in our adult population starts at lower scale in comparison to Western population. In response, IAP has created a nation specific BMI chart for children and adolescents (5 - 18 years old) of both sexes. Khadilkar *et al.*, (2015).

Nutritional status is an important component of physical fitness of an individual and provides a well-being indicator Joseph and Bonita (2011), hence should be emphasized as a way of healthy lifestyle among adolescents. The present findings reflect the existence of overweight and obesity in males (16.00%/18.51%) and females (31.03%/45.94%), respectively. It can be argued that overweight and obesity values found in adolescents are consistent with the high levels of overweight and obesity found in the Mediterranean countries, which prevalence values are between 20 and 40% Lobstein *et al.*, (2014).

### **Suggestions and Recommendations:**

It is suggested that adolescents, school teachers and parents should be informed about overweight and underweight. Children need to be educated on weight management, balanced diet, selection of right food, proper eating habits and weight related health issues both under nutrition and over nutrition. It is recommended that the nutrition education should be imparted in a way that children are also involved in an activity, take interest in learning and in future apply it in daily life.

### **References:**

1. Anantha Narayana Gowda B L and Yamuna B N. Nutritional status and its influencing factors among adolescents in rural field practice area of a medical college in Karnataka, India. International Journal of Contemporary Pediatrics 2018; 5(2):483-488.

2. Cashdan E. Waist-to-hip ratio across cultures: Trade-offs between androgen- and estrogen-dependent traits. *Current Anthropology* 2008; 49: 1099–1107.
3. David A. Hay and Pat Preedy. Meeting the educational needs of multiple birth children. *Early Human Development* 2006; 82: 397- 403.
4. Deshmukh P R, Gupta S S, Bharambhe M S, Dongre A R, Maliye C and Kaur S. Nutritional status of adolescents in rural Wardha. *Indian Journal of Paediatrics* 2006; 73: 139-141.
5. Edward D A W. Observations on the distribution of sub-cutaneous fat. *Clinical sciences* 1950; 9: 259-270.
6. Goyal Ramesh K , Shah Vitthaldas N, Saboo Banshi D, Phatak Sanjiv R, Shah Navneet N, Gohel Mukesh C, Raval Prashad B and Patel Snehal S. Prevalence of Overweight and Obesity in Indian Adolescent School Going Children: Its Relationship with Socio-economic Status and Associated Lifestyle Factors. *Journal Association Physicians India* 2010; 58:151-158.
7. Indian Council of Medical Research, Nutrient Requirements and Recommended Dietary Allowances for Indians. A Report of the Expert Group of the Indian Council of Medical Research. ICMR, New Delhi. 2009.
8. Joshi Shubhangini. *Balanced diet and nutrition*. Tata McGraw-Hill Publishing Company Limited New Delhi. 2000: 160-173.
9. Jelliffe DB. The assessment of the nutritional status of the community. *World Health Organization Monograph*, 1966; Series No. 53, Geneva, 50-84.
10. Kankana De. Anthropometric Status of Adolescent Girls' of Rural India. *Journal of Traditional Medicine & Clinical Naturopathy* 2017; 6(1): 1-4.
11. Khadilkar V V, Khadilkar AV, Choudhary P., Agarwal K N, Ugra D and Shah N K. IAP growth monitoring guidelines for children from birth to 18 years. *Indian Pediatrician* 2007; 44: 187-197.
12. Khadilkar V V, Khadilkar AV, Cole Tj and Sayyad MG. Cross-sectional Growth Curves for Height, Weight and Body Mass Index for Affluent Indian Children. *Indian Pediatrics* 2009; 46(6): 477-489.
13. Khadilkar V, Yadav S, Agrawal KK, Tamboli S, Banerjee M, Cherian A, Goyal JP, Khadilkar A, Kumaravel V, Mohan V, Narayanappa D, Ray I and Yewale V. Revised IAP

- growth charts for height, weight and body mass index for 5- to 18-year-old Indian children. *Indian Pediatrics* 2015; 52(1):47-55.
14. Lobstein T, Baur L, Uauy R. IASO International Obesity Task Force. Obesity in children and young people: a crisis in public health. *Obesity Reviews* 2014; 1: 4-104.
  15. Mahtab S Bamji, N Prahlad Rao, Vinodini Reddy. Textbook of Human Nutrition. First Edition. Published by Oxford and IBH publishing Co Pvt. Ltd, New Delhi 1996; 1-507.
  16. Mondal N and Sen J. Prevalence of undernutrition among children (5-12 years) are belonging to three communities residing in a similar habitat in North Bengal, India. *Annals of Human Biology* 2010; 37:198- 216.
  17. National Family Health Survey (NFHS-3) 2005-2006. International Institute for Population Sciences; Mumbai: 2007.
  18. Parthasarathy A. Partha's fundamentals of pediatrics."1st edition. Chap. 5. Protein energy malnutrition: Assessment by history and clinical examination. New Delhi: Jaypee Brothers; 2007:108
  19. Prashant K and Chandan Shaw. Nutritional Status of Adolescent Girls' from an Urban Slum Area in South India. *Indian Journal of Pediatrics* 2009; 76; 501-504.
  20. Rodríguez G1, Moreno LA, Blay MG, Blay VA, Garagorri JM, Sarría A, Bueno M. Body composition in adolescent's measurements and metabolic aspects. *International Journal of Obesity Related Metabolic Disorders* 2004; 28 (Suppl. 3): S54-S58.
  21. Weiner J S. In Human biology. A guide to field methods. IBP handbook. Oxford: 1969: 621-622. Blann well scientific publication.
  22. WHO Multicenter Growth Reference Study Group (2006).WHO Child Growth Standards: length/height-for-age, weight-for-age, weight-for-length, weight for-height and body mass index-for-age: methods and development. Geneva: WHO.
  23. WHO/UNICEF. WHO Stepwise approach to surveillance (STEPS). Geneva, World Health Organization (WHO); 2008.
  24. WHO/UNICEF. WHO Stepwise approach to surveillance (STEPS). Geneva, World Health Organization (WHO); 2009.
  25. World Health Organization. Bridging the gap. The effects of poor nutrition. 1995; 5-7.