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Chapter II

REVIEW OF LITERATURE

(on work done in physical development of pre-school children).

It was in the late nineteenth and early twentieth centuries that the first truly scientific investigations of children were carried out. G. Stanley Hall (1844 - 1924) in America and Alfred Binet (1857 - 1911) in France were two of the most important persons who stimulated the growth of a science of child development. The work of such pioneers led to the tradition to base generalizations about child behavior on observable evidence. Gradually the society began to think of the child as an individual with peculiar and unique properties rather than a miniature adult. (Gardner, 1964).

Gardner (1964) has classified the ways in which scholars and scientists have viewed the child in the twentieth century : (1) the behaviorist approach of Pavlov, Watson and followers, (2) the normative-descriptive approach, (3) the field theory approach of Lewin and (4) the psychoanalytic approach initiated by Sigmund Freud.

The Normative-Descriptive Approach has yielded behavior descriptions for each age level, or "age norms". These norms provide useful reference points by which growth and behavior

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of a child can be described and understood more clearly. The contribution of Arnold Gesell and his coworkers is most noteworthy (Gesell and Ilg, 1949). Knowledge of age norms enables one to set reasonable levels of expectation for children. Norms are, of course, mere averages which should always be kept in mind.

The child-development point of view has permeated the schools to a marked degree. Schools attempt to design and organize their programmes in keeping with the levels of readiness of the children. In early childhood there is a correlation between body size and physiological functioning. Size, being a fairly obvious characteristic, has been associated with normality of development.

A realistic picture of the changes in body proportions that occur between birth and maturity can be obtained by considering the amount of growth which each major segment of the body normally undergoes (Gardner, 1964).

The head doubles its size.

The trunk triples its length.

The arms increase four folds in length.

The legs increase five folds in length.

There are differences of course, in stature and bodily

proportions. The differences are associated with sex and other genetic factors and with factors of the environment.

It has been noted by scientists that the rate of development is not constant and different parts have their own individual patterns and sequences of development. In measurements of the same child taken at different periods in his life, it is seen that he is growing rapidly at some times and very slowly at others (Hurlock, 1956).

Excellent general accounts are available on the general patterns of child development (Almy, 1955; Bayer and Bayley, 1959; Bayley, 1965; Bhoota, 1970; Breckenridge and Vincent, 1955; Dinkmeyer, 1965; Gabriel, 1964; Gardner, 1964; Gesell and Ilg, 1949; Hurlock, 1956; Ilse, 1954; Kher et al. 1962; Lee and Lee, 1958; Martin and Stendler, 1959; Nimkoff, 1934; Olson, 1949; Stott, 1967; Strang, 1951; Tanner, 1960, 1961, 1970). Baldwin (1967) has given an excellent comparative account of the psychological theories of child development.

The importance of establishing norms of development at different ages has already been emphasized. Reliable norms based on extensive observations under standardized conditions are available for the children of the United States of America and Britain (Meredith and Meredith, 1953; Bayley, 1956; Bayer and Bayley, 1959; Watson and Lowrey, 1962; Meredith, 1968; Tanner, 1960 and 1970; Hansman, 1970).

As far as India and most of the eastern and African countries are concerned, such norms have not yet been established. It has been a general practice in most of these countries to refer to American norms, but of late it has been realized that this practice of referring to American norms is not helpful while evaluating child health and development as growth and development are considerably influenced by ethnic background, geography and nutrition (Currimbhoy, 1963; Desai, 1968; I.C.M.R., 1972). Poffenberger and Verma (1963) have emphasized the importance of health checks during the pre-school years.

Meredith (1968) has compiled the information on body size of pre-school children in different parts of the world. Tanner (1970) has given an excellent and uptodate review of the literature on physical growth of children.

Studies on the physical development of pre-school children in India are relatively few and mostly confined to weight and height. Mukherjee and Sethna (1972) have reviewed the growth studies in India in last 50 years, but the review is far from complete in coverage. According to them the study made by Ghosh *et al.* (1944) seems to be the first such study in India. The significance of these isolated observations is difficult to judge because of the lack of uniformity of procedure of measurements and of ways of stating the age. This last point must be considered when the observations of the various Indian studies are compared.

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In table 2.1 the observations on the anthropometric measurements of the various parts of the body made on Indian children of the pre-school age (two to six years) are compiled for ready reference.

It can be readily seen that the majority of studies concentrate only on weight and height. Again there is no uniform procedure of stating the age-level at which the measurements were made. This makes it rather difficult to compare the different studies and to calculate workable norms for the various components of growth with respect to definite age points. The most notable of the Indian studies on the pre-school age group are those of Currimbhoy (1963), Udani (1963), Datta Banik (1970; 1972) and the Indian Council of Medical Research (I.C.M.R., 1972). The I.C.M.R. study gives averages for 1^+, 2^+, 3^+ years etc. upto 21^+ years, and the "plus (+) sign affixed to each year of age indicates the interval between a year of age and the next. For example '7^+' includes all children aged 7 years and above, excluding those who have completed 8 years of age". Udani's figures are given for the age intervals of 1-2, 2-3, 3-4 years etc. Currimbhoy has tabulated the results against age points 1 year, 2 years etc. These are some reports which give very exact age point (Swaminathan and Jyothi, 1964; Phatak, 1968; Datta Banik et al., 1970; Srivastava et al., 1970, for example). Thus the figures

given in the I.C.M.R. study (I.C.M.R., 1972) for a given age (say 2^+ years) may be comparable to the figures in some of the other studies for the age point $2\frac{1}{2}$ years. The average of any two consecutive ages (say 2^+ and 3^+ years) may be comparable to the figures for the higher age level of the two (i.e. the average of 2^+ and 3^+ years may give the figures for the age point 3 years) in other reports.

Again, the sample sizes of the different studies vary so widely that comparison may not be valid. Many studies give combined averages for boys and girls when it is now fairly well established that the boys and girls show consistent differences from very early age. But with all these shortcomings these studies do give us a fairly good idea as to what to expect in the physical development of a child at a particular age level.

The I.C.M.R. (1972) study is the most complete and standardized study on Indian children available at present, hence its observations and conclusions drawn are summarized here in greater detail than other studies.

The Indian Council of Medical Research undertook the cross-sectional study on different aspects of growth and development of Indian children from birth to 21 years of age on a country-wide basis in 1957 when it found that develop-

mental standards and norms of various anthropometric measurements did not exist for Indian infants and children.

Experts in the field of anthropology, statistics, nutrition and pediatrics participated in this project and collected and processed the much needed information on growth norms and developmental standards of Indian children. The findings were published in 1972.

Weight

The initial sex difference of 0.6 kg. at age 1 year was halved by the age of 5 years and this difference was maintained till the age of 9 years.

Standing height

The boys were taller than girls at all ages save at 10, 11 and 12 years. Between ages 1 through 9 years, sex differences in the mean values lay between 1 cm. and 2 cm.

Both for boys and girls, the variability of the means increased steadily until the age of 12 years.

The sex difference was statistically significant after the age of 15 years.

Sitting height

The increase in mean values of sitting height with age

conformed to that of other measurements, the boys displaying values higher than those for girls. The sex difference was around 1 cm. upto the age of 9 years, and vanished at ages 11 and 14 years.

The pattern of increase of height and weight means differed. The height means increasedmore steeply in the younger ages and the gradient increasedmore steeply in the younger ages and the gradient reduced after the age of 8 years. As regards weight means the pattern was reversed. This was true for both boys and girls.

Head circumference

The head circumference was found to increase steadily upto the age of 18 and 17 years for boys and girls. The maximum increase in the mean values occurred between 1 and 5 years for both sexes.

The boys had a larger mean circumference relative to the girls, except during the ages 13 and 14 years when girls caught up with the boys. The sex difference at 3 and 4 years was about 1 cm. and was statistically significant.

Chest circumference

For all ages the sex difference was not statistically significant. The variability of mean values increasedwith ages.

The ratio of the chest circumference to the head circumference was less than unity upto the age of 2 years and 6 months for girls and 2 years and 9 months for boys, beyond which the chest circumference overtook the head circumference.

Regions - The mean values of standing height and weight of children belonging to different states were found to be significantly different from one another. The growth pattern varied from state to state throughout the age-range. This fact should emphasize the need for establishing regional norms if valid inferences are to be drawn regarding the developmental status of a given child.

Some parts of India (Bengal, Bihar and Gujarat for example) have not been included in the I.C.M.R. study. There is, thus, a pressing and immediate need for studies of children of these regions for establishing regional norms, when the I.C.M.R. study itself definitely reveals significant differences in weight and height between regions.

The I.C.M.R. study considered factors influencing growth and physical development.

Region (Geographical location)

The mean values of standing height and weight of children

belonging to different states were found to be significantly different from one another. The growth pattern varied from state to state throughout the age-range. Variations in the rest of the anthropometric measurements among the children from the different states were also noted.

Milieu (urban/rural)

It was observed that the mean values of height and weight of children belonging to urban areas were higher than those of children from rural areas throughout the growth period. The differences, however, were not statistically significant. The same trend was seen in other anthropometric measurements.

Religion - Significant differences were observed in the mean values of all anthropometric measurements except chest circumference of children over seven years of age belonging to different religions.

Socio-economic status

Socio-economic status plays a dominant role in the growth and development of children.

Children from different socio-economic classes within the same community differ in their average body size at all ages, even at birth, those of upper socio-economic class always having the highest.

In most studies carried out in India socio-economic status had been defined according to the father's occupation or income.

In the I.C.M.R. study occupation and income were combined to arrive at a classification of the socio-economic status of the child.

(In the present (Y.C.P.'s) study education of the father was the third factor which was considered in defining the socio-economic status).

Height and weight were significantly influenced by the socio-economic status in favour of the higher socio-economic groups. Similar trends were seen in the mean values of other anthropometric measures.

Comparison of the I.C.M.R. data with those from other countries.

The Indian children were shorter and lighter than their counterparts in the United States of America and in Britain. The difference in the growth was more pronounced after 13 years of age in both sexes. The growth curve of the British children occupied an intermediate position between those of American and Indian children. The Indian children who belonged to the highest socio-economic class displayed growth pattern similar to that of the British children.

In the present (Yogini C. Pathak's) study the anthropometric measurements have been made on weight, (standing) height, sitting height, head circumference, chest circumference, shoulder breadth (biacromial width), upper-arm circumference, fore-arm circumference, arm length, thigh circumference, calf circumference, leg (lower limb) length, and foot length, (in all 13 parameters of physical growth). It would be worthwhile to classify the notable earlier studies on the physical growth of pre-school age group of Indian children on the basis of the growth parameter measured. The classification is given in the table 2.1.

Another source of information on the anthropometric measurements other than the reports usually published in journals of pediatrics, child health, child development etc. is the work done in Home Science colleges for the purpose of designing garments. A notable example is the Department of Clothing and Textiles of the Home Science Faculty at Baroda. There are quite a few dissertations for the degree of M. Sc. (Home) which deal with anthropometric measurements of varying age groups. The samples are large and measurements standardized and accurate, but often the averages are not given with respect to a definite age point which may reduce their utility for fixing norms of physical growth with respect to age levels (Rajor, 1968; Shingla, 1968; Lakshmi, 1972; Chanchani, 1972; Paul, 1972).

The influence of some factors on the physical development of (pre-school-age) children.

Some studies have been reported involving the following factors :

1. Sex of the child
2. Socio-economic status of the family
3. Family size (number of siblings)
4. Birth order of the child and mother's age
5. Milieu (urban or rural).

1. Influence of the sex of the child on the physical development of children.

Hansman (1970) has reported the results of a long term (over 40 years) longitudinal study of middle and healthy white American children belonging to the middle and upper middle socio-economic groups. She reports that from birth to two years the boys are larger on the average than girls (considering height or length and weight). The sexes are nearly equal in size during the childhood years. Datta Banik et al. (1967) reported that the mean birth weight was higher in male than female infants.

The same sex differences as described for height are demonstrated in sitting height; there is very little difference

between sexes prior to the adolescent years.

In all the Indian studies on the pre-school children the boys have the upper edge in all the dimensions of the physical size studied. However, in the sixth year of life the girls catch up with or surpass the boys in height (Currimbhoy, 1963; I.C.M.R., 1972). Poffenberger and Verma (1963) studied the health problems and sex differences of a sample of urban pre-school children in Gujarat. They hypothesized that the greater number of illnesses found among boys than among girls may be a functional value placed upon the sexes in Indian society. This differential value could be responsible for sex differences seen during the early childhood in other aspect of physical development.

Bailey (1965) finds no differences between boys and girls in mental and motor test scores for ages 1-15 months. Espenschade (1940), however, had reported statistically insignificant and low correlations between motor performance of girls and all measures of physical growth and maturity but positive and significant correlation between motor performance of boys and all measures of maturity - chronological, anatomical and physiological.

2. Influence of socio-economic status of the family on the physical development of children.

Tanner (1970) states that children from different socio-

economic levels differ in average body size at all ages, the upper groups being larger. All Indian studies also report that the children belonging to the upper economic group show better physical growth (Athavle, 1959; Currimbhoy, 1963; Udani, 1963; Swaminathan and Jyothi, 1964; Gokulnathan and Verghese, 1969; Datta Banik et al., 1972; Gupta and Agarwal, 1972; I.C.M.R., 1972). The findings of these studies are summarized in tabular form (table 2·1) as has been mentioned earlier. See also Arora et al.,1963; Mehta and Merchant, 1972). Reports from New Guinea (Malcolm, 1970) and Costa Rica (Villarejos et al., 1971) are similar. It should be noted that there is a conspicuous lack of uniformity in defining the economic or socio-economic status.

Rauh et al. (1967) reporting on urban school children of U.S.A. do not find any significant relation between mean weight and income range. This can be understood and explained when one considers the role of nutrition in physical development (Gupta and Agarwal, 1972). Compared to the people of the lower socio-economic groups in India and countries in Africa, the average American is not limited in food intake by finances. Datta Banik et al. (1972) have pointed out that the mean (50th percentile) of height and weight of both sexes in the higher income groups of India compare well with the American standards. They also report that the mean height of the Indian lower economic group corresponds to the 25th percentile and mean weight to the 10th

percentile of the American standards. They conclude that the nutritional factor plays greater role than genetic factor.

A study of the first year of life of Delhi infants (Ukolanskaya et al., 1960) quoted by Mukherjee and Sethna 1972a revealed a marked relation of the physical growth of the Indian infants in comparison with the Russian norms. This is in line with the studies comparing Indian children with the American children.

The differences between Sikh and Bengalee children reported by Chaudhuri and Ghosh (1966) are related to food habits and living conditions and ways of living.

Phadke (1973) has reported a study of 4721 infants in Maharashtra. He finds the 75th percentile of the group comparable to the 25th of the Harvard study of U.S.A.

Jones and Pereira (1972) state that the requirements of pre-school children are of the order of 80-90 cal./kg.; children tended to gain weight when their caloric consumption was higher. This also explains the differences between the higher and lower socio-economic groups. Bailey and Schaefer (1960) have noted a slight tendency for the mothers of higher socio-economic status to be more warm, understanding and accepting and for those of lower status to be more controlling, irritable and punitive.

3 & 4. Influence of family size, of birth order and of

mother's age.

It is obvious that larger the family size, lower the per capita income of the family and greater probability of malnutrition. Tanner (1970) states that height and weight vary inversely as the number of siblings in the family but he adds that the difference disappears when adult size is reached.

Pachauri (1970) has discussed the socio-economic factors in relation to birth weight. Higher birth weight was observed in single families and there was +ve correlation between birth weight and per capita income.

As far as the birth order is concerned, the situation is a bit more complex.

According to Datta Banik et al. (1967), birth weight increases upto the 3rd parity in male children and upto the 4th in the female children. Again, according to the same researchers, there is a tendency for the birth weight to increase with the mother's age upto 30 years. Arora et al. (1963) observed the same tendency for the birth weight of the infant. They also found that the dietary status of the mother during pregnancy influenced the birth weight of the infant. Earlier Paul and Ahluwalia (1957) in their study on healthy newborns in Delhi had observed that younger mothers had lighter babies upto 35 years and that birth weight increased with parity.

Ballweg (1972) has discussed the family characteristics and nutritive problems of pre-school children of Haiti. It was observed that when the family size reached five, the proportion of children with severe malnutrition increased. It appeared that the younger mother with fewer children was able to provide for the nutrition of her pre-school children to better advantage than the older mother with a larger family.

5. Influence of urban vs. rural milieu.

The I.C.M.R. (1972) study finds that the mean values of height and weight of children belonging to urban areas were higher than those of children from rural areas throughout the growth period. The differences, however, were not statistically significant. The same trend was seen in other anthropometric measurements.

Rao et al. (1961), Rajalakshmi and Ramakrishnan (1969), Srivastava et al. (1970), Chaudhury and Ramakrishnan (1972) and Kumar et al. (1972) have made observations on rural children. The study by Rajalakshmi and Ramakrishnan is one of the few longitudinal studies in India. Phadke (1968), Parekh et al. (1972) and Phadake (1973) have given comparative data for urban and rural children. The observations are in conformity with the I.C.M.R. study mentioned above.

Parekh et al. (1972) reported on the parasitic infestation

in pre-school children of urban and rural communities. Of the 178 urban children 39.3% had evidence of parasitic infestations while the figure was 43% in case of the rural group (72 children).

Other factors

Mother's education and occupation.

Bailey (1965) compared mental and motor test scores for ages 1-15 months. She found no differences among children with respect to the education of either father or mother. Ballweg (1972)'s finding in Haiti also did not find support to the hypothesis that literacy (of the mother) was a possible explanation for nutritional differences. Pachauri (1970) found +ve correlation between the birth weight of infants born to and mothers' literacy. Similarly birth weight was found to be correlated with mother's occupation, the weight being highest in case of the professionally occupied mothers and lowest with the manual labourers, the housewives occupying the middle position. Pachauri has not considered the income levels of the three groups of mothers which would probably explain the differences in birth weight as the dietary status of mothers during pregnancy influences the birth weight of infants born to them (Arora et al., 1963).

Race

Wingred and Solomon (1971) and Malina (1972) did not find

racial differences in patterns of growth. Their findings are in line with those of Bayley (1965) already discussed and of Robson (1965), discussed below.

Season

Robson (1965) observed seasonal variation in relation to weights and heights. The seasonal pattern was reported to be independent of climate, elevation and race.

Miscellaneous observations

Weight and Height - Gurney et al., (1972) have discussed the role of anthropometry in the differential diagnosis of protein - calorie malnutrition. In their opinion weight/age ratio gives a good indication of size at different stages of life. They find that height is relatively nurture-insensitive specially to acute episodes, but does give some indication of chronic malnutrition over time.

Rao et al., (1961) conducted a study to establish physiological norms in Indians. Standing height in men and women showed the best correlation to lung volumes (except expiratory reserve capacity); body weight had a highly significant correlation only to expiratory reserve capacity in both sexes.

Head circumference

Prasad (1964) quotes Westropp and Barber's longitudinal

study of head size in 331 boys and 333 girls of Oxford Child Health Survey in 1944-45. The mean value of head circumference of boys was a fraction larger than mean value for girls.

Chest/Head Ratio

According to Seonae and Latham (1971) chest/head ratio lower than 1 in childhood is a sign of protein-calorie malnutrition. In the I.C.M.R. (1972) study on Indian children the Chest/Head circumference ratio was less than unity upto 2 years and 6 months in girls and upto 2 years and 9 months in boys beyond which the chest circumference overtook the head circumference.

Growth Rhythm - McKee and Eichorn (1955) in their study on metabolism and height and weight during adolescence do not find sufficient evidence for the concept of a general growth rhythm.

Potential Indices of Physical Growth. (Upper) Arm circumference as a growth index -

Jelliffe (1966) has been quoted by Chaudhury and Ramakrishnan (1972) to suggest that the actual arm circumference can be used as a general anthropometric index of protein - calorie malnutrition. Jelliffe and Patrice (1969) have suggested "mid-upper arm circumference (arm circumference or arm girth) as a potentially useful simple field index for the assessment of PCM

(Protein-calorie malnutrition).

Gurney et al. (1972) suggest that all pre-school children with arm circumference of less than, say, 14.5 cm. can be assessed as being potentially or actually malnourished and in need of special care.

Calf circumference

Jelliffe and Jelliffe (1969) quote Gopalan (1968- unpublished data) who observed that the circumference of the calf was more affected than the arm in Indian children, with severe PCM.

Composite Measurements

El Lozy (1972) advocates the technique of multivariate analysis which aim at replacing the numerous correlated measurements by a smaller member of uncorrelated linear combinations of these measurements.

Norms

Jelliffe and Jelliffe (1969) have emphasized the need for a coordinated assessment of anthropometric measurements including the arm circumference in the truly well nourished, disease-protected children of the elite in various selected ethnic groups in different parts of the world.

Gurney (1969) has suggested a "Satisfactory" height or weight line as mean weight per age of the healthy children of well-nourished elites, whatever their racial make up, tend to grow along roughly the same paths and to have similar distributions of height and weight.

Mean for the community concerned (or of similar community) would give an " acceptable " height or weight line and any point or line which falls below $\frac{2}{3}$ of the "satisfactory line would be considered a "dangerous" point or line according to Gurney.

Sharma and Sabarinathan (1969) have put forward a new concept of potential indices of physical growth. This concept is similar to the idea of "satisfactory" height or weight line of Gurney (1969).

Gurney et al. (1972) have strongly condemned the use of calendar age as a concept of time passing to assess eligibility for different forms of secondary education.

Finally a note must be made of what Tanner (1970) calls "Secular Trend". According to him, during the last hundred years there has been a striking tendency for children to become progressively larger at all ages. In Europe and America, he notes, this trend dwarfs the differences between socio-economic classes.

The value of interdisciplinary study has been emphasized by experts in child education and development (UNESCO, 1974). The period from birth to age six is characterized by the rapid physical and psychological development of the child. The interdisciplinary studies of the many aspects of development can contribute to the optimal development of all children. Verma et al. (1973)'s study is an example.

The UNESCO expert committee (UNESCO, 1974) also agreed that changes in the educational process should be planned as a part of a broader approach to improve child health and nutrition.

Professor Fafunawa of Nigeria calls for " a school system for developing countries which will allow children to learn at their own pace, regardless of age sex or area of specialization" (UNESCO, 1974).

Table 2.1 - Anthropometric measurements of the various parts of the body made on Indian children of the pre-school age (two to six years) - compiled from studies reported by different authors.

WEIGHT in Kg.

Investigator	Nearest Age Levels										Remarks
	2 years		3 years		4 years		5 years		6 years		
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
1 Athavle (1959)*	-	-	13.5*	-	14.1*	-	15.7*	-	18.1*	-	897 boys 107 girls 3 to 19 years.
2 Rao et al. (1961)	-	-	-	-	-	-	14.6	14.9	16.1	15.4	rural children
3 Smart (1962)	-	-	12.8	11.9	13.6	13.4	14.7	15.3	-	-	31-60 boys; 14-50 girls
4 Currimbhoy (1963)	9.7	9.5	11.5	10.8	12.8	12.4	14.5	14.0	15.7	15.5	Lower Economic Group
	14.3	-	14.8	13.8	16.6	17.5	17.7	18.9	-	21.3	Upper Economic Group
5 Udani (1963)*	8.8*		10.7*		11.1*		12.4*		14.9*		Poor Income Group
	11.5		13.4		15.4		17.0		17.6		Middle Income Group
	12.9		15.1		17.2		20.5		21.2		Upper Income Group

Table 2.1 - contd. WEIGHT in Kg. contd.

Investigator	Nearest Age Levels										Remarks
	2 years		3 years		4 years		5 years		6 years		
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
6 Swaminathan and Jyothi (1964)	8.2	8.0	9.7	9.3							LS of 40 Boys 47 Girls
7 Phadke (1968)			12.9 11.5	12.3 11.2			15.8 14.7	14.9 14.1			Urban Rural Part of ICMR study
8 Phatak (1968)	10.3	9.1									Age 1-30 months
9 Gokulnathan and Verghese (1969)*	11.5* 10.1		13.5* 12.0		14.7* 13.8		16.1* 14.5				High & Middle Socio-Eco. Group Low Socio-Eco. Group. Age nearest to ICMR study- 390 children.
10 Rajalakshmi and Rama-krishnan (1969)	8.7 11.0*	8.3	9.9 13.0*	9.7							L.S. Study rural sample size ? Lower Income Gr. Upper Income Gr.
11 Agarwal (1970)					15.5	14.8	16.5	15.8	18.2	17.9	Study from 4 to 17 years.

Table 2.1 - contd.

WEIGHT in Kg. contd.

Investigator	Nearest age levels										Remarks
	2 years		3 years		4 years		5 years		6 years		
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
12 Srivastava et al. (1970)	9.5	9.2	10.1	9.6	11.7	11.0	13.1	12.7	-	-	1000 rural children
13 Datta Banik et al. (1970)	9.8	9.3	11.7	11.0	13.3	12.7	14.6	14.3	-	-	L.S.Birth to 5 years, Delhi. To begin with 1725 children (finally 124).
14 Chaudhuri and Ramakrishnan (1972)	8.4	7.6	8.9	8.3	10.3	9.0	11.6	11.4	-	-	1203 rural children
15 Datta Banik et al. (1972)	10.8	10.3	12.5	11.9	14.0	13.8	15.6	15.1			Underpreviliged - sample size 85 to 160
	12.2	11.9	14.2	13.7	16.1	15.9	18.1	17.2			Wellpreviliged - sample size 22-45
16 Gupta and Agarwal (1972)*	7.8*		9.6*		11.1*		13.2*				Low calorie & protein diet
	8.9		12.1		16.6		17.3				High calorie & protein diet

Table 2.1 - contd.

WEIGHT in Kg. contd.

	Investigator	Nearest Age Levels										Remarks
		2 years		3 years		4 years		5 years		6 years		
		Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
17	I.C.M.R. (1972)+	10.1	9.5	12.0	11.1	13.5	12.8	14.9	14.4	16.1	16.1	All India study
						HEIGHT in cm.						
1	Athavle (1959)*			93.0*		98.8*		106.2*		111.8*		897 boys and 107 girls. 3 to 19 years.
2	Rao et al. (1961)							98.3	95.0	103.8	101.9	Rural children (sample size very small for 5 yrs.)
3	Smart (1962)			90.6	89.1	96.6	95.7	101.0	103.1			31-60 boys; 14-50 girls.
4	Currimbhoy (1963)	81.5 91.7	80.4 90.8	88.5 97.9	86.1 97.3	95.2 105.5	95.5 105.6	101.9 111.8	99.8 112.3	106.6 -	107.0 116.8	Lower Eco.Group Upper Eco.Group
5	Udani (1963)*	76.2* 83.3 85.6		82.6 91.2 94.0		85.1 98.0 106.7		88.9* 107.7 109.2		101.6* 112.8 117.6		Poor Income Group Middle Income Group Upper Income Group
6	Phadke (1968)			92.5 89.9	90.8 88.2			104.7 101.5	104.3 100.5			Part of ICMR study Urban | Urban semi- Rural | urban rural samples

Table 2.1 - contd.

HEIGHT in cm. contd.

Investigator	Nearest Age Levels										Remarks
	2 years		3 years		4 years		5 years		6 years		
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
7 Phatak (1968)	81.7	80.4									Age - 1-30 months
8 Gokulnathan and Verghese (1969)*	92.8		97.5		105.7		112.7				High & Middle Socio-Eco.Group.
	82.0		90.0		98.0		101.0				(Low Socio-Eco. Group quoted from other study). 390 children age nearest to ICMR study.
9 Rajalakshmi and Ramakrishnan (1969)	79.0	77.0	87.0	84.0							Lower Income Group
	83.0*		89.0*								Upper Income Group. L.S.rural study sample size ?
10 Agarwal (1970)					103.1	100.6	106.0	105.0	110.9	110.5	Study from 4 to 17 years
11 Srivastava et al. (1970)	81.7	78.2	83.5	81.6	89.7	89.1	97.2	96.7			1000 rural children
12 Datta Banik et al. (1970)	80.0	77.9	84.5	85.7	94.1	92.7	104.4	99.3			L.S.Birth to 5 yrs. 1725 children (finally 124).

Table 2.1 - contd.

HEIGHT in cm. contd.

Investigator	Nearest Age Levels										Remarks
	2 years		3 years		4 years		5 years		6 years		
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
13 Chaudhuri and Ramakrishnan (1972)	78.5	77.8	81.8	79.2	86.3	83.8	94.4	93.8			1203 rural children.
14 Datta Banik et al. (1972)	84.1	83.0	93.0	91.3	100.6	99.1	104.9	102.8			Underpriviliged - sample size :85-160.
	86.6	85.5	95.8	94.3	102.2	100.9	107.4	106.1			Well-priviliged - sample size :22-45.
15 Gupta and Agarwal (1972)*	73.2*		81.6*		87.2*		95.5*				Low calorie & protein diet.
	77.4		90.3		104.6		106.5				High calorie & protein diet.
16 I.C.M.R. (1972) +	82.0	80.2	89.0	87.0	96.0	94.7	102.2	101.5	108.1	107.5	All India study.

Table 2.1 - contd.

SITTING HEIGHT in cm.

Investigator	Nearest Age Levels										Remarks
	2 years		3 years		4 years		5 years		6 years		
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
1 Currimbhoy (1963)	44.9	43.5	47.5	46.4	50.5	49.7	52.3	51.8	54.0	53.8	Head to pubis.
2 Chaudhuri et al. (1964)	48.2	46.1	50.1	51.4	55.4	52.9	55.8	55.4			(Sample size:3-15) Age comparable to ICMR -small sample size.
3 I.C.M.R. (1972) +	48.9	47.7	51.8	50.1	54.5	53.2	57.0	56.1	59.3	58.4	All India study.

HEAD CIRCUMFERENCE in cm.

1 Currimbhoy (1963)	50.3	46.4	49.3	49.6	50.2	49.8	50.5	50.9	-	-	Upper Eco. Group.
	47.3	46.0	48.5	47.6	49.2	49.6	50.3	49.8	50.6	49.0	Lower Eco. Group. (Total 1078 Children).
2 Udani (1963)*	-	-	-	-	47.6*	-	-	-	49.5*	-	Poor Income Group.
	-	-	-	-	49.5	-	-	-	50.8	-	Middle Income Group.
	-	-	-	-	52.1	-	-	-	50.8	-	Upper Income Group.
3 Swaminathan and Jyothi (1964)	44.0	44.0	45.7	46.2	-	-	-	-	-	-	L.S. 40 Boys, 47 Girls.
4 Phadke (1968)	46.2*	-	-	-	47.9*	-	-	-	-	-	

Table 2.1 - contd.

HEAD CIRCUMFERENCE in cm. contd.

Investigator	Nearest Age Levels										Remarks
	2 years		3 years		4 years		5 years		6 years		
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
5 Srivastava et al. (1970)	46.3	44.7	47.3	46.0	48.2	46.2	48.4	47.1	-	-	1000 rural children
6 Chaudhuri and Ramakrishnan (1972)	46.6	45.6	46.9	46.1	47.8	46.4	48.6	47.7	-	-	1203 rural children upper age limits.
7. Gupta and Agarwal (1972)*	45.1*	-	47.2*	-	48.1*	-	48.7*	-	-	-	Low calorie and protein diet.
	46.8	-	48.5	-	50.0	-	50.3	-	-	-	High calorie and protein diet.
8 I.C.M.R. (1972) +	46.1	45.1	47.4	46.2	48.3	47.1	48.7	47.9	49.0	48.3	All India study.

CHEST CIRCUMFERENCE in cm.

1 Currimbhoy (1963)	52.2	-	51.8	49.8	53.2	54.1	54.3	55.2	-	57.6	Total 1078 children Upper Eco. Group.
	47.8	47.0	49.4	48.1	50.9	50.6	52.9	53.3	53.3	52.7	Lower Eco. Group.
2 Udani (1963)*			48.3*				52.6*				Poor Income Group
			50.3				53.3				Middle Income Group
			53.1				55.4				Upper Income Group.

Table 2.1 - contd. CHEST CIRCUMFERENCE in cm. contd.

Investigator	Nearest Age Levels										Remarks
	2 years		3 years		4 years		5 years		6 years		
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
3 Swaminathan and Jyothi (1964)	43.4	43.0	46.2	45.2							L.S. 40 Boys, 47 Girls.
4 Phadke (1968)*	46.2	-	-	-	49.5	-	-	-	-	-	5,000 urban 7,500 rural children Part of ICMR all India study.
5 Srivastava et al. (1970).	45.8	44.8	47.1	46.0	48.6	47.7	49.9	49.0	-	-	1000 rural children
6 Chaudhuri and Ramakrishnan (1972)	47.2	45.7	47.5	47.1	49.1	47.5	50.9	50.1			1203 rural children upper age limits.
7 Gupta and Agarwal (1972)*	43.5*		46.6*		48.8*		50.9*				Lower calorie and protein diet.
	47.0		49.7		54.8		54.1				Upper calorie and protein diet.
8 I.C.M.R. (1972) +	45.9	45.1	48.3	47.0	49.3	48.6	51.2	50.1	52.3	51.4	All India study.

Table 2.1 - contd.

UPPER ARM in cm.

Investigator	Nearest Age Levels										Remarks
	2 years		3 years		4 years		5 years		6 years		
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
1 Srivastava et al. (1970)	12.9	12.9	13.1	13.2	13.7	13.4	13.7	13.8	-	-	1000 rural children
2 Chaudhuri and Ramakrishnan (1972).	13.0	12.8	12.7	13.0	13.7	13.2	14.0	14.0	-	-	1203 rural children. Upper age limit
3 Gupta and Agarwal (1972)*	-	-	13.1*		13.7*		14.4*				Low calorie and protein diet.
			15.2		16.0		16.2				High calorie and protein diet.
					CALF CIRCUMFERENCE in cm.						
1 Shingla (1968)*			19.4*								50 boys + 50 girls.
2 Srivastava (1970)	16.9	16.2	17.1	17.1	18.2	17.9	18.9	18.6	-	-	
3 Chanchani (1972)			19.3	19.2							500 children.(Age comparable to ICMR).
4 Gupta and Agarwal (1972)*			16.0*		16.4*		17.7*				Low calorie and protein diet.
			18.1		20.3		19.7				High calorie and protein diet.

Table 2.1 - contd.

LEG (LOWER LIMB) LENGTH in cm.

Investigator	Nearest Age Levels										Remarks
	2 years		3 years		4 years		5 years		6 years		
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
1 Currimbhoy (1963)	36.6	36.5	41.1	40.0	44.7	45.7	49.5	46.1	52.5	53.1	
2 I.C.M.R. (1972)+			33.1	32.5	37.2	36.9	41.5	41.5	45.2	45.4	

FOOT LENGTH in cm.

1 Shingla (1968)*			15.0								
2 Chanchani (1972)			16.1	16.0							

* no distinction between male and female sex.

\+ the age point includes all children from the past point to just below the next.

L.S.= Longitudinal Study.

Table 2. 1 - contd.

Total studies reviewed :	17
Growth Parameter :	**Number of studies**
Weight	17
(Standing) Height	16
Sitting Height	03
Head Circumference	08
Chest Circumference	08
Shoulder (biacromial) Width	-
Upper arm Circumference	03
Fore arm Circumference	-
Arm length	-
Thigh Circumference	-
Calf Circumference	04
Leg (lower limb) Length	02
Foot Length	02