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GROWTH OF CHILDREN FROM EXTREMELY POOR FAMILIES

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For both sexes mean height and weight follow fairly closely the 3rd percentile line of a U.S. growth standard after the second semester of life, the one just below, the other just above. Weight to height relationship is increased and indicative of overweight, consistent with the physical appearance. Other studies have shown that an improved environment and nutrition can produce dramatic linear growth; therefore the weight/height ratio observed cannot be considered indicative of adequate nutrition.

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Growth of Children From Extremely Poor Families

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The purpose of this study is to characterize the growth pattern of a group of children belonging to 115 very poor, primarily mestizo Peruvian families living in the peripheral slums of Lima, all of whom had at least one child who had been hospitalized for severe malnutrition. It is based on anthropometric data gathered on 444 siblings of 144 patients admitted with severe forms of malnutrition (marasmus or kwashiorkor). Among the 144 there were 29 siblings of previous patients: they are not included in this report, as are none of the other 115 index patients. Nineteen subsequently born siblings were admitted to a special unit at an early age to follow their growth for the first 18 to 27 months of life in a generally adequate environment, on optimum diets and with good medical surveillance (1). Their growth data are not included.

All 444 siblings (0 to 219 months old at the time of observation) were in apparent good health and had no history of severe malnutrition; there were 232 males and 212 females. They were studied from August 1966 to September 1970.

METHODS

A concerted effort was made to find and register the families of all patients discharged prior to August, 1966. Contact with the families of the patients who were hospitalized was established by home visits and verification of addresses, and was maintained by providing free medical care and some

social services. We were in no position to modify their extremely poor socio-economic status.

In all families contacted, all their members were studied for height, weight, head circumference, and other parameters not reported here. The schedule for these observations was as follows: the first was 6 months after the discharge date of the sibling that had been hospitalized for severe malnutrition; the second, 6 months after the first; the third, 12 months after the second; the fourth and subsequent observations, 12 months after the preceding one.

Length in the recumbent position until 6 years of age, and standing height thereafter, were determined with calibrated instruments sensitive to 0.1 cm. Calibrated suspension beam scales were used: a) the infant model sensitive to 5 gm for weights up to 16 kg; and b) the adult type sensitive to 50 gm for weight over 16 kg. Children were weighed nude up to 12 months of age, then with light clothing but without shoes.

All anthropometric data have been studied separately for males and females and related to age. The age has been determined by counting the number of months from birth until the day of measurement. Fractions of 15 days or more have been counted as a full month.

Data have been grouped by age ranges of six months from birth to 219 months, with the exception of the youngest age group which included only the first 3.5 months of life. The mid-points of these groups label the age groups (Table 1).

Four hundred and sixteen of the siblings, (members of 103 families), were studied 3.01 times on the average (males 3.18 times and females 2.96 times). The other twenty-eight subjects, 14 of each sex, were observed only once (members of remaining 12 families).

Weight and height were each determined 1,283 times on the 444 subjects studied (676 times on the 232 males, and 607 times on the 212 females). The number of observations for head circumference were 2 less for males and 2 less for females, giving a total of 1,279 determinations.

The mean follow-up time for the 103 families was 30.86 months (about 2½ years) with a range of 2 to 49 months, and a standard deviation of 11.37 months. The frequency distribution of length of observation for this group of families shows peaks at around 18, 30 and 42 months, illustrating the high degree to which the initial protocol was followed. A lack of peaks at 6 and 12 months was due to the fact that no routine observations were made during the last 6½ months of study. A peak at 0 groups the 12 families observed only once.

RESULTS

The mean and the standard deviation for height (or length), weight, and head circumference of each of the age groups mentioned have been calculated (Table 1). The median was determined for the same age groups, and for height and weight followed almost identical curves as the mean. It is evident that for males and females both height and weight are well below U.S. standards.

The means ±2 standard deviations (S.D.) for height and weight of each age group up to age 13 years have been plotted for males in figure 1 and for females in figure 2. Data for older age groups are scanty and of great variation, as can be seen in Table 1; the continuation of this study will solidify this information. The 3rd and 50th percentile of a U.S. standard (2) have been plotted for comparison in each figure.

The mean and ±2 S.D. for head circumference are plotted for males in figure 3 and for females in figure 4. The mean and -2 S.D. of the Practical Composite International and Interracial Graphs, P.C.I.I.G. (3), are plotted for comparison.

DISCUSSION

These data illustrate several characteristics of growth in this group of Peruvian children. The curves for mean length for males and females follow the U.S. 50th percentile

only during the very early months of life; they drop below the 3rd percentile during the 2nd semester of life in males and during the 3rd semester in females; from then on they run parallel or just below the 3rd percentile up to age 13 years in both sexes. The curves for mean weight for males and females run between the 50th and 3rd percentile up to age 5 (60 months), then the mean for males gets closer to the 3rd percentile and remains there up to age 13 (156 months). In females it goes up from age 10 (120 months) and gets closer to the 50th percentile at age 13½ (160 months); this weight spurt is not accompanied by any remarkable spurt in height. Thus at nearly all times children of both sexes could be classified as overweight for their height, at least by U.S. standards, a relationship different from what one might expect. In looking at growth data from a population considered undernourished, and this particular group was selected as most likely to be hard hit, it would be reasonable to expect that the children would be physically underdeveloped and that they would be even more jeopardized in their weights than in their heights. Our observations suggest underdevelopment in height starting in infancy, but relatively the opposite for weight. They actually look short and chubby, leading most observers to classify them as healthy and well-nourished.

Several alternate explanations can be considered for the weight to height relationship seen in these children.

Even a cursory look at a poor adult mestizo group in Peru, as in many other countries, suggests that they are of very short stature when compared to adults from developed countries or the more prosperous, primarily white, members of their own society. One might then assume that this is genetically determined. To our knowledge a falling off in relative height, while weight is maintained, has been demonstrated only in one obviously well-nourished group of middle-class Eskimo children (4). Our own studies, with children from these same Peruvian families, have demonstrated that their genetic potential for height is at least as good as the 25th percentile of the U.S. standard, whether their nutrition and health is maintained from early infancy (1) or only from the mean age of 4 years, despite a disastrous start (5). We are thus quite confident that these growth patterns are not genetically determined.

Consumption, during most or all of the growth period, of a diet which is poor in the amount or quality of protein and relatively generous in calories, might theoretically be expected to result in poor linear growth and poor increases in lean body mass, but ready accumulation of body fat. Our own earlier studies suggest that this is not the case: under such circumstances a child might cut back on intake and fail to gain, or continue to ingest the same amount

without gaining weight (increased post-prandial heat production?). Such a situation seems to be the case in studies with primates (6). If the infant or child continues to gain weight on such a diet he develops hypoalbuminemia and a fatty liver (7), certainly not present in the present population. We are thus reluctant to accept such an explanation.

Studies of body composition in recovering malnourished infants reveal a very significant lag in lean body mass accretion and linear growth, whereas fat is readily accumulated, this in association with seemingly inadequate insulin responses (8). The recovering primate also gains weight more readily (6). If we take into account the appalling environment of these families, we can easily picture a life of intermittently adequate and grossly inadequate nutrition, this last conditioned by frequent infections. We can then postulate a series of never sufficiently prolonged periods of recovery, with easy weight gain but incomplete return to normal of mechanisms necessary for linear growth. Seasonal variations in the food supply might produce a similar effect but this is not the case in this study, as the measurements were evenly distributed throughout the whole year. The urban population studied here, despite their having been selected in the basis of a known case of severe malnutrition, is growing better than a rural population of similar ethnic origin with a lower incidence of clinically apparent malnutrition (9).

Growth patterns similar to these have been reported in other populations (10), as well as from Peru (11, 12).

Growth pattern of head circumference (Figures 3 and 4) differs from that for height. The curve for mean head circumference runs close to the lower values (minus 2 S.D.) of the standard from the 4th to the 18th month of life; it then increases and runs considerably closer to the mean of the standard. The pattern of the curve for mean weight, on the other hand, is very similar to that followed by head circumference from age 18 to 156 months (13 years), inasmuch as both run over the 3rd percentile (U.S.) and over the -2 S.D. (P.C.I.I.G.) during that age span. Below 18 months of age, weight runs at higher values than head circumference.

These data suggest that head (brain) growth is better maintained than the longitudinal growth of the body. Whether this difference is all nutritionally determined or represents a racial characteristic is not clear.

If nothing else, our results suggest that the seemingly "healthy" siblings of malnourished infants and children can hardly be considered to have been well-nourished or to be properly expressing their genetic potential. In such families all children must be considered as likely to be chronically undernourished or intermittently malnourished,

seldom achieving their full potential. That most of them survive in seeming good health, although stunted to varying degrees, is tribute to the adaptability of the human species.

SUMMARY

A combined cross-sectional and longitudinal study of the growth pattern of a group of children belonging to Peruvian families of very low socio-economic condition, taxed with severe malnutrition in at least one of its members, and studied during 4 years (1966-1970), is presented.

For both sexes mean height and weight follow fairly closely the 3rd percentile line of a U.S. growth standard after the second semester of life, the one just below, the other just above. Weight to height relationship is increased and indicative of overweight, consistent with the physical appearance. Other studies have shown that an improved environment and nutrition can produce dramatic linear growth; therefore the weight/height ratio observed cannot be considered indicative of adequate nutrition.

Mean head circumference runs close to a line 2 S.D. below the mean of an international standard up to age 18 months, slowly increasing toward the mean thereafter. Growth of head is seemingly better preserved than linear growth in this population.

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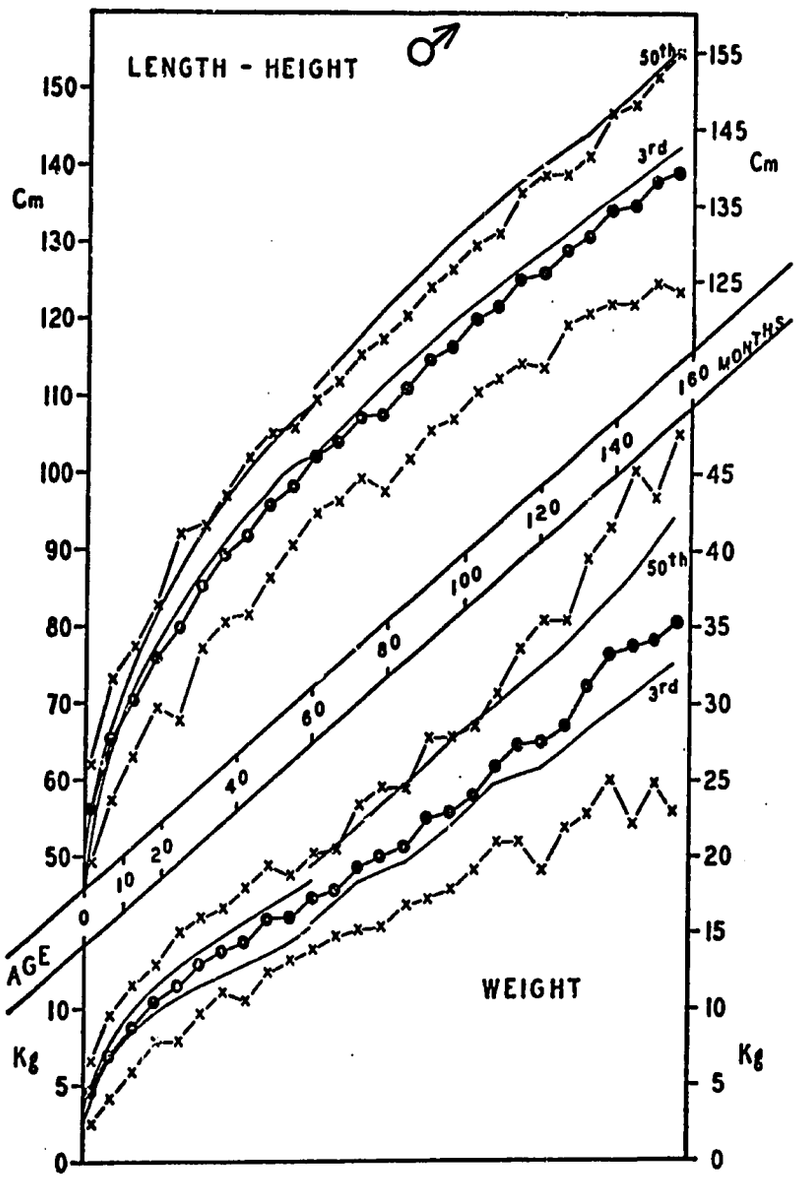
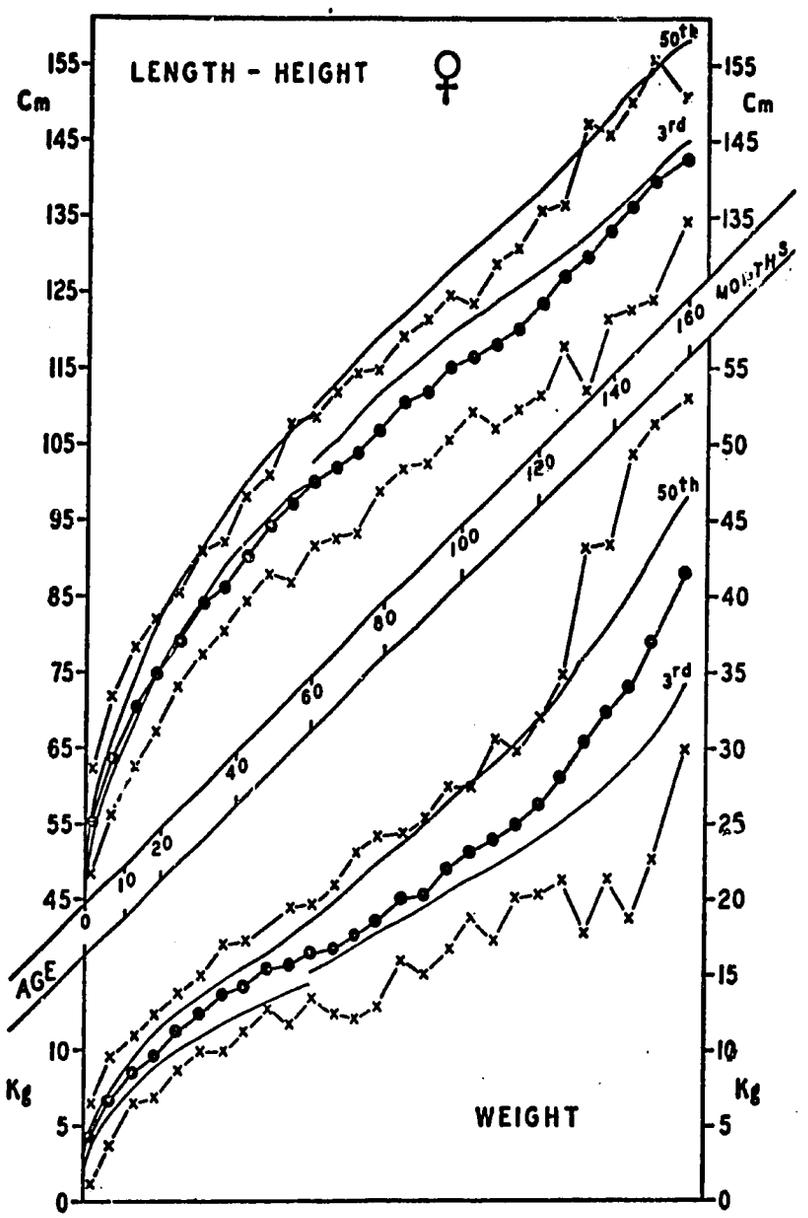
Figure 1.



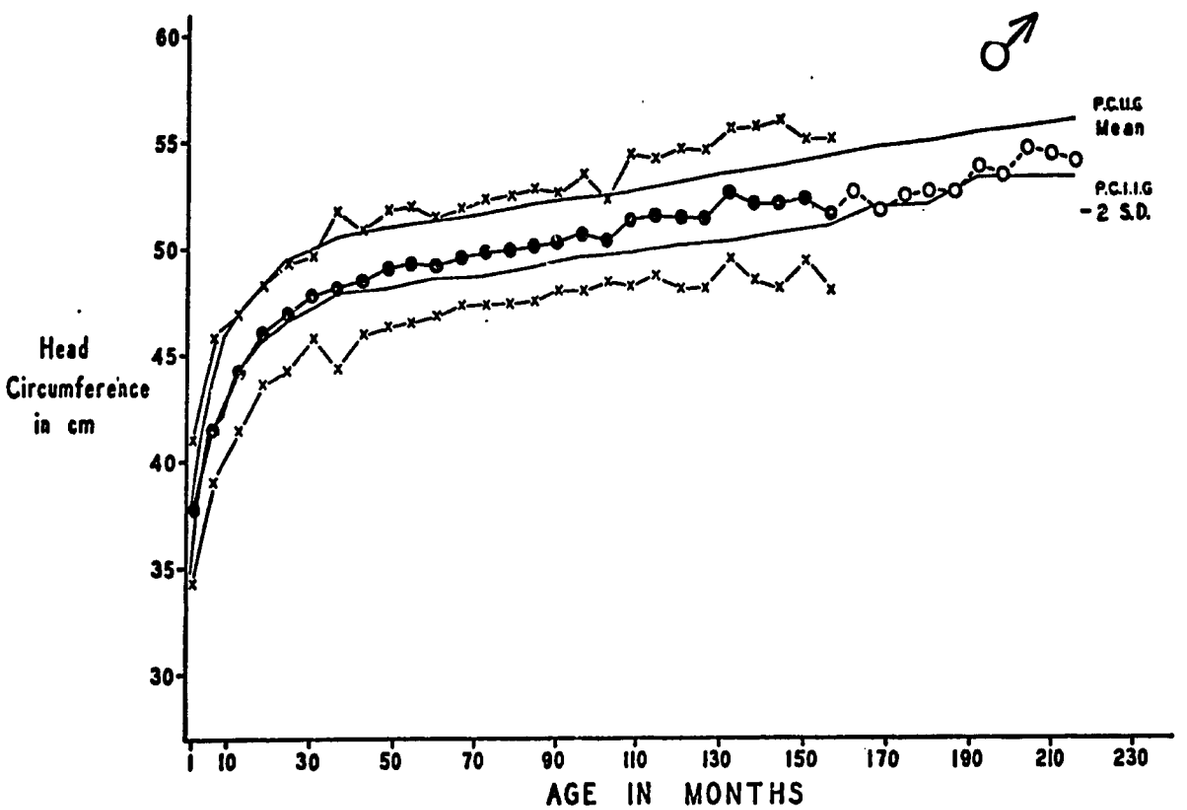
Means ±2 standard deviations of length-height and weight of 232 males from 115 very poor families. (•——•) Means. (x——x) ±2 standard deviations of means. (———) 3rd and 50th percentiles of a U.S. standard.

Figure 2.



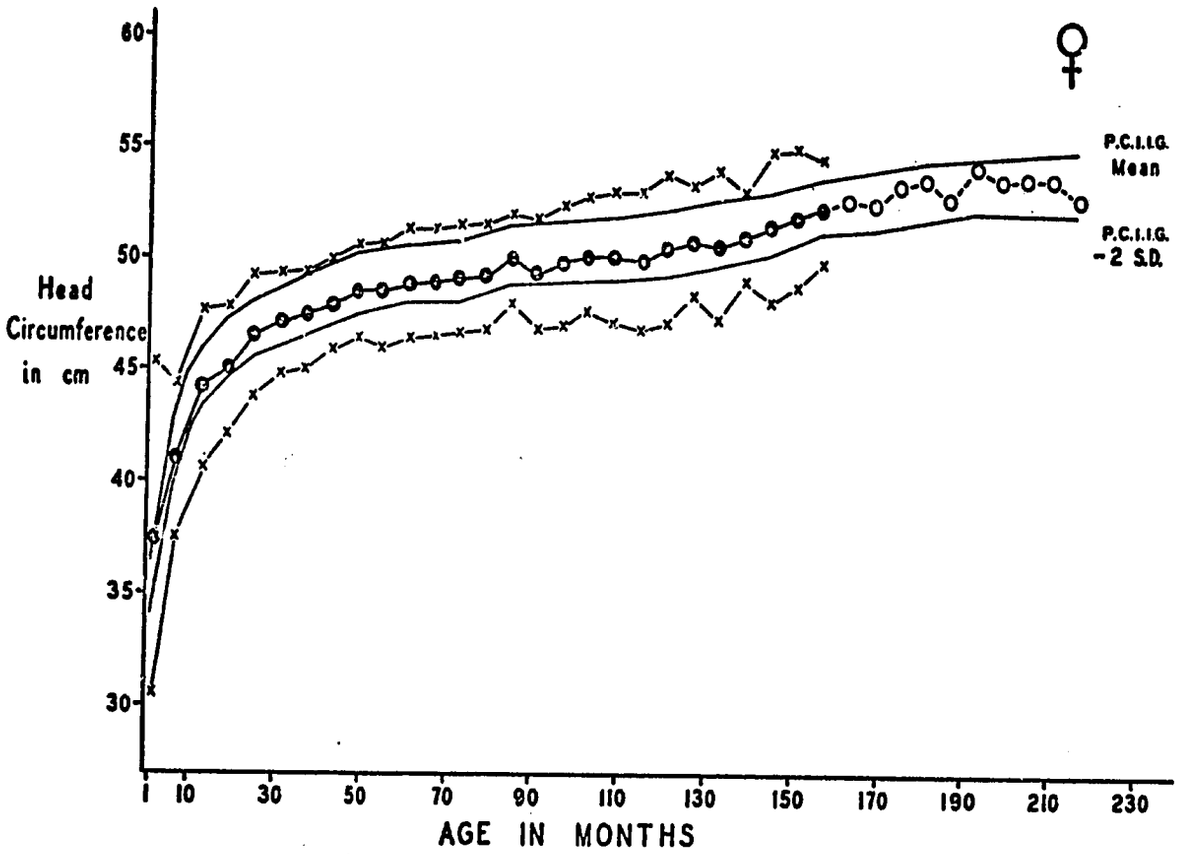
Means ±2 standard deviations of length-height and weight of 212 females from 115 very poor families. (•——•) Means. (x——x) ±2 standard deviations of means. (——) 3rd and 50th percentiles of a U.S. standard.

Figure 3.



Means ±2 standard deviations of head circumference of 232 males from 115 very poor families. (•——•) Means. (o---o) Means of older age groups with low "n". (x——x) ±2 standard deviations of the means. (———) Means and -2 standard deviations of Practical Composite International Interracial Graph.

Figure 4.



Means ±2 standard deviations of head circumference of 212 females from 115 very poor families. (•——•) Means. (o---o) Means of older age groups with low "n". (x——x) ±2 standard deviations of the means. (┌——) Means and -2 standard deviations of Practical Composite International Interracial Graph.

TABLE I

Mean and standard deviation (S.D.) of length or height (Height), weight, and head circumference (Head) for 232 male and 212 female siblings of children admitted with severe malnutrition. Combined cross-sectional and longitudinal observations.

Age (in months)		Males							Females						
			Height cm		Weight kg		Head cm			Height cm		Weight kg		Head cm	
Range	Mid-point	n	Mean	SD	Mean	SD	Mean	SD	n	Mean	SD	Mean	SD	Mean	SD
0-3	1.75	30	56.1	3.25	4.63	1.02	*37.7	1.68	28	55.3	3.48	4.34	1.09	37.4	3.95
4-9	6.5	27	65.3	3.93	6.96	1.37	42.4	1.68	36	63.9	3.89	6.73	1.46	41.0	1.71
10-15	12.5	20	70.4	3.64	8.76	1.40	*44.2	1.38	27	70.4	3.93	8.60	1.50	44.2	1.75
16-21	18.5	20	76.2	3.33	10.45	1.25	46.0	1.16	23	74.6	3.72	9.66	1.37	45.0	1.42
22-27	24.5	18	79.9	6.08	11.55	1.80	46.9	1.25	22	79.2	3.12	11.32	1.32	46.5	1.33
28-33	30.5	26	85.2	3.99	12.90	1.56	47.8	0.98	22	84.1	3.37	12.50	1.24	47.1	1.13
34-39	36.5	21	89.4	4.35	13.81	1.44	48.1	1.85	18	86.3	2.92	13.48	1.78	47.4	1.21
40-45	42.5	24	91.8	5.15	14.39	1.86	48.5	1.23	22	91.2	3.43	14.33	1.49	47.9	1.05
46-51	48.5	21	95.9	4.82	15.95	1.73	49.1	1.39	21	94.4	3.27	15.47	1.46	48.5	1.05
52-57	54.5	27	98.4	3.81	16.01	1.39	49.3	1.38	17	97.2	5.22	15.71	1.95	48.5	1.14
58-63	60.5	30	102.2	3.75	17.06	1.57	49.2	1.18	20	100.0	4.26	16.55	1.62	*48.8	1.21
64-69	66.5	17	104.1	3.93	17.74	1.45	49.6	1.15	20	102.1	4.79	16.75	2.13	48.9	1.22
70-75	72.5	26	107.2	3.99	19.27	2.05	49.8	1.25	18	103.9	5.31	17.67	2.77	49.1	1.20
76-81	78.5	20	107.6	4.84	19.95	2.28	49.9	1.27	15	106.8	4.03	18.57	2.80	49.2	1.17
82-87	84.5	25	111.1	4.57	20.63	1.88	50.1	1.34	21	110.5	4.34	20.10	2.16	50.0	0.99
88-93	90.5	22	114.9	4.62	22.48	2.60	50.3	1.14	23	112.0	4.72	20.29	2.58	49.3	1.23
94-99	96.5	26	116.5	4.85	22.86	2.47	50.7	1.38	22	115.0	4.78	22.00	2.73	49.8	1.32
100-105	102.5	24	120.0	4.76	23.95	2.34	50.4	0.98	18	116.4	3.57	23.18	2.15	50.1	1.15

(Continued)

TABLE I (Continued)

Age (in months)		Males							Females						
			Height cm		Weight kg		Head cm			Height cm		Weight kg		Head cm	
Range	Mid-point	n	Mean	SD	Mean	SD	Mean	SD	n	Mean	SD	Mean	SD	Mean	SD
106-111	108.5	28	121.7	4.75	25.85	2.43	51.3	1.55	24	118.2	5.53	24.00	3.35	*50.1	1.48
112-117	114.5	23	125.2	5.47	27.28	3.19	51.5	1.38	18	120.2	5.34	25.00	2.42	49.9	1.54
118-123	120.5	25	126.1	6.27	27.56	3.97	51.4	1.65	19	123.5	6.12	26.24	2.93	50.5	1.66
124-129	126.5	18	129.1	4.95	28.64	3.37	51.4	1.63	19	127.3	4.68	28.10	3.42	50.8	1.23
130-135	132.5	24	130.9	5.13	31.17	4.16	52.6	1.54	16	129.8	8.80	30.50	6.33	50.6	1.68
136-141	138.5	16	134.3	6.22	33.21	4.16	52.1	1.81	17	133.7	6.09	32.37	5.51	51.0	1.01
142-147	144.5	18	135.0	6.54	33.76	5.78	52.1	1.99	15	136.4	6.89	34.10	7.65	51.5	1.70
148-153	150.5	16	138.0	6.66	34.13	4.67	52.3	1.42	22	139.7	7.96	37.00	7.17	51.9	1.56
154-159	156.5	12	139.2	7.87	35.31	6.16	51.6	1.77	8	141.7	3.23	42.90	6.74	52.3	1.17
160-165	162.5	11	149.1	5.73	42.61	5.72	52.6	1.16	13	143.0	4.64	40.47	5.47	52.7	1.42
166-171	168.5	6	146.5	3.54	39.30	2.38	51.7	1.24	7	146.2	4.13	42.54	6.79	52.8	1.39
172-177	174.5	6	151.8	6.27	45.90	8.89	52.4	1.39	9	147.0	7.08	47.58	4.20	53.4	1.14
178-183	180.5	9	149.9	8.87	44.34	6.37	52.6	1.14	6	147.3	5.90	48.73	7.94	53.7	1.08
184-189	186.5	3	156.7	10.75	52.40	7.60	54.6	0.52	4	148.3	4.61	48.06	2.22	52.8	1.89
190-195	192.5	4	155.3	4.11	49.75	4.46	53.8	0.64	3	148.2	4.76	51.10	2.25	54.2	1.04
196-201	198.5	4	150.4	18.46	44.50	10.54	53.5	2.16	5	150.3	3.91	49.76	2.37	53.6	1.43
202-207	204.5	2	157.8	13.86	54.23	9.58	54.7	0.42	4	146.5	5.32	49.88	5.60	53.7	2.05
208-213	210.5	2	163.4	6.51	50.53	3.50	54.4	0.50	2	149.9	4.46	44.75	7.43	53.7	2.40
214-219	216.5	5	153.6	15.33	48.98	9.03	54.0	1.73	3	147.3	3.01	45.00	4.33	52.8	0.76

* One observation less in each one of these groups