Skinfold Thicknesses at Seven Sites in Rural Guatemalan Ladino Children Birth Through Seven Years of Age[1]

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ABSTRACT

Age changes and sex differences for seven skinfolds are reported for a mixed longitudinal sample of 1,119 rural Guatemalan Ladino children birth through seven years of age. For this mixed longitudinal sample, there are approximately 5,030 observations for the triceps and subscapular skinfolds and approximately 2,055 observations for the biceps, midaxillary, anterior thigh, lateral thigh and calf skinfolds. All seven skinfolds increase sharply in thickness between birth and 3-6 months of age, followed by a decrease to 18-21 months. The increase in fat thickness during the first six months is less than that reported for well nourished children. After 21-24 months of age, skinfold thicknesses in five of the seven sites increase, while the remaining two level off. Sex differences in skinfold thicknesses are variable between birth and four years, being more apparent in the two thigh skinfolds. After four years of age, girls have thicker skinfolds. Rural Guatemalan children have smaller skinfolds than samples of well nourished children. Factors that may be related to these observations are discussed.

The adequacy of weight and height as indicators of growth and nutritional status of young children in developed and developing countries is reasonably well established. Such measures of gross body size and mass, however, provide little specific information on the composition of the body, which is frequently viewed in terms of leanness and fatness (Malina, 1969). To this end, skinfold thicknesses taken at a variety of body sites are used widely as measures of subcutaneous fatness. Body fat varies considerably with nutritional status, and its measurement provides an estimate of calorie reserve available to the individual.

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Hence, the study of skinfold thicknesses in populations living under variable nutritional circumstances has received much attention. Representative skinfold data for example, are available for school age children from a variety of ethnic groups the world over (Hammond, 1955; Pett and Ogilvie, 1956; Fry, 1960; Wadsworth and Lee, 1960; Ferro-Luzzi, 1962; Ferro-Luzzi and Ferro-Luzzi, 1962; Roche and Cahn, 1962; Tanner and Whitehouse, 1962; Nagamine et al. 1963, 1964; Robson, 1964; Fry et al. 1965; Malina, 1966, 1971; Frisancho and Baker, 1970; Jenicek and Demirjian, 1972; Johnston et al. 1972; Malina et al. 1972). Such information for preschool children (birth to 5 or 7 years) in developing areas of the world is, however, limited. Some observations have been made on Asiatic Indians (Goel and Kaul, 1971), Surinam Indians (Glanville and Geerdink, 1970), Australian aborigines (Abbie, 1967), Papuans and New Guineans (Jansen, 1963; Malcolm, 1969, 1970a, 1970b), Colombians (Mora Parra et al. 1970), Nigerians (Rea, 1971), Caribbean Negroes (Robson et al., 1971), and Ethiopians (Belew et al. 1972). More recently, triceps skinfold measurements have been used in conjunction with arm circumference to provide an estimate of arm muscle circumference as an index of protein-calorie malnutrition (Jelliffe, 1966; Jelliffe and Jelliffe, 1969). In many of the cited studies sample sizes are small and age categories are disparate. Since the subcutaneous fat composition of the body is undergoing rapid changes early in life, grouping children into rather broad age categories, e.g., birth to 5 months, 6 to 12 months, 1 to 2 years, etc., may mask the true variability and change in the development of subcutaneous fatness during infancy and early childhood. It likewise limits the value of sample comparisons at these ages, especially in field studies of nutritional status. There is a need for data collected at frequent intervals during infancy and early childhood. In this report, age changes and sex differences for seven skinfolds in a mixed longitudinal sample of preschool rural Guatemalan Ladino children living under conditions of mild to moderate protein-calorie malnutrition are presented.

Methods

The data presented here are mixed longitudinal observations on 1,119 clinically normal rural Guatemalan Ladino children, under study by the Division of Human Development of the Institute of Nutrition of Central America and Panama (INCAP). Medical examinations of all children established their clinical normality. It should be noted, however, that mild to moderate protein-caloric malnutrition is endemic in this population (Habicht et al. 1973). The sample comprises approximately 84% of all children who were 0 to 84 months of age within the period of January, 1969 through May 1, 1972, in four villages in the department of El Progreso[4] northwest of Guatemala City. The villages are on the Atlantic slopes of the Guatemalan highlands at altitudes between 300 meters and 1,100 meters.

The study sample are participants in a longitudinal supplementation program to elucidate the effects of improved nutrition on mental development (Klein et al. 1973), so that the nutritional and health standards of this village are better than the average in rural Guatemala. Medical care provided to the villages has altered the high mortality and morbidity figures so that the skinfold data may be viewed as typical of the growth of children in clinically good health but suboptimal nutritionally (Habicht et al. 1973). No consistent differences were apparent in a variety of anthropometric dimensions of children in the four villages; hence, data from the four villages were pooled for the present report.

All measurements were taken by a trained and standardized anthropometrist, using a Harpenden skinfold caliper. Seven skinfolds were measured at the following sites:

(a) Triceps—measured over the triceps muscle midway between the acromial and olecranon processes. The measurement site was located by placing the middle fingers of each hand on the acromial and olecranon landmarks respectively and then estimating the midpoint with the extended thumbs. This method was quicker and more reliable than locating the midpoint by measurement.

(b) Biceps—measured over the biceps muscle at the same level as the triceps skinfold landmark.

(c) Subscapular—measured one centimeter below the inferior angle of the scapula.

(d) Midaxillary—measured at the level of the xiphoid in the midaxillary line. This was the same level at which chest circumference was measured.

(e) Anterior Thigh—measured midway between the greater trochanter and lateral condyle of the femur on the anterior aspect of the thigh. The measurement site was located in the same manner as that described for the triceps skinfold.

[4] None of these four villages in the present study have been previously studied by INCAP.

(f) Lateral Thigh—measured at the same level as the anterior thigh skinfold, but on the lateral aspect of the thigh.
(g) Calf—measured on the posterior aspect of the calf at the level of the maximum calf circumference.

All skinfolds were measured on the left side of the body with the child in a seated position. The measurement location for all skinfolds except the subscapular was marked on the child's body. All skinfolds were measured to the nearest 0.1 mm (Division de Desarrollo Humano, INCAP, 1971, Habicht, n.d.).

Measurement error standard deviations for each skinfold are presented in Table 1. Monthly standardization sessions were conducted

Table 1

Measurement Error Standard Deviation in Standardization Sessions and in the Field

Skinfold	n	Orphanage Replicates	Field Replicates (n = 146)	Estimated Within Child Variation
Triceps	117	0.47 mm	0.64 mm	0.43 mm
Biceps	97	0.26 mm	0.69 mm	0.64 mm
Subscapular	117	0.27 mm	0.34 mm	0.21 mm
Midaxillary	107	0.21 mm	0.41 mm	0.35 mm
Anterior thigh	97	0.62 mm	0.83 mm	0.55 mm
Lateral thigh	97	0.95 mm	0.98 mm	0.24 mm
Calf	92	0.27 mm	0.62 mm	0.56 mm

in a local orphanage, while field replicates were obtained on a random group of approximately 10% of the study sample, re-measured at a one week interval. In all instances the field measurement standard deviations were higher than the corresponding orphanage standardization values. This was not entirely unexpected because variability in the field situation included not only technical errors of measurement, but also day-to-day variations. The orphanage replicates, on the other hand, were completed on the same day; for these replicates measurement location marks were removed and then re-marked. Based upon the orphanage and field replicates, the weekly within child variation was estimated (Table 1). The results suggest that much of the variation in the skinfolds measured was due to fluctuations within the child rather than to the field measurement procedures per se.

Skinfolds were measured at birth or 15 days of age, and at 15 specific age intervals through 84 months. The permitted variation around the measurement intervals was ±3 days at 15 days of age, ±5 days from 3 through 24 months of age, and ±7 days from 30 through 84 months of age. Specific age intervals and sample size per age group are indicated later in the report. Triceps and subscapular skinfolds were measured since the beginning of the study, while the other five skinfolds were incorporated since April, 1971. Hence, the mixed longitudinal data on the study sample include approximately 5,030 observations for the triceps and subscapular skinfolds, and approximately 2,055 observations for the other five skinfolds.

Subsequent to measurement, skinfold values which were clearly unusual for the age of the child were discarded. The rate of discard was approximately 0.2%. In the latter stages of data collection for the study sample this procedure was subject to verification by re-measurement.

Throughout the report mean skinfold thickness rather than median is used, despite the existence of statistically significant skewing in older ages. We do this because absolute differences between means and medians are small (typically 0.1-0.2 mm), and the skew, though significant, is not large. Only in older girls (5-7 years) do skew values approach 2; otherwise, the values generally range between 0.5 and 1.2. Thus, procedures using means seem acceptable.

Results

Sample sizes per age group, means and standard deviations around the means, and medians for each skinfold in rural Guatemalan Ladino children birth through 7 years of age are presented in Tables 2 and 3 for boys and girls respectively. Age trends are illustrated for each skinfold in Figures 1 through 4.

All skinfolds show a rapid increase in thickness from birth or 15 days to 3 months of age. With the exception of the biceps and calf skinfolds which show a continued increase to 6 months, the five other skinfolds decrease in thickness slightly to 6 months of age. From 6 to 18-21 months of age, all seven skinfolds decrease in thickness, the slope of decrease being especially marked between 6 and 12 months. Five of the seven skinfolds, the triceps, biceps, subscapular, axillary and lateral thigh, then show a general increase in thickness between 21 and 36-42 months of age. During this same time, the calf and anterior thigh

Table 2

Skinfold Thickness in Rural Guatemalan Ladino Boys

Age Group	Triceps				Biceps				Subscapular				Midaxillary				Anterior Thigh				Lateral Thigh				Calf			
	n	X	sd	Md	n	X	sd	Md	n	X	sd	Md	n	X	sd	Md	n	X	sd	Md	n	X	sd	Md	n	X	sd	Md
Birth	29	4.5	1.0	4.4					29	4.4	1.2	4.4																
15 days	118	4.7	1.1	4.7	71	4.2	0.9	4.2	118	5.4	1.2	5.2	71	4.1	1.0	4.0	71	6.9	1.8	6.5	71	8.1	3.0	7.4	71	6.1	1.6	6.1
3 months	208	7.4	1.7	7.1	80	6.2	1.3	6.1	207	7.1	1.5	7.1	80	6.1	1.5	5.9	79	12.4	2.8	12.4	80	13.7	3.1	14.1	79	10.2	2.1	10.3
6 months	195	7.2	1.9	6.9	71	6.3	1.4	6.1	195	6.7	1.5	6.5	72	5.4	1.2	5.1	72	12.3	2.2	12.1	72	12.8	2.5	12.5	72	10.5	1.8	10.5
9 months	192	6.6	1.8	6.2	76	6.1	1.3	6.0	192	6.2	1.4	6.1	76	4.8	1.0	4.7	76	11.4	2.2	11.3	76	11.6	2.2	11.3	76	9.9	1.8	9.7
12 months	188	6.3	1.6	6.1	80	5.6	1.1	5.4	188	5.7	1.1	5.6	80	4.4	1.0	4.3	80	9.8	2.0	9.9	80	10.4	1.9	10.2	79	8.9	1.6	8.8
15 months	185	6.1	1.6	5.9	74	5.5	1.1	5.3	185	5.4	1.1	5.2	74	4.2	0.8	4.1	74	9.3	1.8	9.0	74	9.7	1.8	9.4	74	8.2	1.6	7.8
18 months	178	6.1	1.6	5.9	76	5.3	1.0	5.1	178	5.2	1.1	5.1	76	4.1	0.9	4.1	76	8.6	1.9	8.1	76	9.5	1.9	9.1	76	7.7	1.4	7.5
21 months	165	6.1	1.5	5.9	69	5.4	1.1	5.1	166	5.1	1.0	4.9	69	4.2	0.8	4.0	68	8.2	1.6	7.9	69	9.3	1.6	9.3	69	7.2	1.5	7.1
24 months	182	6.3	1.5	6.1	76	5.8	1.3	5.7	182	5.2	1.0	5.1	76	4.4	1.1	4.1	76	8.3	1.8	8.1	76	9.8	2.1	9.3	76	7.4	1.4	7.3
30 months	165	6.7	1.6	6.4	61	6.2	1.2	6.1	165	5.3	1.1	5.1	61	4.6	1.3	4.3	61	8.2	1.7	8.0	61	11.0	1.8	10.7	61	7.3	1.2	7.1
36 months	170	6.8	1.6	6.7	65	6.0	1.0	6.1	170	5.3	1.1	5.2	65	4.3	1.1	4.1	64	8.4	1.8	8.0	65	11.3	1.8	11.4	65	7.2	1.4	6.9
42 months	167	7.0	1.9	6.8	64	6.0	1.3	5.9	166	5.2	1.0	5.1	64	4.4	1.0	4.1	64	8.2	1.7	7.9	64	11.3	1.8	11.3	64	7.1	1.4	6.9
48 months	160	6.5	1.4	6.3	57	5.9	1.4	5.6	160	5.3	1.0	5.1	57	4.3	1.1	3.9	57	7.4	1.8	7.0	57	10.7	2.3	10.7	57	6.7	1.4	6.5
60 months	145	6.0	1.5	5.7	58	4.9	1.3	4.5	145	4.8	0.8	4.7	58	3.7	0.8	3.5	58	6.2	1.5	6.1	58	9.0	2.1	8.5	58	5.7	1.2	5.6
72 months	128	5.3	1.4	5.0	59	4.2	0.8	4.1	128	4.5	0.6	4.4	59	3.4	0.6	3.3	59	5.9	1.5	5.7	59	8.2	1.9	8.0	59	5.3	1.1	5.1
84 months	116	5.1	1.5	4.7	44	4.0	0.9	3.9	118	4.6	0.8	4.5	44	3.3	0.6	3.2	44	5.2	0.9	5.1	44	7.3	1.8	6.9	44	5.0	1.1	5.2

Table 3

Skinfold Thickness in Rural Guatemalan Ladino Girls

Age Group	Triceps				Biceps				Subscapular				Midaxillary				Anterior Thigh				Lateral Thigh				Calf			
	n	X	sd	Md	n	X	sd	Md	n	X	sd	Md	n	X	sd	Md	n	X	sd	Md	n	X	sd	Md	n	X	sd	Md
Birth	16	4.7	0.9	4.6					16	4.3	0.8	4.2																
15 days	108	4.9	1.1	4.9	66	4.1	0.7	4.1	108	5.6	1.2	5.7	66	4.2	1.1	3.9	66	7.6	2.1	6.9	66	8.4	2.4	7.7	66	6.2	1.6	6.0
3 months	165	7.3	1.8	7.1	72	6.3	1.3	6.1	165	7.2	1.7	7.2	71	6.3	1.6	6.4	70	13.2	2.6	13.1	72	14.5	2.8	15.0	72	10.4	1.9	10.3
6 months	159	7.2	1.6	7.1	69	6.8	1.1	6.6	159	7.0	1.5	6.9	68	5.6	1.2	5.5	69	13.0	2.2	13.1	69	13.6	2.1	13.3	68	10.6	1.8	10.3
9 months	160	6.6	1.6	6.4	73	6.3	1.1	6.3	159	6.4	1.5	6.3	73	5.2	1.2	4.9	73	11.1	2.2	10.9	75	11.7	2.3	11.7	73	9.9	1.7	9.9
12 months	154	6.3	1.5	6.2	68	5.7	1.1	5.7	154	5.9	1.5	5.8	68	4.5	1.1	4.3	68	10.3	2.0	10.1	68	10.6	2.0	10.3	68	9.1	1.5	8.9
15 months	146	6.0	1.4	5.9	63	5.7	1.1	5.9	146	5.5	1.2	5.3	63	4.4	0.9	4.3	63	10.0	1.8	9.9	63	10.3	2.0	10.0	62	8.5	1.5	8.3
18 months	153	6.1	1.4	6.0	69	5.6	1.2	5.7	154	5.3	1.2	5.1	69	4.3	1.0	4.1	69	9.4	2.0	9.5	69	10.2	2.1	10.0	69	8.1	1.5	8.0
21 months	136	6.2	1.3	6.2	60	5.7	1.0	5.9	137	5.1	1.5	5.1	60	4.2	0.9	4.0	60	9.1	1.8	8.6	60	10.6	2.0	10.1	60	8.1	1.5	8.0
24 months	142	6.3	1.6	6.2	61	5.8	1.1	5.9	141	5.2	1.1	5.2	61	4.2	1.0	4.1	62	8.7	1.8	8.7	61	10.4	2.3	10.4	61	7.8	1.7	7.9
30 months	151	6.9	1.7	6.7	66	6.2	1.0	6.1	151	5.5	1.2	5.3	65	4.5	1.1	4.3	66	8.7	2.0	8.9	66	11.2	2.3	10.7	66	7.4	1.4	7.3
36 months	147	7.4	1.9	7.1	48	6.4	1.4	6.1	147	5.8	1.4	5.7	49	4.8	1.4	4.9	49	8.6	2.2	8.3	48	11.8	2.2	11.9	49	7.4	1.4	7.3
42 months	146	7.4	1.9	7.4	42	5.9	1.1	5.9	145	5.8	1.3	5.5	43	4.5	1.4	4.3	43	8.2	1.9	7.9	43	11.6	2.5	11.3	43	7.3	1.5	7.3
48 months	149	6.9	1.8	6.8	56	5.9	1.4	5.9	149	5.5	1.2	5.3	57	4.3	1.2	4.1	57	8.4	1.8	8.1	57	11.7	2.0	11.3	57	7.4	1.4	7.1
60 months	149	6.4	1.6	6.3	55	5.2	1.5	5.2	150	5.4	1.3	5.2	58	4.3	1.3	3.9	58	8.0	2.4	7.7	58	10.9	2.2	10.5	57	6.7	1.5	6.3
72 months	137	6.1	1.6	5.9	51	4.7	1.2	4.6	136	5.0	1.0	4.9	51	3.7	0.9	3.4	51	7.5	1.8	6.9	50	10.3	2.2	9.9	50	6.5	1.4	6.2
84 months	120	5.7	1.7	5.2	53	4.3	1.1	3.9	121	5.0	1.0	5.0	53	3.5	0.9	3.3	53	7.0	1.8	6.7	53	9.7	2.4	9.2	53	6.2	1.6	5.9

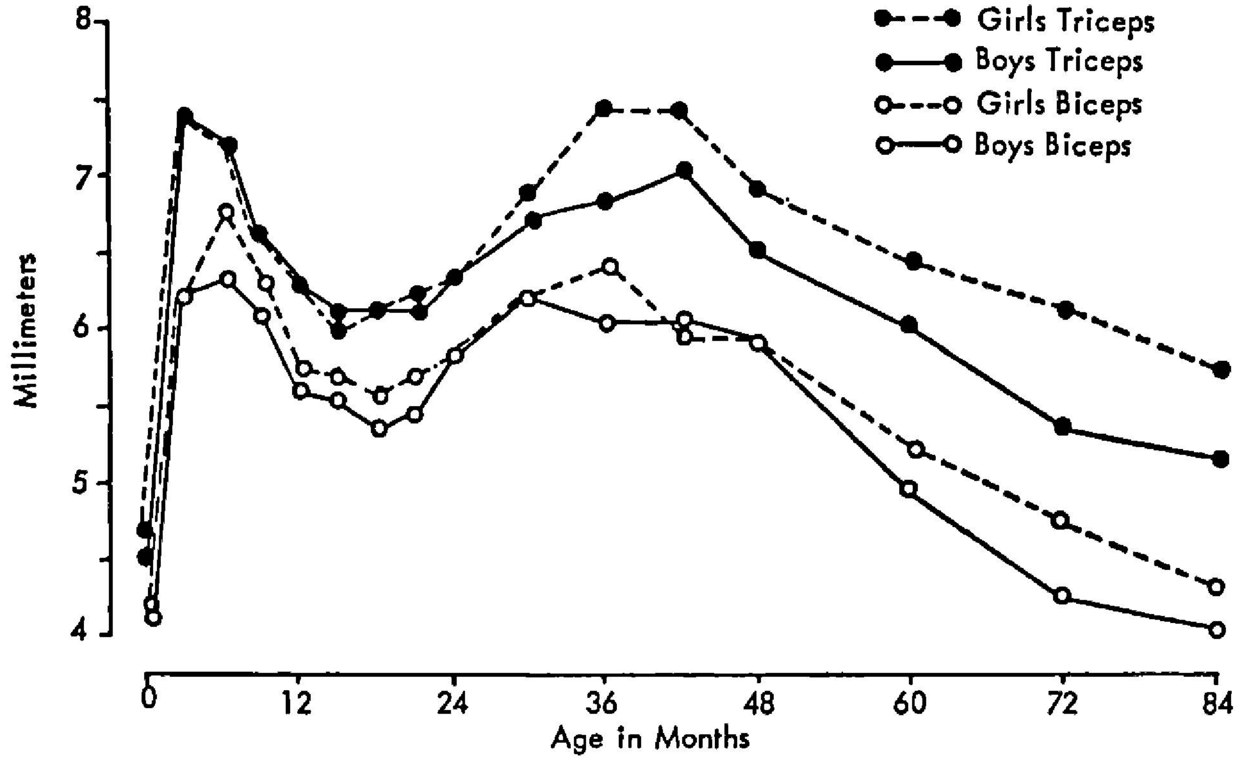

FIG. 1. Mean upper arm skinfold thickness in rural Guatemalan Ladino boys and girls.

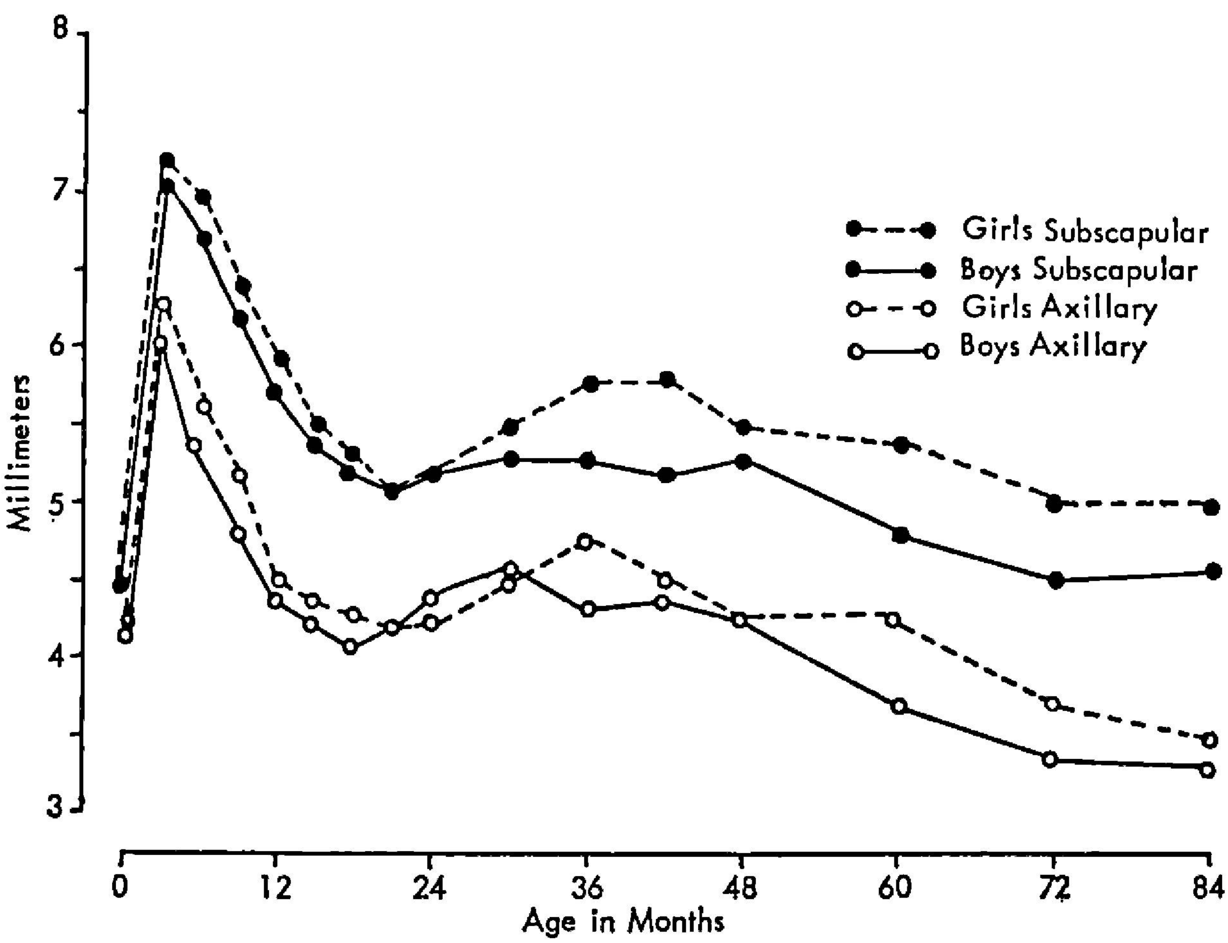

FIG. 2. Mean trunk skinfold thickness in rural Guatemalan Ladino boys and girls.

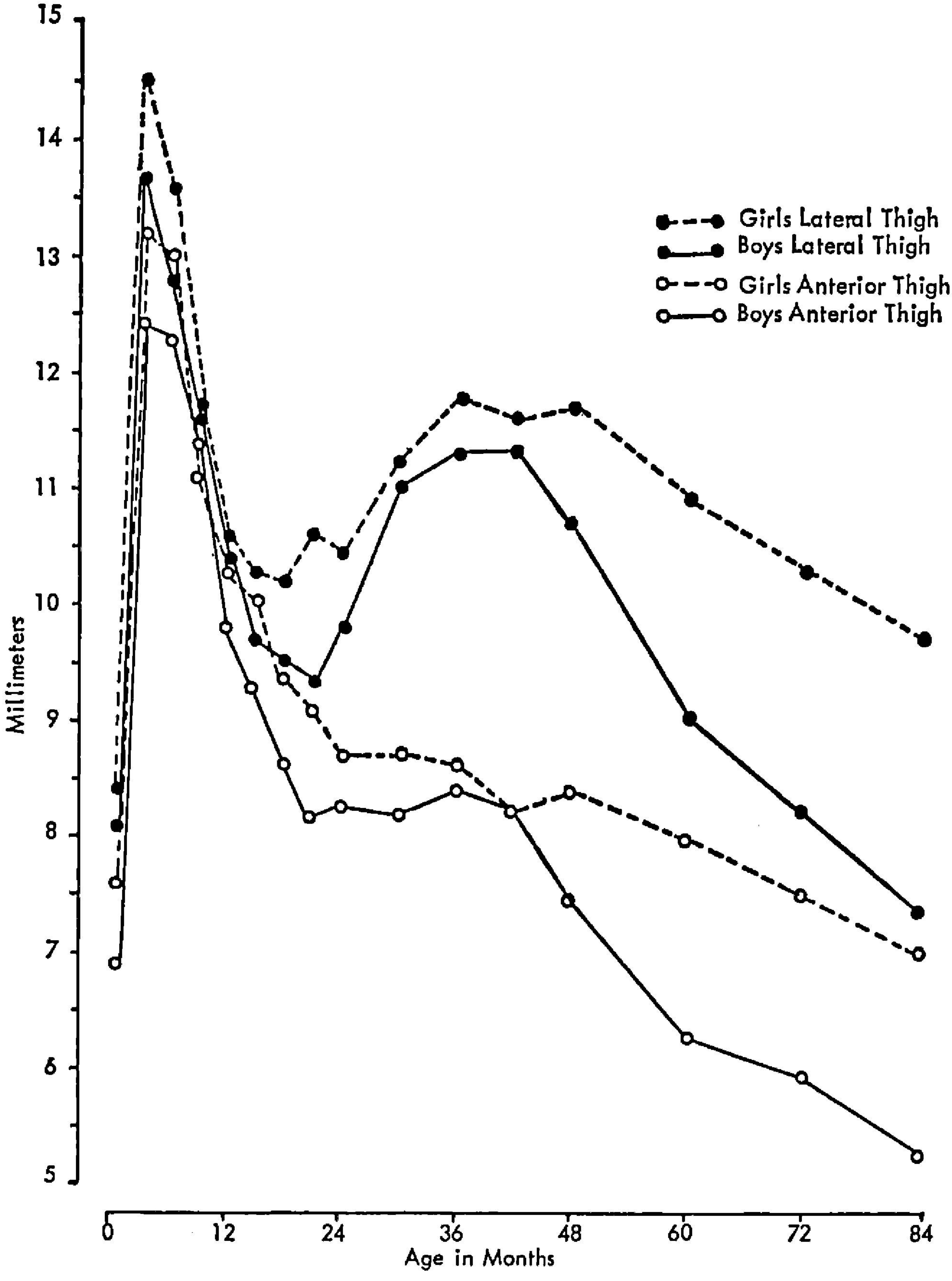

FIG. 3. Mean thigh skinfold thickness in rural Guatemalan Ladino boys and girls.

skinfolds show somewhat of a plateau. After 42 months of age in boys, all skinfolds show a steady decrease in thickness through 84 months. In girls, on the other hand, the tendency of skinfold thicknesses to decrease is apparent after 42 months only for the triceps skinfold, after

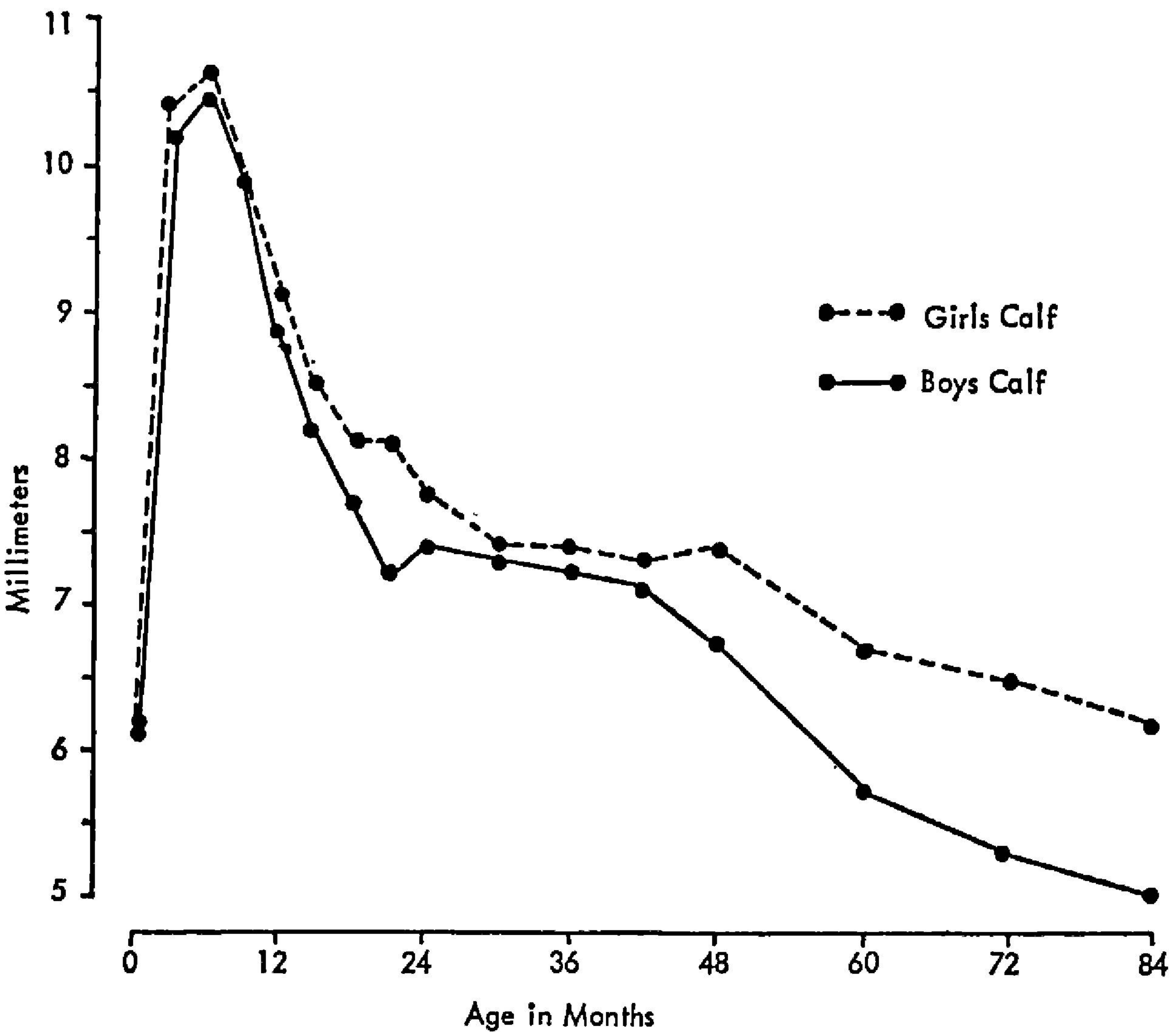

FIG. 4. Mean calf skinfold thickness in rural Guatemalan Ladino boys and girls.

48 months for the biceps, lateral thigh, anterior thigh and calf skinfolds, and after 60 months for the subscapular and axillary skinfolds. The general slope of the decrease in skinfold thicknesses at these ages is steeper for the five skinfolds on the extremities than for the two on the trunk, suggesting, perhaps, differential fat reduction on the extremities and trunk between 4 and 7 years of age.

Sex differences in skinfold thicknesses vary over age and with the specific measurement site (Figure 5). At the triceps and subscapular sites, for example, there are negligible sex differences until 24 months, after which girls, on the average, have thicker skinfolds through 7 years. The biceps and axillary skinfolds show variable sex differences through 4 years, after which girls have thicker skinfolds. With two exceptions, girls have, on the average, larger thigh skinfolds throughout, the sex differences being most marked at 4 years of age and older. A similar pattern is apparent for the calf skinfold, though sex differences

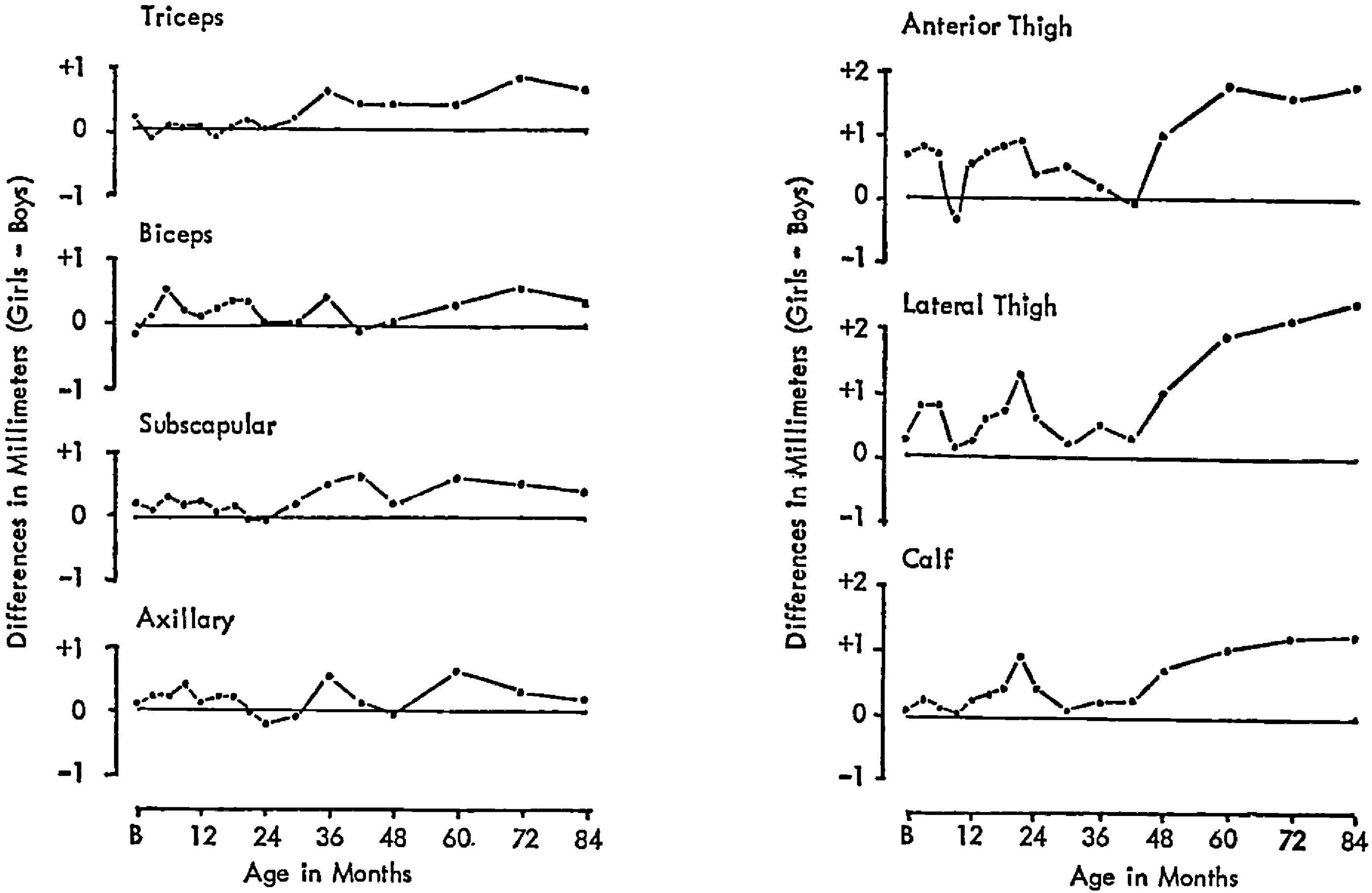

FIG. 5. Differences of average skinfold thicknesses between rural Guatemalan Ladino girls and boys.

are smaller and more variable than those for the thigh skinfolds prior to 4 years of age.

Discussion

The general pattern of age changes in subcutaneous fat development during infancy and early childhood of well nourished children is one of rapid rise from birth to 9-12 months, with a subsequent gradual decrease to 6-7 years of age (Hammond, 1955; Garn et al. 1956; Tanner and Whitehouse, 1962; Mora Parra et al. 1970). The fall after 12 months, however, is not necessarily smooth. In the present study sample, all seven skinfolds increased sharply in thickness between birth-15 days and 3-6 months of age, followed by a decrease to 18-21 months. The increase in fat thickness during the first six months of life is generally less than that reported for well nourished children. In the latter, subcutaneous fat thickness continues to increase until about one year of age, while in the present sample the fat gain falters at 3-6 months and gradually decreases throughout infancy. Thus, the decrease in subcutaneous fat appears to occur 3-6 months earlier than that generally reported. This probably reflects the caloric inadequacy of breast milk with insufficient food supplementation that is prevalent in the study villages from this age until weaning. The median age of weaning in the Guatemalan Ladino villages is 18 months, which corresponds quite well with the nadir of the dip in all the skinfolds at 18-21 months of age. Thus, infants in the present study gain slightly less fat during the first six months of life and begin to lose it earlier than better nourished children.

After weaning or at about 21-24 months of age, the Guatemalan data show a rise in five of the seven skinfolds until 42 months of age. During this time, the remaining two skinfolds tend to level off, not showing a decrease in thickness. The significance of this rise and/or plateau in skinfold thicknesses at these early childhood ages possibly reflects a shift in the limiting nutrients of the diet. After weaning in this population, the diet is limited in protein (Habicht et al. 1972, 1973), and excess calories will be laid down as fat instead of being used for growth, which is stunted because of protein deficiency. By about 42-48 months of age, the caloric excess over proteins relative to the growth needs of the children is less severe and the fat folds then show a parallel decrease described in well-nourished children.

The general pattern of a premature peak in skinfold thicknesses followed by a decrease and then a secondary peak is found in other data reported for preschool children in underdeveloped areas. Malcolm (1969, 1970a, 1970b), for example, reported an early reduction in subcutaneous fat at 3-6 months of age for small samples of New Guinea infants. However, only Malcolm's data for girls show a tendency for a slight increase in fat thickness after the early reduction. New Guinea boys, on the other hand, show a continuous decrease in fatfold thicknesses until 3-4 years of age. Rea (1971) reported a "recovery phase" in the growth of Nigerian children between 21 months and three years. During this time, the rate of growth exceeded the British norms. In Rea's sample, the mean triceps skinfold values move steadily towards and approximate the 50th percentile. In the Guatemalan Ladino children, the triceps skinfold values only approximate the 10th percentile of these ages. However, the subscapular skinfold values move steadily from the 25th percentile to the 50th percentile of the British standards between 24 and 36 months, and remain at the 50th percentile at 42 and 48 months. Similarly, the data of Robson et al. (1971) show an increase in the triceps skinfold thickness from 2 to about 4 years of age in Caribbean Negro children. Age changes in the subscapular skinfold did not show such a pattern; rather, this skinfold was somewhat stable over these ages.

Sex differences are apparent at some skinfold sites between birth and 4 years of age; nevertheless, the consistency and magnitude of these differences are variable. They tend to be more apparent in the anterior and lateral thigh skinfolds at these ages (Figure 5). From 4 through 7 years of age, however, girls have, on the average, thicker skinfold measurements at all sites. The sex differences at these ages are more marked in the three lower extremity skinfolds compared to the two upper extremity and two trunk skinfold measurements. The absolute magnitude of the sex differences in the two thigh skinfolds and the calf skinfold is approximately twice as large as those in the other sites. The pattern of sex differences between birth and 7 years of age is generally similar to that noted in other samples from both developed and developing areas of the world (Hammond, 1955; Tanner and Whitehouse, 1962; Abbie, 1967; Malcolm, 1969, 1970a, 1970b; Mora Parra et al. 1970). Nevertheless, it should be noted that most studies are limited to the triceps and subscapular skinfolds.

Data available for comparative purposes are derived to a large extent mostly from the triceps and subscapular skinfolds. Comparisons of skinfolds between different populations, however, is rendered difficult by the magnitude of error associated with skinfold measurement, by technician variability, by variation in skin compressibility, by variation among types of calipers used, as well as by the normal variation in fat thickness characteristic of growing children. Further, subcutaneous fat is one of the most variable components of the body's composition, being affected primarily by diet and physical activity. Hence, comparisons, though suggestive of absolute population differences, need to be interpreted with caution.

The mean skinfold thicknesses of the rural Guatemalan Ladino children are generally smaller than those of children in developed countries (Pett and Ogilvie, 1956; Roche and Cahn, 1962; Tanner and Whitehouse, 1962). They are likewise smaller than those of urban children in the upper socio-economic strata in developing countries (Mora Parra et al. 1970). The mean skinfold thicknesses of the Guatemalan sample are generally similar in magnitude to those of urban lower class children in Bogota (Mora Parra et al. 1970), Caribbean Negroes (Robson et al. 1971), and high altitude Andeans (Frisancho and Baker, 1970), while they are consistently higher than those of young children in New Guinea (Malcolm, 1969, 1970a, 1976b) and Papua (Jansen, 1963). In contrast, the mean skinfolds of the study sample are slightly smaller than those of very small samples of Australian aboriginal children (Abbie, 1967). Thus, variation among the mean skinfold thicknesses of the samples compared is considerable. This is particularly apparent among the children from developing areas of the world, who probably vary to a large extent in their nutritional status. Many of the preceding comparisons are further limited by sample size and age categories, especially at the younger ages. The children in the present study sample were seen within a few days of the ages indicated for specific age groups. In contrast, many studies group children as those five months and less, between 6 and 11 months, 1 to 2 years, etc.

The Tanner and Whitehouse (1962) standards for the triceps and subscapular skinfolds are, perhaps, the most widely used skinfold norms. Plotting the present mean values on the Tanner and Whitehouse standards for British children shows the INCAP children of both sexes to have triceps skinfolds that are between the 25th and 50th percentiles at 3 months, and generally at or below the 10th percentile between 6 months and 7 years. In contrast, the mean values for the subscapular skinfolds in both sexes approximate the 75th percentile of the British standards at 15 days, the 90th percentile at 3 months, and the 75th percentile at 6 months. From one through 7 years, the subscapular skinfold values vary between the 25th and 50th percentiles, approximating the 50th percentile between 3 and 4 years of age in boys and girls. Whether the foregoing comparisons imply differential fat reduction on the extremities and trunk in marginal nutritional status, or whether they are artifacts of measurement variation is not clear. This last possibility merits consideration because measurement techniques for skinfolds are variable. Methods of reporting observer error for skinfold measurements are likewise variable (Burkinshaw, et al. 1973; Johnston et al. 1972; Womersley and Durnin, 1973). Although measurement errors for skinfolds in the present study (Table 1) are less than those reported for three skinfolds in another standardized survey (Johnston et al. 1972), there is no assurance that the techniques are comparable with other studies considered in the discussion any more than that the data are comparable among themselves. This is a serious limitation for comparative growth studies. This limitation can perhaps be remedied easily through periodic replicate sessions with those engaged in ongoing growth studies. Such sessions would provide estimates of differences in skinfold measurements due to technical variation. Estimates of replicability, which should accompany reports of skinfold data, would also be provided.

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