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Height, Weight and Arm Girth of College Girls in Delhi: Selected Centiles

Raghbir Singh
Department of Anthropology, University of Delhi, Delhi-110 007, India

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ABSTRACT Mean values, standard deviations and selected centiles of standardised measurements of height, weight and arm girth of 771 girls aged 17 to 20+ years studying in different colleges in Delhi and New Delhi are presented separately for different age groups. The mean and selected centiles of body weight at different heights are also presented. A positive secular trend towards higher mean values of height of the present generation of girls is observed. Means, SDs and selected centiles of surface area and anthropometric indices are also presented. $\sqrt[3]{\text{Weight}}$/Height is independent of age and hence of great significance and practical importance in nutritional studies. Arm girth shows high positive correlation with body weight and still higher correlation with height weight ratio. Arm girth, therefore may be considered as a simple and important nutrition index.

Height, weight and arm girth are very simple and important nutritional anthropometric measurements. But recent data on these measurements of college girls are scanty. Information on nutritional anthropometric indices/ratios of college girls is also extremely scanty. The object of present study therefore is:

(1) To present mean values, standard deviations and selected centiles of height, weight and upper arm girth of college girls in Delhi.

(2) To study whether a secular trend towards increase in the mean values of height of the present generation of girls in Delhi is occuring or not.

(3) To present means, SDs and selected centiles of surface area, height weight ratio, body mass index, arm girth: height index and the age independent height weight index.

(4) To present values of correlation coefficient r between height and weight; arm girth and weight and arm girth and height weight ratio.

MATERIAL AND METHODS

Seven hundred and seventy one college girls, randomly selected from different colleges in Delhi and New Delhi formed the subjects of the present study. The distribution of girls and their mean ages in different age groups are presented in table 1.

Table 1: Number of girls studied and their mean ages in different age groups

Age group (years)	*n*	*Mean age (years)*
17+	159	17.60
18+	246	18.59
19+	231	19.46
20+	135	20.41

Age Grouping

The International convention of expressing the age at the last birth day was followed for the present study. For instance, all the girls who had completed 17 years of age but were less than 18 years at the time they were measured were placed in the age group of 17+ years. If a girl was measured on her 18th birth day, she was placed in the age group of 18+ years. If a girl was less than 18 years by even one day at the time of taking her measurements, she was placed in 17+ years age group. Similarly age group of 19+ years

included all the girls who had completed their 19th birth day and 20 years age group included all the girls who had completed their 20th birth day at the time they were measured. Due care was taken to ensure that only those girls were included in the study who could provide their correct dates of birth.

Health History

The health history was also enquired from each subject. Only those girls were included in the present study who were apparently healthy *i.e.*, who did not have any complaint of serious illness or disease during the past three months prior to taking their measurements. Girls with any physical deformity were also not included in the present study.

Income and Family Members

Information on total family income per month and total number of members of the family was also obtained from each subject. Mean values and selected centiles of total family income per month and number of members of the family in different age groups are presented in tables 2 and 3 respectively. The 50th centile value of total family income in most of the age groups was Rs. 1500/= only per month (Table 2). The 50th centile value of total family members was six members in all the four age groups (Table 3).

Anthropometric Measurements

Standardised measurements of height, weight and upper arm girth were obtained from each subject. Height was measured with anthropometer which was held vertically in front of the subject who stood erect bare footed with her arms hanging down and her heels, buttocks and backs of the shoulders firmly touching against a vertical wall. The heels of the subject were touching and toes were placed apart while standing. The subject looked straight in front and her head was positioned in the eye ear plane. The distance between vertex and ground was the stature. As the measurements of stature obtained in the evening are lower than those of the same subjects obtained in the morning (Majumdar 1958; Singh, 1968a), all the measurements were obtained in the forenoon only.

Body weight with minimal clothing was obtained with 'Prince' lever actuated balance and due reduction was made for the minimal clothing. The measurement was taken to the near-

Table 2: Means and selected centiles of total family income (in Rupees) per month of parents

Age group (years)	*Mean*	*Income (Rupees per month)*						
		Centiles						
		5th	*10th*	*25th*	*50th*	*75th*	*90th*	*95th*
17+	1590	800	1,000	1,000	1,500	2,000	2,400	3,000
18+	1380	600	800	1,000	1,200	1,800	2,000	2,395
19+	1761	750	900	1,000	1,500	2,000	3,000	4,000
20+	1673	690	900	1,000	1,500	2,000	3,000	3,840

Table 3: Means and selected centiles of number of family members

Age group (years)	*Mean*	*Number of family members*						
		Centiles						
		5th	*10th*	*25th*	*50th*	*75th*	*90th*	*95th*
17+	5.8	4.0	4.0	5.0	6.0	7.0	8.0	9.0
18+	6.3	4.0	4.0	5.0	6.0	7.0	8.0	9.0
19+	6.2	4.0	4.0	5.0	6.0	7.0	8.0	9.0
20+	6.0	3.8	4.0	5.0	6.0	7.0	8.0	9.0

est 50 gm. *i.e.* to the nearest 0.05 kg.

Arm girth of the left arm was measured with flexible steel tape. The measurement was obtained at a level midway between the tip of the acromion process of scapula and olecranon process of ulna and at right angles to the long axis of the arm when it was hanging down freely. Due care was taken that the tape did not press or deform the contours of the upper arm. The tape just touched the perimeter of the upper arm. All the data were collected during 1983-84.

RESULTS

Mean values, standard deviations and selected centiles of anthropometric measurements are presented in table 4. Mean as well as 50th centile values of height of girls increased till 18+ years after which there was no increase in height. 50th centile value of height in 18+ age group was 155.9 cm. Body weight also tended to increase upto 18+ age group and arm girth upto 19+ age group in the present study. The mean values and selected centiles of height, weight and arm girth in different age groups (Table 4) of the present study/population may be used as reference standards in the absence of similar data from college girls in Delhi.

Mean values and selected centiles of body weight in successive height groups at every 5 cm. interval *e.g.* 140.0-144.9 cm, 150.0-154.9 ..... 165.0-169.9 cm. of different age groups are presented in table 5. These figures may be used as reference standards of body weight for girls of different heights.

Surface area tended to increase upto 18+ years, after which there was no increase in the surface area (Table 6).

Means, SDs and selected centiles of height: weight ratio, body mass index; $3\sqrt{}$Weight (kg)/ Height (m) index, arm girth: height index and arm girth: height^2 index are presented in table 7. It was interesting to note that the mean as well as 50th centile value of $3\sqrt{}$Weight (kg)/Height (m) was 2.3 in all the 4 age groups. This is the only index of all the five anthropometric indices which remains constant in all the age groups. This index *i.e.*, $3\sqrt{}$Weight/Height, therefore, may be termed as ageindependent height weight index. The mean

Table 4: Means, SDs and selected centiles of height, weight and arm girth

Age group (years)	*Mean*	*S.D.*	*Centiles*						
			5th	*10th*	*25th*	*50th*	*75th*	*90th*	*95th*
Height (cm)									
17+	154.9	5.8	145.7	148.1	150.5	154.0	159.6	163.4	165.5
18+	155.6	5.4	146.5	148.7	151.7	155.9	159.3	162.6	164.2
19+	155.4	5.1	146.6	149.0	151.9	155.4	159.0	162.5	164.7
20+	155.5	4.9	148.2	149.7	152.0	155.3	159.0	162.1	164.0
Body weight (kg)									
17+	45.4	5.8	35.7	37.5	41.3	45.7	49.3	52.9	55.4
18+	46.6	5.6	38.3	40.0	43.0	45.9	50.0	53.9	56.9
19+	46.6	6.1	37.7	39.4	42.6	45.8	50.5	55.0	56.4
20+	46.0	5.5	39.4	40.2	42.0	45.0	48.5	54.5	57.2
Arm girth (cm)									
17+	21.9	2.0	18.6	19.2	20.5	22.0	23.5	24.0	25.3
18+	22.2	1.8	19.4	20.0	21.0	22.0	23.5	24.5	[illegible]
19+	22.4	2.0	19.2	20.0	21.0	22.3	23.7	25.0	[illegible]
20+	22.2	2.0	19.2	20.0	21.0	22.0	23.2	25.5	26.1

Table 5: Means and selected centiles of body weight in successive height groups

Height Group (cm)	Mean	Body weight (kg) Centiles						
		5th	10th	25th	50th	75th	90th	95th
17+ years								
140.0 - 144.9	41.6	38.1	38.1	38.1	41.6	45.0	45.0	45.0
145.0 - 149.9	40.6	31.8	34.0	36.7	40.8	44.3	47.4	48.7
150.0 - 154.9	44.6	36.7	38.3	41.0	44.3	47.8	49.7	52.7
155.0 - 159.9	47.5	37.9	38.5	43.2	47.7	52.4	54.7	56.8
160.0 - 164.4	48.0	39.4	41.5	44.8	49.0	51.0	53.2	55.1
165.0 - 169.9	53.1	49.3	49.3	50.2	51.8	56.6	58.5	58.5
18+ years								
140.0 - 144.9	40.3	31.5	31.5	36.0	41.4	44.1	45.8	45.8
145.0 - 149.9	43.9	37.0	38.0	40.6	43.6	45.6	50.0	54.8
150.0 - 154.9	45.5	38.0	39.3	41.5	45.2	48.5	52.0	53.9
155.0 - 159.9	47.6	39.3	40.7	44.4	47.0	51.1	54.8	56.5
160.0 - 164.4	49.7	41.3	42.0	45.0	48.5	53.0	58.8	64.9
165.0 - 169.9	46.0	42.8	42.8	44.0	45.4	47.2	52.3	52.3
19+ years								
140.0 - 144.9	37.5	36.3	36.3	36.3	37.5	38.5	38.7	38.7
145.0 - 149.9	44.0	34.1	37.4	40.0	42.8	46.0	51.6	61.4
150.0 - 154.4	45.3	37.2	37.9	41.4	45.1	49.0	52.4	55.3
155.0 - 159.9	47.6	38.1	40.7	43.3	47.3	51.7	55.8	56.7
160.0 - 164.4	50.0	40.9	43.0	44.7	49.1	53.7	60.5	64.8
165.0 - 169.9	49.3	42.2	42.5	46.0	48.5	53.4	56.0	56.2
20+ years								
140.0 - 144.9	45.4	39.6	39.6	39.6	47.3	49.4	49.4	49.4
145.0 - 149.9	43.3	36.1	37.6	40.4	44.5	46.2	49.0	49.2
150.0 - 154.9	45.7	36.3	39.9	41.3	45.0	48.3	54.2	59.2
155.0 - 159.9	45.8	40.1	41.4	42.8	45.2	48.3	51.3	55.0
160.0 - 164.4	47.9	38.8	40.0	42.5	45.4	51.5	61.7	62.7

values of other indices/ratios were not constant in different age groups.

In all the 4 age groups, positive correlations were obtained between height and weight. Arm girth showed high positive correlation with body weight and still higher correlation with height: weight ratio, *i.e.* with Weight/Height (Table 8). The value of correlation coefficient 'r' between arm girth and height weight ratio in 20 years age group was 0.86.

DISCUSSION

The Indian Council of Medical Research (1972) reported mean and SD values of height, weight and other anthropometric measurements of boys and girls of different age groups from different parts of the country including Delhi. On comparing the mean values of height of the girls of present study with those of Delhi girls reported by ICMR (1972) it was encouraging to note that height of girls of present study was greater than those of Delhi girls reported by ICMR (Table 9). These observations indicate that a positive secular trend towards higher mean values of height in the present generation of girls is occuring. This may possibly be due to better diet and living conditions enjoyed by the present generation.

ICMR (1972) presented anthropometric data on All India boys and girls separately for differ-

Table 6: Means, SDs and selected centiles of surface area

Age group (years)	Mean	S.D.	Surface area (m^2) Centiles						
			5th	10th	25th	50th	75th	90th	95th
17+	1.50	0.11	1.35	1.39	1.46	1.53	1.61	1.68	1.71
18+	1.55	0.10	1.40	1.43	1.48	1.55	1.62	1.67	1.71
19+	1.55	0.10	1.39	1.42	1.49	1.55	1.62	1.69	1.72
20+	1.54	0.09	1.42	1.44	1.48	1.53	1.59	1.67	1.73

Table 7: Means, SDs and selected centiles of anthropometric indices/ratios

Age group (Years)	Mean	S.D.	Centiles						
			5th	10th	25th	50th	75th	90th	95th
Height weight ratio [Weight (kg)/Height (m)]									
17+	29.3	3.3	23.6	24.5	27.0	29.4	31.8	33.1	34.6
18+	29.9	3.3	25.0	25.9	27.5	29.5	31.9	34.8	35.6
19+	30.0	3.7	24.6	25.6	27.5	29.4	32.4	34.8	
20+	29.6	3.5	24.3	26.1	27.0	29.2	31.3	34.2	36.7
Body mass index [Weight (kg)/Height (m^2)]									
17+	18.9	2.1	15.4	15.9	17.5	19.0	20.4	21.5	22.3
18+	19.3	2.2	15.8	16.4	17.7	19.2	20.5	22.4	22.8
19+	19.3	2.4	15.9	16.4	17.6	19.2	20.7	22.3	23.2
20+	19.1	2.3	15.7	16.4	17.4	18.8	20.2	22.3	23.6
3√Weight (kg)/Height (m)									
17+	2.3	0.1	2.1	2.2	2.2	2.3	2.4	2.4	2.4
18+	2.3	0.1	2.1	2.2	2.2	2.3	2.4	2.4	2.5
19+	2.3	0.1	2.2	2.2	2.2	2.3	2.4	2.4	2.5
20+	2.3	0.1	2.1	2.2	2.2	2.3	2.4	2.4	2.5
Arm girth (cm)/Height (m)									
17+	14.2	1.3	12.0	12.4	13.2	14.2	15.1	16.0	16.6
18+	14.3	1.3	12.2	12.7	13.4	14.2	15.2	15.8	16.4
19+	14.5	1.4	12.2	12.8	13.4	14.4	15.3	16.0	16.5
20+	14.3	1.4	12.2	12.7	13.3	14.1	15.0	16.4	17.0
Arm girth (cm)/Height (m^2)									
17+	9.2	1.0	7.5	7.8	8.3	9.1	9.9	10.6	10.9
18+	9.2	1.0	7.5	7.9	8.6	9.2	9.8	10.5	10.9
19+	9.3	1.3	7.6	8.1	8.6	9.3	10.0	10.5	10.7
20+	9.2	1.1	7.6	8.0	8.5	9.1	9.8	10.7	11.2

ent socioeconomic groups. On comparing the height of girls of present study with the height of girls of corresponding are groups of the highest socioeconomic group reported by ICMR (1972) it was again encouraging to note that height of the girls of the present study showed higher mean values of stature (Table 9). These observations also indicate a positive secular trend towards higher mean values of stature in the present generation of girls.

Table 8: Values of correlation coefficient r between height and weight, arm girth and weight and between arm girth and height weight-ratio

Age Group (years)	*Height: Weight*	*Arm Girth: Weight*	*Arm Girth: Weight/ Height*
	r	*r*	*r*
17+	0.51	0.78	0.85
18+	0.35	0.76	0.83
19+	0.34	0.57	0.61
20+	0.21	0.81	0.86

Body weight of girls of the present study were not higher than those of Delhi girls reported by ICMR (Table 10). College girls in Delhi these days are more weight conscious and they possibily prefer to be lean and thin and therefore try to control their body weight.

Hamill et al. (1979) reported NCHS (National Centre for Health Statistics) centiles of height and weight of US boys and girls of 2-18 years age groups. On comparing the height and weight of girls of 17 and 18 years of the present study with those of NCHS centiles of the US girls, the mean values of height of girls of the present study were lower than even the 25th centile of US girls and body weight were lower than the 10th centile of the US girls. The lower values of height and weight of girls of the present study may be due to ethnic/genetic, nutritional and other environmental factors. These results in any case, reiterate the obvious need for developing local regional standards.

Singh (1991) reported that the mean values of $3\sqrt{\text{Weight/Height}}$ index of boys and girls

Table 9: Means and SDs of height of girls of the present study and those reported by ICMR (1972)

Age group (years)	*Height (cm)*								
	Delhi girls (Present study)			*Delhi girls (ICMR 1972)*			*'All India' highest socio-economic group girls (ICMR 1972)*		
	n	*Mean*	*SD*	*n*	*Mean*	*SD*	*n*	*Mean*	*SD*
17+	159	154.9	5.8	65	153.8	5.5	99	154.4	6.2
18+	246	155.6	5.4	58	153.9	5.2	101	154.1	4.9
19+	231	155.4	5.1	51	153.8	7.4	79	154.4	6.3
20+	135	155.5	4.9	8	155.5	6.4	57	154.1	5.1

Table 10: Means and SDs of weight of girls of the present study and those reported by ICMR (1972)

Age group (years)	*Weight (kg)*								
	Delhi girls (Present study)			*Delhi girls (ICMR 1972)*			*'All India' highest socio-economic group girls (ICMR 1972)*		
	n	*Mean*	*SD*	*n*	*Mean*	*SD*	*n*	*Mean*	*SD*
17+	159	45.4	5.8	65	45.7	5.4	99	45.6	8.0
18+	246	46.6	5.6	58	45.9	7.3	101	46.2	6.4
19+	231	46.6	6.1	51	45.9	6.7	79	46.9	6.0
20+	135	46.0	5.5	8	46.9	8.7	57	46.2	6.3

remai..ed constant in all the nine age groups from 9 to 17 years. It was constant in boys as well as girls of public schools, central schools as well as government schools (Singh, 1991) In the present study the mean values as wel" as 50th centile values of this index remained unchanged in all the 4 age groups of college girls (Table 7). It is therefore concluded that 3√Weight/Height is age independent index. This age independent index is of significance and practical importance in nutritional studies. Girls having the value of this index as 2 or less than 2 may be considered undernourished and those having the value more than 2.5 may be considered obese.

In all the 4 age groups very high positive correlations were obtained between arm girth and body weight and still higher values of 'r' were obtained between arm girth and height: weight ratio (Weight/Height) (Table 8). These observations support the earlier finding of the present author (Singh, 1968b, 1970, 1979, 1991). As height weight ratio is a very simple nutrition index, very high positive correlation between arm girth on the one hand and height weight ratio on the other indicates that arm girth measurement which is very simple and easily practicable measurement, may be used as a very simple and important nutrition index.

The important findings of this study are: 1. A secular trend towards higher mean values of height of Delhi girls is occuring and 2. 3√Weight/ Height is an age independent index which is of significance and practical importance in nutritional studies.

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