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M. K. DAS, D. P. MUKHERJEE

TRICEPS SKINFOLD THICKNESS IN SOUTH ASIA WITH SPECIAL REFERENCE TO A BENGALI SAMPLE

ABSTRACT. — The paper presents a general review of human variation in triceps skinfold thickness, compiles South Asian data and compares a fresh series of measurements from a homogenous cluster of 62 Bengalee families from Sodepur town near Calcutta. The influence of heredity and environment, age, sex, ethnic and socioeconomic differences as also the need for specific standards for each population are brought out by the accumulated data, despite limitations of age estimation and lack of uniform techniques in some materials. The highest values in South Asia are obtained for some populations of Southern India and lowest for hill people and isolated tribal populations except the Negrito Onge population of Andamans. The average values of Bengalis in all ages are lower than that of Punjabis of northern India and Pakistan. A meaningful pattern of ontogenic change emerges when age-groups of five years, and more for older ages, are compared. It indicates low values for boys and girls in early infancy and prepubertal girls under conditions of nutritional stress as in the Sodepur sample. The housewives included in the Sodepur sample have thicker upper arm fat than that of Bengali college women of Calcutta. The medians and quartile values are recorded for different periods of life, which show apparent trends of change, for future comparison.

INTRODUCTION AND REVIEW

Subcutaneous fat is an index of caloric reserve in human body, dietary inadequacy or obesity (Garn, 1962; Jelliffe, 1966). A heritability estimate of 0.2 (Howells, 1966) places skinfold thickness on equal footing with trunk measurements, facial breadth and bodygirths for purposes of anthropological studies. The skinfold measurement on triceps is more influenced by hereditary, ethnic and sex differences (Albrink and Meigs, 1964; Robson et al, 1971 and Johnston et al, 1974) than skinfolds at other sites. It is also less correlated with obesity (Shephard et al, 1969), systolic pressure (Barnicot et al, 1972) and coronary heart disease (Damon, 1969) than subscapular and suprailiac skinfolds. It is an easily obtainable and reliable estimate of bodyfat (Seltzer and Mayer, 1965 and 1967; Raugh and Schumsky, 1968) although its usefulness for estimating obesity is limited to women (Berry, 1974).

A greater amount of comparative material is available for triceps skinfold than for skinfolds at other sites of the body (Eveleth and Tanner, 1976). There are of course unavoidable limitations of uncertain estimations of age, small cross-sectional samples and ethnic heterogeneity (Malina, 1966; Huizinga, 1977; Rona and Altman, 1977) in some materials. Again, standard techniques (Tanner and Whitehouse, 1962; Damon, 1965; Jelliffe, 1966; Wiener and Lourie, 1969) of measuring skinfolds on left triceps are not followed by White (1963), Nagamine and Suzuki (1964), Fry et al (1965), Roy and Roy (1971), Rosing (1977), Sen et al (1977), Roy (1978) and others and that of using calipers with jaw pressure of 10 g/mm^2 are disregarded by a few investigators (Chen et al, 1963; Sloan and Wir- 1970). But inspite of this, these studies bring out some general trends of human variation in triceps skinfold. It is thicker in young adults than in others (Tanner and Whitehouse, 1975; Rona and Altman,

1977), in women than in men (Malina, 1966; Raugh and Schumsky, 1968; Huizinga, 1977), in people of European descent than in others (Nagamine and Suzuki, 1964; Fry et al, 1965; Malina, 1966; Robson et al, 1971), in the plains than in high altitudes (Surks et al, 1966; Krzywicki et al, 1969; Bharadwaj, 1972; Singh, 1977) with a few exceptions (Siri et al, 1954; Picon-Reategui et al, 1961), in urban and well-to-do populations than in rural and poor (Fry et al, 1965; Underwood et al, 1967; Johnston et al, 1978), and in settled agriculturists than in isolated foodgatherers (Fernandez et al, 1965; Glanville and Geerdink, 1970; Barnicot et al, 1972; Huizinga, 1977) and shifting cultivators. The triceps skinfold also appears to be thicker in the harvest season than in the lean months in certain people (Roy, 1978). A greater amount of fat utilization in cold stress (Baker and Danials, 1956) contributes to the low triceps skinfold thickness in the Eskimos (Shephard et al, 1973; Shephard, 1974). The experimental observation in Ladakh of an initial reduction of values is attributed to dehydration of dermis (Bharadwaj, 1972). But a smaller thickness of upper arm fat in Tamilian residents of Ootacamund hill than in those of Madras (Singh, 1977) equally emphasizes the role of physical exertion and cold climate in maintaining a low skinfold value. Larger increase in metabolism during shivering is accomplished by mobilisation of triglycerides of the adipose tissue (Folk, 1974). Sloan and Masali (1978) suggest that a very small proportion of fat in the Sherpas might contribute to mechanical efficiency in carrying loads uphill. Appropriate skinfold standards developed for assessment of nutritional status in particular populations will also serve as indicators of ecological adaptation (Johnston et al, 1971), biological indices of techno-economic development (Rona and Altman, 1977), and basilines for future surveillance of secular trends (Janes, 1974) or of socio-economic disparity between different sections of a population. Furthermore, studies of homogeneous samples and in all age-groups may further elucidate the pattern of age-sex variations. There are reports of little age-changes in a few male (Pett and Ogilvie, 1956; Montoye et al, 1965; Glanville and Geerdink, 1970) and even female samples (Young et al, 1963; Shephard et al, 1969), post-adolescent decrease in two of the male samples from hot and dry Savana (Huizniga, 1977) and females from highland Peru (Johnston et al, 1971), and constant values in adult life in others. The bulk of the studies test the hypothesis of linear increase in limb adiposity through ages with truncated data, rather than locating universal elements in particular patterns. Some authors overemphasise small yearly differences ignoring sampling variations and individual differences in growth. For example, the suggested prepubertal fatwave at 10th, 11ht or 12th year of life (Fry et al, 1965; Malina, 1966; Raugh and Schumsky, 1968) cannot be located in most of the available data (Eveleth and Tanner, 1976) even when a difference of 0.1 mm irrespective of its standard error is taken into consideration.

South Asian data on triceps skinfold relate to certain geographical and socioeconomic differences or obesity, and are yet inadequate to provide appropriate standards for specific populations. A few samples combine male and female data (Sen and Banerjee, 1958; TCRTI, 1974) and a few are only expressed in British standarts (Choudhury, 1975). Percentile values of triceps skinfold thickness available for a sample of 192 "people, chosen randomly from the eastern part of India" (Sen et al 1977) cannot also be utilised as reference standards in the absence of information on the age, sex, ethnic group and the location of the sample. The rest of this paper provides normative data of triceps skinfold thickness for the entire age-range of a Bengali sample from an industrial suburb of Calcutta, analyses the pattern of age-sex variations in the homogeneous family series and makes an overall comparison with available South Asia data compiled here and particularly with three earlier Bengalee samples from Calcutta and Midnapore and that of refugees from Bangladesh.

MATERIALS AND METHODS

Skinfolds were measured by one of us (MKD) on the left triceps of 127 males and 141 females using a Harpenden skinfold caliper following IBP recommendations (Weiner and Lourie, 1969) during February 1978 to January 1979. The subjects belonged to 62 families residing in a colony in Sodepur town, 20 kms to the north of Calcutta, and had apparently normal health. The older members of these families had immigrated in 1950 from what is now Bangladesh and were employed as workers in local industries. The sample represents two endogamous groups, the Bengali Brahmans and Kayasthas, which do not differ significantly between them in most of the genetical traits studied (Mukherjee and Saha, 1970). It is thus, largely homogeneous in genetical, ecological and socioeconomic background. The variability in dietary patterns in these families is rather small.

It has been possible to minimise the errors of crossectional analyses by verification of yearly ages through genealogical method and by suitable age-grouping to smoothen the trend-curves. The age at the time of taking the measurement is considered for this analysis. The ages range from 9 months to 90 years in males and to 74 years in females. Means and distributions of measurements instead of their log-values are used for objective and wider comparisons, although parametric statistics may not be applicable to skinfold thickness in the strict sense. Medians and quartile values are also recorded as standards of comparison in the final table. Other physical, physiological and serological data from the same cluster of families are separately reported (Das and Mukherjee, 1978a, b and c).

RESULTS AND DISCUSSION

The mean values of triceps skinfold thickness for adult males *(Table 1)* and females *(Table 2)* from South Asia including that of the present series display a wide range of variation. There is a consistent rise of the values in men older than 30 to 35 years of age both in this sample and in the data from Lahore. Slightly lower values in the older than in younger women of the present series is due to the inclusion of women over 50 years, who display lower mean values *(Table 5)* as in the Lahore sample. But the different age-ranges represented in different samples do not obviously account for most of mean differences, and some general trends of variation in this and other series of data have been mentioned earlier. It can be added that the values tend to be the largest in populations of Southern India and are larger in the plains people of the Nothern than of the Eastern part of India. The hypothesis of ethnic variability underlying these differences is strengthened by the evidence of a greater increase of triceps thickness in Southern Indians than in the Himalayan Gurkhas after acclimatization in high altitude for ten months (Bharadwaj, 1972). The lower average values in the sample from near Lahore, compared to that of the Punjabis from Chandigarh may be attributed to the rural component in the former data. Underwood et al (1967) have obtained an average about 7.5 mm only even in the men of the upper class in the Lahore study.

The tribal populations show lower amounts of subcutaneous fat than others. But the non-tribal Garhwali hillmen engaged in road construction work at the Himalayan foothills display thinner skinfolds than their co-workers from Dumka, Bihar, who belong to the agriculturist Santhal tribe. The average values for males of different age-groups from tribes of Arunachal Pradesh (cited in, Gopalan and Raghavan, 1971) range from 4.3 mm to 5.8 mm and those in females from 6.1 mm to 11.5 mm. The Onges of Little Andaman show a higher value than that of other food gathering tribes, due to their physiological adaptation to food scarcity through a high fat component in their body composition (Mukherjee 1977). The data from tribal women of East and

TABLE 1. *Mean triceps skinfold thickness in men from South Asia*

Country and State	Place	People	Age in years	n	m	Reference
INDIA						
West Bengal	Sodepur town	Bengali, Brahman and Kayastha (industrial family)	18—30 31—90	36 44	5.68 8.15	Present series
West Bengal	Mirpur village, Midnapore	Bengali, Christian (agriculturist)	adults	56	5.16	Gupta, 1979
Bihar	Dumka	Santhal tribe (road workers at Himalayan foot hills)	16—35	72	5.70	Gupta et al., 1977
Orissa	Koraput forest	Koya tribe (shifting cultivators)	24—45	184	4.80	Roy and Roy 1971
Orissa	Keonghar village	Juang tribe (shifting cultivator & food gatherers)	25—45	114 1) 2)	3.50 4.61	Roy, 1978
Andamans	Island	Onge tribe (food gatherers)	15+		5.90	Cited by Gopalan and Raghavan, 1971
Tamil Nadu	Madras	Tamilian (clerks)	20—55	318	10.40	Singh, 1975
Tamil Nadu	Ootacamund hill	Tamilian (clerks)	20—55	315	8.89	Singh, 1975
Uttar Pradesh	Himalayan foot hills	Garhwali (road workers)	16—35	72	4.50	Gupta et al., 1977
Ladakh	Ladakh	South Indians (soldiers)	18—30	28 a) b)	7.58 8.43	Bharadwaj, 1972
Ladakh	Ladakh	Gurkhas (soldiers)	18—30	35 a) b)	6.90 7.03	1972 1972
Punjab	Chandigarh	Punjabi students	20+	984	8.20	Berry, 1968
PAKISTAN	Lahore	Rural & urban	15—21	114	5.30	Underwood
			22—35	192	5.60	et al, 1967
			36—50	96	6.30	et al, 1967
			50+	103	5.80	et al, 1967
NEPAL	Khumbu, East Nepal	Sherpa (hill men agriculturist)	18—35	54	5.90	Sloan and
			36—50	36	5.50	Masali,
			51.—85	19	5.20	1978

The values at the begining (a) and end (b) of 10 months stay, and those in harvest (1) and lean season (2) are recorded.

TABLE 2. *Mean triceps skinfold thickenss in women from South Asia*

Country and State	Place	People	Age in Years	n	m	Reference
INDIA						
West Bengal	Sodepur	Bengali Brahman and Kayastha	18—30	43	14.15	Present series
			31—74	43	13.56	
West Bengal	Calcutta	Bengali, College girls	20—27	286	13.17	Sen, 1969
Orissa	Koraput	Koya tribe	20—40	150	7.10	Roy and Roy, 1971
Andamans	Island	Onge tribe, food gatherers	15+		11.60	Cited by Gopalan and Raghavan, 1972
Andhra Pradesh	Hyderabad	Chenchu tribe	adult 1)	62	7.05	
			2)	5	9.60	TCRTI, 1973
			3)	32	8.14	
Andhra Pradesh	Adilabad	Gond tribe	adult 1)	18	10.71	
			2)	35	10.17	TCRTI, 1973
			3)	15	9.53	
Andhra Pradesh	East & West Godavari district	All tribes	adult 1)	17	9.29	
			2)	48	9.91	TCRTI, 1974
			3)	43	11.60	
Delhi	Delhi	Indian	20—25	65	14.50	Raja et al., 1977
Delhi	Delhi	Punjabi	18—30	65	15.35	Satwanti et al., 1977
PAKISTAN	Lahore	Rural & Urban	15—21	133	10.80	Underwood et
			22—35	221	11.40	al., 1967
			36—50	107	12.90	al., 1967
			50+	88	11.10	al., 1967

(1), (2) and (3) denotes pregnant, Lactating and other women.

TABLE 3. *Yearly averages of triceps skinfold thickness in South Asian boys and girls aged 6 to 19 years*

	BOYS					GIRLS					
Age in years	Nilgiris, rural, Rao et al., 1954	Hyderabad, Well-off, Raghavan et al., 1974	Hyderabad, Low Socioecon, Raghavan et al., 1974	All India, Well off, NIN, 1977	Sodepur, 24 Parganas, Present series	Nilgiris, rural, Rao et al., 1954	Hyderabad, Well-off, Raghavan et al., 1974	Hyderabad, low socioecon. Raghavan et al, 1974	Delhi, Punjabi, middle class, Raja et al., 1978	Calcutta, Sen, 1969	Sodepur, 24 Parganas, Present Study
6	7.9	8.1	6.2	.	.	8.2	10.1	6.9	.	.	.
7	8.1	8.7	5.9			8.4	10.7	6.9			
8	7.8	8.7	5.7			8.0	10.7	6.5			
9	7.4	9.2	5.9			7.8	11.1	7.3		11.5	
10	7.8	9.5	5.9		5.0	8.4	11.2	7.1	8.4	9.2	8.6
11	8.0	9.6	5.8		4.1	8.2	11.2	7.4	9.3	10.5	6.0
12	8.0	9.8	6.2		4.9	8.1	12.8	7.7	9.3	10.2	6.6
13	7.9	9.5	6.5		4.8	8.1	13.2	8.2	11.7	11.7	10.0
14	7.3	9.1	6.0		5.6		13.7	9.6	13.9	12.4	8.1
15	7.6	9.0	6.3		5.2		14.1	10.5	13.8	12.5	10.8
16		9.2	6.0		4.2		14.4	10.2	16.6	12.7	11.4
17		9.3	6.1	9.9	6.2		13.5	8.6	12.3	12.6	12.0
18				10.5	6.2				11.9	12.8	17,5
19				10.5	5.7				14.3	12.7	16.0

West Godavari districts indicate a decline of upper arm fat in women during pregnancy and lactation (TCRTI, 1974). This, in the background of observed increase of adipose tissue in pregnant women as a store against demands of lactation (Davidson et al. 1975) may reflect undernutrition in these tribal women. The pregnant and lactating women among the Chenchu and Gond tribes living near Hyderabad, however, show higher values as expected.

The average value for adult males of a rural Bengalee sample from Midnapore district, not specified for age-range (Gupta, R. 1979) lie below that of the present urban series. The younger Bengalee women (18—30 years) of the present series who mostly remain at home, display a greater amount of upper arm fat on average than that of the Bengalee college women of about the same age group (20—27 years) of Calcutta (Sen 1969). Eating habits may account for such differences. For example, Farby (1967) found in Prague that those who ate three times a day were likely to be more obese than those who ate five or six times. Again, nibbling between meals rather than overeating contributes to obesity in many housewives engaged in cooking (Davidson et al. 1975). The adolescent and younger girls of the same series of Sodepur consistently display smaller averages for each year from 10—17 years *(Table 3)* than that of the urban Calcutta girls (Sen 1969) of similar age. But thereafter the trend is reversed. The comparison of yearly averages for preadolescent children and adolescents *(Table 3)* indicate an upward trend between 10 and 14 years in girls. A sharp rise of the value at about 13 years of age in middle class Punjabi girls may be related to a decline of body density (Raja et al. 1978). The same phenomenon is observed in the middle class Calcutta girls, and may occur earlier in upper class girls and later in poor girls of Hyderabad and present series.

A similar rise during this age is not observed in male samples. Some authors have noticed a fall in the value at about 15th and 16th years, during the adolescent spurt in European and American boys. But this is not clear in the Indian data. In the boys, belonging to poor families of Hyderabad and the present series, a low value is maintained up to 11 and 13 years in order, followed by an irregular increase. A reduced value in the Sodepur boys of 16 years apparently reflects a sampling error.

The age-specific averages of triceps skinfold thickness for South Asian children *(Table 3 and 4)* have been used for overall comparisons during particular periods of life, because, in the absence of sample size in some reports, errors of yearly estimates cannot be properly assessed. In this comparison, the data from the Nilgiris collected about a generation ago and before the standardisation of techniques (Tanner and Whitehouse 1962) show rather high values for hill children. About equally high values are detectable in infants of well-to-do urban families and of the Chenchu tribe of Hyderabad as also of the Gond tribe of Adilabad *(Table 4)* covered by supplementary nutrition and other welfare programmes. Only these four populations display gradual decline of the value from the first to the fifth year of age, especially in males, which in some European populations is attributed to excessive use of bottles and baby food (Tanner and Whitehouse 1975). In the children from Ludhiana and Bangladesh refugees there is a slightly higher vaue in the first than in the second year of age after which there is an upward trend as in most other South Asian samples. Otherwise, the observed trend of variation in adults holds good for the children as well. The lower values in Punjabi children from Ludhiana may be due to their rural background. There is no apparent sex difference up to 5 years of age except in the present series. Consequently, the average value of the Sodepur boys below 5 years is lower and that of the Sodepur girls of the same age a little higher than those reported from Calcutta (ICMR, cited in Gopalan and Raghavan 1971). But rural boys, presumably of the same age from Midnapore district, West Bengal (Gupta 1979) and children of Bangladesh refugees display still lower values.

As in almost all samples, the trends of age-changes in skinfold thickness in the present series become more consistent when data of five successive years are combined together. The mean value of triceps skinfold thickness in the present series decreases (significantly at 0.05 level of probability assumming normal distribution, which is not strictly applicable) in the females of 5—9 years age-group and less markedly in males of the 10—14 years age-group *(Table 5)*. Slight indications of decline of average values in successive years in girls of 5—9 years in the South Asian and most other data (Eveleth and Tanner 1976) suggest a universal feminine trend of a prepubertal recession of subcutaneous fat, which serves as a quick source of energy during adolescence stress. The lowest variability observed in the girls of this age-group *(Table 5)* reflects a uniformly low value of skinfold thickness in them.

An equally steep rise of the mean value is observed in the girls of 10—14 years which is also detectable in a few other published data (Eveleth and Tanner 1976). A universal phenomenon is the postpubertal gain at the age of about 15 years, which is more striking than the earlier rise of the value in the present series. The quantity of oestrogen which increases 20-fold following puberty caused increased deposition of fat in the breasts and the subcutaneous tissue in females (Guyton 1976). This phenomenon can be demonstrated by comparing the mean ages at menarche and at growth spurt of subcutaneous fat. For example, among the Kunbi girls of Central India the mean age at menarche is estimated to be 14.3 years and that of adolescent spurt in skinfold thickness between 14 to 15 years of age (Agarwal and Singh 1978). Therefore, the reported temporary check of the rise of upper arm fat (Tanner and Whitehouse 1962) in the adolescent females can be explained by the variation in pubertal age. The two-step rise instead of a gradual increase in the present series may, therefore, be related to the lower average menarcheal age of the Bengalee urban girls of the same endogamous groups (Sen 1953; Bardhan 1962; Bhattacharyya et al. 1977). The present series of data

TABLE 4. *Yearly averages of triceps skinfold thickness of South Asian children upto 5 years of age*

Place	People	Reference	Average age in Years							
			1	1.5	2	2.5	3	3.5	4	5
Pre-school boys										
Nilgiris	Hill	Rao et al., 1954			10.0		9.5		8.5	8.7
Vellore	urban	ICMR cited by Gopalan & Raghavan, 1971	6.0		6.5		7.2		7.2	
Hyderabad	urban	ICMR cited by Gopalan & Raghavan, 1971	6.8		7.1		7.6		7.3	
Hyderabad	Well off Well off	Rao et al., 1976	9.2	8.5	8.3		8.6 7.5		9.0 7.9	8.2 6.7
Hyderabad	rural	Rao et al., 1969	6.8	6.8	7.0	7.3	7.6		7.3	
Hyderabad	rural	Pratap and Rao, 1972	6.8		7.1		7.6		7.6	
Hyderabad	Chenchu tribe	Pratap and Rao, 1972	9.2		9.0		8.0		7.4	
Adilabad	Gond tribe	TCRTI, 1973				8.6		7.1		
Ludhiana	Punjabi, rural	Neumann et al., 1969	5.6		5.0		5.7			
Bhopal	urban	Bakshi & Bhandari, 1977	5.8	6.1	6.4	6.2	7.1	6.2	7.1	6.5
Calcutta	urban	ICMR cited by Gopalan & Raghavan, 1971	6.5		6.9		7.1		6.6	
Mirpur	rural	Gupta, 1979			*5.1					
Sodepur	urban	Present series				6.0				
West Bengal	refugee from Bangladesh	ICMR cited by Gopalan & Raghavan, 1971	5.1		4.6		5.4		5.7	5.6
Pre-school girls										
Nilgiris	Hill	Rao et al., 1954			9.4		6.2		5.9	5.1
Vellore	urban	ICMR cited by Gopalan & Raghavan, 1971	6.0		6.7		7.4		7.4	
Hyderabad	urban	ICMR cited by Gopalan & Raghavan, 1971	7.0		7.2		8.0		8.0	
Hyderabad	Well off	Rao et al., 1976	8.9	8.9	8.9		9.4		10.1	10.1
Hyderabad	rural	Rao et al., 1969	6.9	7.2	7.3		7.1		8.0	8.0
Hyderabad	rural	Pratap & Rao, 1972	70		7.2		8.0		8.0	
Hyderabad	Chenchu tribe	Pratap & Rao, 1972	8.0		9.9		8.0		9.7	
Adilabad	Gond tribe	Pratap & Rao, 1972 TCRTI, 1973				8.9		7.9		
Ludhiana	Punjabi, rural	Neumann et al., 1969	5.6		4.9		5.5			
Bhopal	urban	Bakshi & Bhandari, 1977	5.3	5.75		6.5	6.45	.	6.5	7.1
Calcutta	urban	ICMR cited by Gopalan & Raghavan, 1971	6.6		6.8		7.2		6.8	
Sodepur	urban	Present series				8.35				
West Bengal	refugee from Bangladesh	ICMR cited by Gopalan & Raghavan, 1971	5.1		4.6		6.0		6.0	6.0

* Age not specified.

TABLE 5. *Mean triceps skinfold values (mm) in different age-groups in the Bengali sample from Sodepur*

Age in Years	n	Male Mean ± se	SD	n	Female Mean ± se	SD
0—4	8	6.03±0.52	1.48	8	8.35±0.66	1.57
5—9	15	5.98±1.85	1.85	14	6.00±0.27	0.99
10—14	19	4.88±0.22	0.98	22	8.37±0.57	2.68
15—19	14	5.46±0.29	1.09	14	13.04±1.12	4.20
20—24	18	5.01±0.34	1.44	21	13.37±0.88	4.05
25—34	18	6.56±0.62	2.64	28	14.63±1.32	6.99
35—44	14	9.67±0.85	3.19	14	12.37±1.39	5.22
45—54	10	7.72±1.59	5.02	9	14.61±1.73	5.19
55—64	6	6.81±1.04	2.56	8	12.25±1.13	3.20
65—74	2	9.52±0.08	0.18	3	12.78±3.78	6.56
75—84	2	11.17±2.16	4.31			
85—94	1	5.08±0.0	0.0			

TABLE 6. *Trends of age changes in triceps skinfold thickness in the Bengali sample from Sodepur and some quartile values*

	Age in Years					
	0—4	5—9	10—14	15—34	35—54	55+
MALE						
n	23		19	50	24	11
m	6.0		4.9	5.7	8.9	7.9
SD	1.7		1.0	2.0	3.9	3.0
1st Quartile	3.7		3.3	3.4	4.2	4.8
Median	5.1		4.1	4.3	7.5	7.2
3rd Quartile	6.2		4.9	5.4	10.5	8.7
FEMALE						
n	8	14	22	63	22	12
m	8.3	6.0	8.4	13.8	13.4	12.2
SD	1.6	1.0	2.3	5.6	5.3	3.9
1st Quartile			5.5	8.8	8.3	8.4
Median	7.75	5.12	7.0	12.3	11.0	10.7
3rd Quartile	8.27	6.05	8.6	16.1	16.0	14.2

do not show any regular trend of increase of values in women during the subsequent years.

But discounting the irregular rise of the mean value due to a few women of 45—54 years, a gradual increase of the means and variances can be traced until below 35 years, and a depletion of fat inferred from the fifth decade of age. In fact, the onset of old-age depletion which is marked from the sixth decade in the present series widely varies in different populations. Occasional disturbances in the trend of the age-curve may reflect occasional inclusion of obese subjects.

In males there is a slower rate of change of mean values through the years than in females *(Table 3 to 5)*. A very mild trend of decline sets in at about 5 years of age, as noticed in some other data. But in this series the trend reaches its minima during 10—14 years *(Table 5)*, the pubertal age for most of the boys, and more particularly between 11 to 13 years *(Table 3)*. However, a low value in the earlier ages is more easily detectable in the published data of yearwise means. The period of fat depletion before or during puberty in boys may be related to the variability in their physiological age in different populations. A gradual increase of values at a slow rate from after the pubertal age until about the middle of the fourth decade of life followed by a significant rise characterises the age distribution of triceps skinfolds in the males of this series. An old-age decline in males as well can be traced from the next age decade of 45—54 years onwards, ignoring small sampling fluctuations in older ages. This broadly corresponds to the observed increase in ratings of fat and muscle with decrease in that of bones until the fifth decade of life when the trend is reversed (Bharadwaj and Pichan, 1966). There is no exact correspondence between the trends of age-sex variation in triceps skinfold thickness and haemoglobin levels in the present series of data (Das and Mukherjee 1978a, b, d). This agrees with data obtained in Ten State Nutrition Survey in USA (Guthrie and Guthrie 1976).

The apparent trends of age-sex variation indicated by mean values of five-yearly age-groups

are summarised by combining successive age-groups with small and irregular mean difference between them *(Table 6)*. For utilisation of these results as standards of reference for the upper caste Bengalee populations of relatively low economic status in an urban-industrial setting the medians and upper and lower quartile values for each period of life are obtained through graphical analyses.

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REFERENCES

AGARWAL P., SINGH R., 1978: Physical growth and age at menarche of Kunbi girls of Nagpur district. Abstract. *Xth International Congress of Anthropological and Ethnological Sciences*, Vol. 2, No. 1002.

ALBRINK M. J., MEIGS J. W., 1964: Interrelationship between skinfold thickness, serum lipids and blood sugar in normal men. *American Journal of Clinical Nutrition*, 15: 255—261.

BAKER P. T., DANIALS F. JR., 1965: Relationship between skinfold thickness and body cooling for two hours for 15 °C. *Journal of Applied Physiology*, 8: 409—416.

BAKSHI A. C., BHANDARI N. R., 1977: Assessment of nutritional status of pre-school chlidren in Bhopal. *Indian Pediatrics*, 14: 615—623.

BARDHAN A., 1964: A short note on the relationship between menarcheal age and certain anthropometric measurements of physique of the age 11 to 25 years. *Anthropologist*, 9: 25—30.

BARNICOT N. A., BENNET F. J., WOODBURN J. C., PILKINGTON R. E., ANTONIS A., 1972: Blood pressure and serum cholesterol in the Hadza of Tanzania. *Human Biology*, 44: 87—116.

BERRY J. N., 1968: Height and Weight of male college and polytechnic students in northern India. *Indian Journal of Medical Research*, 56: 1783—1799.

BERRY J. N., 1971: Skinfold thickness and obesity in male college and polytechnic students. *Indian Journal of Medical Research*, 59: 585—597.

BERRY J. N., 1974: Use of skinfold thickness for estimation of body fat. *Indian Journal of Medical Research*, 62: 233—239.

BHARADWAJ H., 1972: Effect of prolonged stay at high altitude on body fat content-an anthropometric evaluation. *Human Biology*, 44: 303—316.

BHARADWAJ H., PICHAN G., 1966: A study of the variation in body build with age, among the airforce ground duty personnel. In: *Human adaptability to environments and physical fitness*, (ed. Malhotra, M. S.) p. 290—296, Madras, Defence Institute of Physiology and Allied Science.

BHATTACHARYYA S., CHATTERJEE S., BHATTACHARYYA S. K., 1977: Menarcheal age in some endogamous groups of Bengal. *Journal of Indian Anthropological Society*, 12: 60—68.

CHEN K. P., DAMON A., ELLIOT O., 1963: Body form, composition and some physiological functions of Chinese in Taiwan. *Annals of New York Academy of Sciences*, 110: 760—777.

CHOUDHURY M. K., 1975: Nutritional profile of Calcutta pre-school children. I. Nutritional Anthropometry. *Indian Journal of Medical Research*, 63: 173—188.

COMMITTEE ON CALORIC REQUIREMENTS, 1957: *Caloric Requirements. Nutritional Studies*, No. 15, FAO, Rome.

DAMON A., 1965: Notes on anthropometric technic. Adult weight gain, accuracy of stated weight and their implications for constitutional anthropology. *American Journal of Physical Anthropology*, 23: 305—311.

DAMON A., DAMON S. T., HARPENDING H. C., KANNEL W. B., 1969: Predicting coronary heart disease from body measurements of Traningham males. *Journal of Chronical Diseases*, 2: 781—802.

DAS M. K., MUKHERJEE D. P., 1978a: Haemoglobin level with age, sex and OAB Blood groups in a Bengalee, sample. *Journal of Indian Anthropological Society*, 13: 71—79.

DAS M. K., MUKHERJEE D. P., 1978b: Physiological variations in a Bengalee population. Abstract. *Xth International Congress of Anthropological and Ethnological Sciences*, Vol. 3, No. 2007.

DAS M. K., MUKHERJEE D. P., 1978c: Quantitative variability of ABH antigens in a Bengalee sample. Abstract. *Xth International Congress of Anthropological and Ethnological Sciences*, Vol. 3, No. 2006.

DAS M. K., MUKHERJEE D. P., 1978d: Variation in haemoglobin level, body weight and skinfold thickness. *Abstract, Proceedings of the Vth Annual Conference of the Indian Society of Human Genetics*, Bombay.

DAVIDSON S., PASSMORE R., BROCK J. F., STRUSWELL A. S., 1975: *Human Nutrition and Dietetics*. Sixth edition, p. 290—291, New York. English Language Book Society and Churchill Livingstone.

EVELETH P. B., TANNER J. M., 1976: *World wide variation in human growth*. Cambridge. Cambridge University Press.

FARBY P., 1967: In: *Handbook of Physiology*, Section 6: Alimentary Canal, Volume 1, p. 31. Washington, American Physiological Society.

FERNANDEZ N. A., BURGOS J. C., PLOUGH I. V., ROBERTS L. J., ASENGO C., 1965: Nutritional status of people in isolated areas in Puerto Rico: Survey of Bario Mavilla, Vega Alta, Puerto Rico. *American Journal of Clinical Nutrition*, 17: 305—316.

FOLK G. E. JR., 1974: *Environmental Physiology*. 2nd edition, p. 152. Philadelphia, Lea and Febiger.

FRY E. I., CHANG K. S. F., LEE M. M. C., C. K. Ng., 1965: The amount and distribution of subcutaneous tissue in Southern Chinese Children from Hong Kong. *American Journal of Physical Anthropology*, 23: 69—80.

GARN S. M.,1962: The genetics of normal human growth. *Yearbook of physical anthropology*, 9: 291—310.

GLANVILLE E. V., GEERDINK R. A., 1970: Skinfold thickness, body measurements and age changes in Trio and Wajana Indians of Surinam. *American Journal of Physical Anthropology*, 32: 455—462.

GOPALAN C., RAGHAVAN K. V., 1971: *Nutritional Atlas of India*, National Institute of Nutrition, Hyderabad, India.

GUPTA M. C., RAMCHANDRAN K., TANDON B. N., MITHAL S., 1977: A health and nutrition survey of heavy manual workers. *Indian Journal of Medical Research*, 66: 244—252.

GUPTA R., 1979: A study on bilateral asymetry in skinfold thickness measurements. Calcutta, Indian Statistical Institute, *Technical Report No. Anthrop* (1) 79.

GUTHRIE H. A., GUTHRIE G. M., 1976: Factor analysis of nutritional status data from ten state nutrition survey. *American Journal of Clinical Nutrition*, 29: 1238—1241.

GUYTON A. C., 1976: *Textbook of Medical Physiology*. W. B. Saunders Company. Philadelphia, pp. 1092—1093.

HOWELLS W. W., 1966: Variability in family lines Vs Population variability. *Annals of New York Academy of Sciences*, 134: 624—631.

HUIZINGA J., 1977: A comparative survey of African people living in the northern semiarid zone: a search for a base line. In: *Population structure and human variation*, (ed. Harrison, G. A.) pp. 241—271. Cambridge University Press. IBP.

HUIZINGA J., REINGNDERS B., 1974: Skinfold thickness and body fat in adult male and female Fali (North Cameroon). *Proceedings of Koninklijke Nederlandse Akademie Van Wettenschappen*. C. 77: 496—503.

JANES M. D., 1974: Physical growth of Nigerian Yoruba Children. *Tropical and Geographical Medicine*, 26: 389 to 398.

JELLIFFE D. B., BENNETT F. J., STROUD C. E., NOVOTNY M. E., KARRACH H. H., MUSOKE L. K., JELLIFFE E. F. P., 1961: Field survey of the health of Bachinga Children in the Kayonza district of Kigezi, Uganda. *American Journal of Tropical Medicine and Hygiene*, 10: 435.

JELLIFFE D. B., 1966: *The assessment of the nutrition status of the community*. With special reference to field Surveys in developing regions of the World. World Health Organisation, Monograph series. 53.

JOHNSTON F. E., GINDHART P. S., JANTZ R. L., KENSINGER M. K., WLAKER G. F., 1971: The anthropometric determination of body composition among the Peruvian Cashinahua. *American Journal of Physical Anthropology*, 34: 409—416.

JOHNSTON F. E., HAMILL P. V. V., LEMESHOW S., 1974: Skinfold thickness in a national probability sample of US males and females aged 6 through 17 years. *American Journal of Physical Anthropology*, 4P: 321—324.

JOHNSTON F. E., HAMIL P. V. V., LEMESHOW S., 1974: *Skinfold thickness of youths 12--17 years*. United States, Washington, D.C., National Centre for Health Statistics, Series 11, 132.

JOHNSTON F. E., KIGNEY Mc. J. I., HOPWOOD, SMELKER J., 1978: Physical growth and development of urban native Americans: a study in urbanization and its implications for nutritional status. *American Journal of Clinical Nutrition*. 31: 1017—1027.

KRZYWICKI H. J., FRANK C., CONSOLAGIO, MATOUSH L. R., JOHNSON H. L., BARNHART R. A., 1969: Body composition changes during exposure to altitude. *Fed. Proc. 28:* 1190—1194.

MALINA R. M., 1966: Patterns of development in skinfolds of Negro and White Philadelphia Children. *Human Biology*, 38: 89—103.

MONTOYE J. J., EPSTEIN F. H., KJELSBERG M. O., 1965: The measurement of body fatness. *American Journal of Clinical Nutrition*. 16: 417—427.

MUKHERJEE D. P., 1977: Some Biological dimensions of Tribal Economy in India. *Proceedings of the seminar on Tribal Economy*, Calcutta.

MUKHERJEE D. P., SAHA K. C., 1970: Dermatoglyphics in normal Bengalee population. *Journal of Indian Medical Association*, 54: 405—414.

NAGAMINE S., SUZUKI S., 1964: Anthropometry and body-composition of Japanese young men and women. *Human Biology*, 36: 8—15.

NEUMANN C. G., HARISHANKER N., BEROI I. S., 1969: Nutritional and anthropometric profile of young rural Punjabi Children. *Indian Journal of Medical Research*, 57: 1122—1149.

PETT L. B., OGILVIE G. E., 1956: The Canadian Weight — height Survey, *Human Biology*, 28: 1977—1988.

PICON-REATEGUI E., LOZANO R., VALIDI-VIESO J., 1961: Body composition at sea level and at high altitudes. *Journal of Applied Physiology*, 16: 589—592.

PRATAP D. R., RAO V. V. R., 1972: The nutrition status of the preschool children, pregnant and lactating mothers among Chenchus. *Tribal Affairs*. Tribal Cultural Research and Training Institute, A. P. Hyderabad, Mineographied.

RAGHAVAN V. K., SINGH D., SWAMINATHAN M. C., 1974: Arm Circumference and fat fold at triceps in well-nourished Indian school Children, *Indian Journal of Medical Research*, 62: 994—1061.

RAJA C., SINGH R., BHARADWAJ H., 1977: Anthropometric determination of body volume, body density and segmental volume in adult Indian Women. *Annals of Human Biology*, 4: 565—575.

RAJA C., SINGH R., BHARADWAJ H., SINGH I. P., 1978: Relationship of extremity volumes with total body volume and body density of young Indian girls. *Human Biology*, 50: 103—113.

RAO N. P., SINGH D., SWAMINATHAN M. C., 1969: Nutritional status of pre-school children of rural communities near Hyderabad city. *Indian Journal of Medical Research*, 57: 2132—2146.

RAO S. K., TASKAR A. D., RAMANATHAN M. K., 1954: Nutrition and haemeglobin surveys in children in Nilgiris district, *Indian Journal of Medical Research*, 42: 55—70.

RAUH J. L., SCHUMSKY D. A., 1968: An evaluation of triceps skinfold measures from urban school children. *Human Biology*, 4: 363—374.

ROBSON J. R. K., BAZIN M., SODERSTROM R., 1971: Ethnic differences in skinfold thickness. *American Journal of Clinical Nutrition*, 24: 864—868.

ROCHE A. F., CAHN A., 1962: Subcutaneous fat thickness and caloric intake in Melbourne children. *Medical Journal of Australia*, 1: 595—597.

RONA R. J., ALTMAN D. G., 1977: National study of Health and Growth: Standards of attained height, and skinfold in English children 5—11 years old. *Annals of Human Biology*, 4: 501—523.

RÖSING F. W., 1977: Anthropometry in six tribal populations in Angola. *Zeitschrift für Morphologie und Anthropologie*, 68: 107—122.

ROY J. K., 1978: Upper arm skinfold thickness as a measure of nutriture: study on grossly under-fed tribal group. *Journal of Indian Anthropological Society*, 13: 47—56.

ROY J. K., ROY B. C., 1971: Diet and nutritional anthropometry of the Koya, an aboriginal tribe of Orissa. *Bulletin of Anthropological Survey of India*, 20: 55—68.

SATWANTI H., BHARADWAJ J., SINGH I. P., 1977: Relationship of body density to body measurements in young Punjabi women: Applicability of body composition prediction equiations developed for women of European descent. *Human Biology*, 49: 203—213.

SELTZER C. C., MAYER J., 1965: A simple criterion for obesity, *Postgraduate Medicine*, 38: 101—107.

SEN R. N., NAG P. K., ROY G. G., 1977: Some anthropometry of people of Eastern India. *Journal of Indian Anthropological Society*, 12: 199—206.

SEN T., 1953: Reproductive life of some Indian women. *Man in India*, 33: 31—54.

SEN T., 1969: Subcutaneous fat of the Bengali school and college girls. *Journal of Indian Anthropological Society*, 4: 31—42.

SHEPHARD R. J., HATCHER J., RODE A., 1973: On the body composition of Eskimos. *European Journal of Applied Physiology*, 32: 3—15.

SHEPHARD R. J., 1974: Work physiology and activity patterns of circumpolar Eskimos. *Human Biology*, 46: 203—294.

SINGH R., 1975: Nutritional anthropometric measurements of male Tamil Clerks in Madras (sea coast plains) and Ooty (hills). *Annals of Human Biology*, 2: 301—304.

SIRI W. E., REYNAFARJE C., BERLIN N. I., LAWRENCE J. H., 1954: Body water at sea level and at altitude. *Journal of Applied Physiology*, 7: 333.

SLOAN A. W., WIR J. B. de V., 1970: Nomograms for prediction of body density and total body fat from skinfold measurements. *Journal of Applied Physiology*, 28: 221—222.

SLOAN A. W., MASALI M., 1978: Anthropometry of Sherpa men. *Annals of Human Biology*, 5: 453—458.

SURKS M., KENNETH I., CHINN S. K., MATOUSH L. R. O., 1966: Alterations in body composition in man after acute exposure to high altitude. *Journal of Applied Physiology*, 21: 1741—1746.

TANNER J. M., WHITEHOUSE R. H., 1962: Standards for subcutaneous fat in British Children. *British Medical Journal*, 1: 446—450.

TANNER J. M., WHITEHOUSE R. H., 1975: Revised standards for triceps and subscapular skinfolds in British Children. *Archives of Disease in Childhood*, 50: 142 to 145.

TRIBAL CULTURAL RESEARCH AND TRAINING INSTITUTE GOVT. OF A. P. HYDERABAD (TCRTI), 1974: *Impact of special nutrition programme on the Tribals*

of East and West Godavari districts. Research Report No. 14.
UNDERWOOD B. A., HEPNER R., CROSS E., MIRZA A. B,. HAYAT K., KALLUE A., 1967: Heigth, weight and skinfold thickness data collected during a survey of rural and urban populations of West Pakistan. *American Journal of Clinical Nutrition.* 20: 694—701.
VISWESWARA RAO K., SINGH D., 1970: An evaluation of the relationship between nutritional status and anthropometric measurements. *American Journal of Clinical Nutrition,* 23: 83—93.
WHITE R. M., 1963: Skinfold Thickness measurements. In: *Anthropometric survey, of Turkey, Greece and Italy,* (eds Hertzberg, H. T. E., E. Churchil, C. W. Dupertuis, R. M. White and A. Damon). Pergamon Press, Oxford.
WIENER J. S., LOURIE J. A., 1969: *Human Biology: a guide to field methods.* Oxford and Edinburgh: Blackwell.
YOUNG C. M., MARTIN M. E. K., TENSUAN R., BLOUDIN J., 1962: Predicting specific gravity and body fatness in young women. *Journal of American Dietetrics Association,* 40: 102—107.
YOUNG C. M., BLOUDIN J., TENSUAN R., FRYER J. H., 1963: Body composition studies of "Older" women, thirty to seventy years of age. *Annals of the New York Academy of Sciences,* 110: 589—607.

M. K. Das
Dr. D. P. Mukherjee
School of Anthropology
Anthropological Survey
of India
27 Jawaharlal Nehru Road
Calcutta — 700 016
India