

## Study of physical growth standards of adolescents (10-15 years) from Karad, Maharashtra

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### Abstract

**Research question:** What are the anthropometric measurements of adolescents of Karad?

#### Objectives:

1. To study anthropometric characteristics (height, weight and BMI) of study population.
2. To validate study findings with national (ICMR) and international NCHS, WHO 2007 reference.
3. To study the correlates of weight with age, height, BMI.

#### Methods:

**Study design:** Cross sectional, school based study.

**Sample size:** 451 adolescents (259boys and 192 girls), aged 10yrs and above attending selected school.

**Statistical analysis:** Unpaired t test, correlation coefficient(r) and coefficient of determination (r<sup>2</sup>).

**Results and Conclusion:** Compared to NCHS standard- For boys- at 10, 12 & 15 yrs the 50<sup>th</sup> percentile values for height of present study are greater. In case of girls the 50<sup>th</sup> percentile value for height are higher; at 10, 11 & 13 yrs and is almost equal to NCHS values; at 14. When compared to WHO 2007 reference 10- The 50<sup>th</sup> percentile for the boys in the present study was higher at the age of 10, 12, 15 yrs. The data of ICMR for boys and girls is lower compared to present study for height and weight. In the present study at all ages' 50<sup>th</sup> Percentile value of BMI is lower than that of WHO 2007 reference and 85<sup>th</sup> percentile values are higher than the same. Coefficient of determination calculated for weight and height shows the extent to which the variation in these variables could be explained by the studied

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variables. With the increased nutritional status and standard of living it is necessary that regional standards are to be developed and revised regularly.

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**Key words:** BMI, growth, height, weight, Karad

## **Introduction**

Adolescent is a significant period of human growth and maturation. Individuals between the age of 10-19 yrs are placed in adolescent age group. In this period spurt in somatic growth & the accompanying appearance of secondary sexual characteristics, menarche, spermarche occurs. This is also a period of increased nutritional requirements.<sup>1</sup> Adolescence contribute about >20% of total growth in stature & up to 40-50% of body weight as somatic growth.<sup>2</sup>

Recent reports of WHO suggest that in South East Asian Region a large number of adolescents who constitute about 20% of the population in these countries suffer from malnutrition and anemia, which adversely impact their health and development.<sup>3</sup> The problem of overweight and obesity are increasing all over the world and India is no exception to the trend. This has been shown by work of various workers in various parts of the country.<sup>4,5,6</sup>

In a country like India with wide variation in the growth determinants, it is essential that the normal values are developed region wise and are redefined from time to time.<sup>7</sup> This study was planned to develop the mean, standard error and percentile values of anthropometric measurements for studied population according to age and to compare them with national (ICMR)<sup>8</sup> and international (National Centre of Health Statistics (NCHS), USA) standards<sup>9</sup>, WHO 2007 reference.<sup>10</sup>

## **Materials and Methods**

The study was carried out in the Karad taluka of Satara district which is situated in the western well developed belt of Maharashtra. Updated lists of English Medium Schools were used as the sampling frame. Of which one school was randomly selected and the entire apparently healthy adolescent in the age group of 10-15 yrs were included in the study. As per the guidelines given by the International Union of Nutritional Sciences, English medium schools cater to the elite population. These children have no constraints likely to interfere with growth<sup>11</sup>.

Prior permission was obtained from the school Principal. The purpose and the process of the study was explained to all participants and their teachers. Ethical clearance was obtained for the research project. The data was collected from February 2009 to April 2009. All students aged (as recorded by the school register) 10 -15 years were included in the study. Children suffering from any systemic disease or with any major surgical operations likely to affect their growth were excluded from the study. A total of 451 subjects aged between 10-15 years were included in the study. Data was collected by a trained team. Height was measured to the nearest 0.1 centimeter using a calibrated ruler fixed to the wall as the child stood barefoot

with the heels, back, and head touching the wall and head held in Frankfurt plane. A thin, wooden scale was placed above the head perpendicular to the ruler and parallel to the ground. Weight was measured to the nearest 0.1 kilogram using a portable weighing machine, which was standardized regularly by calibrating it to zero before each measurement, child being barefoot, emptied his /her pockets while standing on the weighing machine. Body mass index was computed using the standard equation:  $BMI (kg/m^2) = Weight (kg)/Height^2 (m^2)$ . Data were analyzed using the SPSS 16 software for windows. In order to test the significance of the difference, unpaired t test was used, wherever necessary. Correlation coefficients (r) and coefficient of determination ( $r^2$ ) for weight with age, height, and BMI were calculated.

## Results

A total of 451 subjects were included in the study out of which 259 (57.4%) were boys and 192 (42.6%) were girls. The height correlated positively with the age and increases with the increase in age. Median (50<sup>th</sup> percentile) largely coincided with the mean in various age groups in both the sexes. There was progressive increase in mean height with age in boys. Increases in height for boys are 5.72 and 10.29cm in 13-14 yrs and 14-15 yrs age groups respectively. In girls the trend for progressive increase in mean height lasts up to 13 years. During 11-12 yrs of age, girls have higher mean height by 1.69 to 4.69 cm as compared to boys of that age. This is because the adolescent growth spurts occur earlier in girls. At the age of 11 years mean height in girls is significantly higher than boys ( $p=0.021$ ). At 14 yrs of age the boys are taller by 2.1 cm & at 15 yrs 12.3 cm than the counterpart girls respectively. This is because in boys, adolescent growth continues for a longer period. At the age 14.5 & 15 years mean height is significantly ( $p=0.000$  and  $p=0.006$  resp.) higher in boys compared to girls. (Table 1)

Body weight increased in both the sexes with increase in the age. In boys mean weight increased from  $31.83 \pm 7.94$  (10 yrs) to  $52.20 \pm 10.89$  (15 yrs). Weight gain was more in later age groups. In girls similar trends was seen, whereby weight increased from  $34.55 \pm 8.30$  (10 yrs) to  $44.42 \pm 5.615$  (15 yrs). Up to the age of 13.5 mean as well as median weight were higher for girls than boys and the difference was statistically significant at the age of 11.5 ( $p=0.041$ ) & 14.5 ( $p=0.008$ ) years. Ultimately boys are heavier than girls by 7.6kg at the age of 15 years. (Table 2)

Median values of BMI, like height and weights coincides with the corresponding mean values in various age group and both the sexes. Mean values of BMI are higher for girls than boys up to the age of 14yrs. (Table 3).

Weight correlated positively and significantly with age, height and BMI in total population as well as in various sub groups. Coefficient of determination showed the amount of variation in weight, to the extent explained by the variation in that individual variable. Height and BMI could explain 36.3 to 62.5% & 37.7 to 99 % of weight variation among different subgroup of age respectively. Also it could explain 8-61.6 % & 95.4-71.1 % of weight variation among males and females. (Table 4)

## Discussion

The present study covered adolescents in the age group of 10-15 yrs. When compared to NCHS<sup>9</sup> standard- For boys- at 10, 12 & 15 yrs the 50<sup>th</sup> percentile values for height of present study are greater, the maximum difference being; at age of 15 yrs(3.2cm).. In case of girls the 50<sup>th</sup> percentile value for height are higher; at 10, 11 & 13 yrs and is almost equal to NCHS values; at 14, the difference being maximum at the age of 11 (5.5cm). At all other age group the present study values are lower in both the sexes

Compared to WHO 2007 reference 10-The 50<sup>th</sup> percentile for the boys in the present study was higher at the age of 10, 12, 15 yrs. At the age of 13 & 14 years values are lower by 5cm & 7.2 cm respectively. For girls the 50<sup>th</sup> percentile values in present study are higher at 10 & 11 years. At the age of 13, 14, 15 yrs values are lower by 3.40, 1.30 and 6.95cm respectively.

The data of ICMR<sup>8</sup> are lower by 1-7.7cm for boys in 10-15 yrs of age group and at 15 yrs of age boys in our study are taller by 6.4cm. Similarly for girls the data of ICMR study are lower by 3-9.68cm for 10-15 yrs of age and at 15 yrs of age girls in our study are taller by 3.15cm. Since, the ICMR study was carried long back and lots of improvement in the standard of living and nutritional status of the Indian population has taken place in the recent decade, the present study mirrors those improvements by the increase in mean height. The mean height of boys and girls in the present study were consistently higher than that of D.K.Agawal et al<sup>12</sup> study for all age group. The 50<sup>th</sup> percentile height for boys in the present study was slightly higher (max at 14.5 yrs age group 4.9cms) than V.V.Khakilkar et al study for all age group except 13-14 yrs of age (3.8cm less). For girls the 50<sup>th</sup> percentile values for present study are corresponding to that study.<sup>13</sup>

The mean height for boys are almost equal to that of CDC growth chart 2000 values at 10,11 and 12 yrs and at the age of 13,14 and 15.5 yrs present study values are lower by 5.40,7.32 and 5.27cm respectively. In girls the mean height of present study was more till age of 12yrs and after that mean height was lower by approximately 4cm in all age groups.<sup>14</sup>

The 50<sup>th</sup> percentile of weight for both boys and girls were consistently lower for all age groups, the maximum difference being at the age of 13 yrs (4.95kgs) in case of boys and at 15 yrs (10.18kgs) in case of girls. Thus, the difference was more pronounced in case of girls, when compared with NCHS standards.<sup>9</sup> The mean weight for both the sexes was considerably higher as compared to ICMR standards.<sup>8</sup> The mean weight for both boys and girls were consistently lower for all age groups than the CDC growth charts.<sup>14</sup>

For the present study the mean weight for boys and girls was higher (except at 14.5 & 15 yrs in case of girls) than a nationwide study<sup>12</sup>, the difference being maximum at 14.5 yrs (6.6kgs) in case of boys and at 10 yrs (4.9kgs) in case of girls. The mean weight for boys is little less (~2kgs) for all age group in the present study as compared to V.V.Khadilkar et al study. In case of girls the mean weight was higher for the present study till the age of 11.5 yrs & again at 14 yrs when compared with same study.<sup>13</sup>

In the present study at all ages 50<sup>th</sup> percentile value of BMI is lower than that of WHO 2007<sup>10</sup> reference by about 0.64 to 1.55 kg/m<sup>2</sup> and 85<sup>th</sup> percentile value in our study at all ages are higher than WHO 2007 standards by about 0.47 to 2.33 kg/m<sup>2</sup>. In recently carried out nationwide study<sup>13</sup>, both the 50<sup>th</sup> & 85<sup>th</sup> percentile values for BMI are higher than the present study and their value are even higher when compared with the WHO reference<sup>10</sup> and NCHS

standards.<sup>9</sup> In present study mean values of BMI were higher for girls than boys up to age of 14 yrs. Similar finding was reported by Thakor G.H et al study.<sup>15</sup> The present study data for 85<sup>th</sup> percentile for boys was higher for all age group except 12 & 13 years when compared to K.N.Agarwal.et.al<sup>2</sup>study. But, in case of girls the 85<sup>th</sup> percentile of the present study was lower for all age group except 10 & 12 yrs when compared with that study. Thus, local references are helpful in directing the limited resources more efficiently to the needed ones.

Significant positive correlation coefficients (r) were seen for body weight with age, height and BMI in total population as well as in various subgroups. Similar finding was reported by a study carried out at Surat.<sup>15</sup> Various coefficients of determination ( $r^2$ ) showed the proportion of variation in weight which can be explained by the variation in other variable.

## **Conclusion**

The present study provides the physical growth pattern for school based population (10-15 years of age) of Karad, Dist Satara. The present study values of height and weight are higher than those of Agarwal et al and ICMR standards. Thus there is secular trend in height, weight of Indian children which can be attributed to the increased nutritional status and standard of living. It is necessary that regional standards are to be developed and revised regularly.

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## **Authors Contribution**

Study was planned by SSP, PMD & SRP. SVK helped in data analysis. Manuscript was prepared by all authors.

**Conflict of Interest:** None

**Role of funding source:** None

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**Table 1:** Anthropometric Profile- Height for studied population

AGE IN YEARS	BOYS						GIRLS					
	N	Mean	S.E	Percentiles			N	Mean	S.E	Percentiles		
				5	50	95				5	50	95
10	18	141.58	1.529	131.00	140.50	154.50	20	142.18	1.476	135.00	140.00	155.90
10.5	19	141.97	1.885	127.00	144.50	155.00	15	143.10	1.269	138.50	142.00	155.00
11	31	143.58	1.086	136.00	142.00	157.00	24	148.27	1.755	133.62	150.50	162.25
11.5	26	145.04	1.332	135.00	145.00	156.00	27	146.48	2.065	113.20	149.00	156.00
12	31	148.73	1.175	137.90	150.00	161.80	26	150.42	1.557	137.00	150.00	164.90
12.5	19	152.50	1.797	139.00	152.00	168.00	16	151.50	1.746	140.00	151.00	163.00
13	29	153.09	1.426	143.50	151.00	169.25	19	154.05	1.786	140.00	153.00	168.00
13.5	25	158.58	2.238	140.20	155.00	182.00	8	153.19	2.542	139.00	154.75	160.00
14	21	158.81	2.262	145.30	156.00	189.00	23	156.74	1.488	139.70	158.50	167.60
14.5	17	171.59	1.921	162.00	169.00	190.00	8	156.44	2.060	150.00	155.50	167.00
15	15	168.40	1.927	149.00	171.00	178.00	6	156.25	4.020	144.00	154.75	171.00
15.5	8	167.12	1.894	160.00	168.50	175.00	-	-	-	-	-	-

For all tables-N=No of subjects, SE=Standard error of mean

**Table 2:** Anthropometric Profile- Weight for the studied population

AGE IN YEARS	BOYS						GIRLS					
	N	Mean	SE	Percentiles			N	Mean	S.E	Percentiles		
				5	50	95				5	50	95
10	18	31.83	1.872	20.00	30.25	51.50	20	34.55	1.858	23.05	33.50	49.00
10.5	19	31.92	1.850	22.00	29.00	53.00	15	34.50	1.612	25.00	33.50	46.00
11	31	33.77	1.638	23.80	33.00	55.20	24	36.71	1.828	26.25	35.75	61.50
11.5	26	32.77	1.331	24.00	32.00	49.90	27	37.15	1.605	25.40	36.50	58.60
12	31	38.10	1.378	25.60	39.00	53.60	26	39.90	2.134	26.88	37.00	64.30
12.5	19	38.92	1.869	28.00	37.00	55.00	16	41.69	2.788	28.00	39.50	69.50
13	29	42.00	1.522	31.00	40.00	62.00	19	46.11	2.980	29.00	45.00	93.00
13.5	25	44.48	2.108	29.80	43.00	67.80	8	44.88	2.165	35.00	44.25	55.00
14	21	49.48	3.219	31.30	45.00	86.80	23	48.13	2.261	34.00	46.00	75.00
14.5	17	54.74	2.330	45.00	53.00	80.00	8	43.56	2.495	36.00	42.75	56.00
15	15	52.20	2.814	40.00	49.00	72.00	6	44.42	2.307	37.50	43.50	53.00
15.5	8	54.25	5.577	42.00	50.00	90.00	-	-	-	-	-	-

**Table 3:** Anthropometric Profile- BMI for the studied population

AGE IN YEARS	BOYS						GIRLS					
	N	Mean	S.E	Percentiles			N	Mean	S.E	Percentiles		
				50	85	95				50	85	95
10	18	15.680	.6212	15.155	19.072	21.570	20	16.934	.6945	15.910	21.285	22.055
10.5	19	15.648	.5920	14.700	19.160	22.350	15	16.774	.6275	17.080	19.908	20.920
11	31	16.245	.6515	15.350	20.630	24.152	24	16.527	.5785	15.755	18.032	25.492
11.5	26	15.473	.4587	15.315	19.089	20.736	27	17.350	.6954	16.440	19.408	26.072
12	31	17.085	.4322	16.860	19.634	21.498	26	17.484	.7485	16.340	22.262	26.560
12.5	19	16.667	.6485	16.650	20.200	22.640	16	17.945	.8476	17.095	22.090	26.160
13	29	17.833	.4894	17.540	20.225	24.070	19	19.335	1.0943	18.650	22.210	36.79
13.5	25	17.549	.5693	16.950	20.986	23.535	8	19.245	1.1198	19.665	22.740	23.290
14	21	19.330	.8433	18.130	24.624	27.306	23	19.432	.6695	18.900	22.502	28.028
14.5	17	18.614	.7659	18.140	20.626	28.010	8	17.708	.6615	17.965	20.275	21.080
15	15	18.320	.8123	17.780	22.660	24.800	6	18.248	.9242	17.890	21.600	21.700
15.5	8	19.638	2.3886	17.155	30.921	35.160	-	-	-	-	-	-

**Table 4:** Correlation(r) and Determination ( $r^2$ ) between weight and different variables

Variable Group	Age		HEIGHT		BMI	
	R	$r^2$	R	$r^2$	R	$r^2$
All	0.354**	0.1253	0.661**	0.4369	0.153**	0.0234
Male (1)	0.612**	0.3745	0.785**	0.6162	0.867**	0.7516
Female (2)	0.222**	0.0492	0.283**	0.0800	0.977**	0.9545
10	-	-	0.791**	0.6256	0.948**	0.8987
10.5	-	-	0.750**	0.5625	0.911**	0.8299
11	-	-	0.671**	0.4502	0.927**	0.8593
11.5	-	-	0.548**	0.3003	0.771**	0.5944
12	-	-	0.678**	0.4596	0.931**	0.8667
12.5	-	-	0.648**	0.4199	0.922**	0.8500
13	-	-	0.037	0.0013	0.995**	0.9900
13.5	-	-	0.603**	0.3636	0.760**	0.3776
14	-	-	0.753**	0.5670	0.907**	0.8226
14.5	-	-	0.620**	0.3844	0.806**	0.6496
15	-	-	0.608**	0.3696	0.809**	0.6544

\*correlation is significant at the 0.005level (two tailed)

\*\* Correlation is significant at the 0.001level (two tailed)



