CHAPTER IV

HISTORICAL REVIEW OF PHYSICAL GROWTH AND

DEVELOPMENT

A - Review of Studies of Physical Growth and Development
in other Countries :

Introduction :

Bayley & Davis 1935, Thompson 1956, Merminod 1962,

Falkner 1966 and Kessen et al 1970 present fairly
comprehensive reviews of work on external measurements,
bone age, water, fat and protein composition of the body,
as well as currently available data on variation in early
physical growth that can be assigned to variations in
nutrition, social environment, and sex differences. In
these reviews there is a persistent and striking finding
of the individual regularity of certain aspects of physical
growth.

For the purposes of this study, this review is
organised with physical growth measurements of infancy as
the central idea.

Pre 1940 studies :

The first interest in bodily growth strangely enough came from the artist. The practical problem of presenting a child form realistically, led the artist to study size and proportion in relation to age. During the early years of the study of physical growth, relevant to the absolute nature of the then prevelant concepts of beauty, the artist looked for perfect proportions in the young. (Beldwin 1921)[1].

Around 1760, there appeared the first scientific study of weight and physical proportions of the new born. Prior to 1799, there were no standardised measuring instruments. In 1799, when the standardised meter bar was constructed, some uniformity came in the measuring instruments. During this period (1755-1799), Count Philbert de Montbeillard took 6 monthly increments in stature, on his son from birth to 18 years and drew a curve. This was the first longitudinal study of physical growth. It was published by Buffon (1837)[2] in 1837.

The year 1817 saw the publication of Anthropometric by Quetelet.[3] He was the first one to systematise the study

1. Baldwin, B.T.1921. The Physical Growth of Children from Birth to Maturity. University of Iowa Studies on Child Welfare, 1.No.1.
2. Buffon, Count de. (1837). Supplement to the Histoire Naturelle.
3. Quetelet, A.1817. Anthropometric Brussels: Muquardt.

of physical growth. Credit for originating the word 'anthropometry' goes to him.

According to Scammon, [1] the physical growth studies of children started quite late in the history of natural science. It was not till the last quarter of the 19th century that anthropologists and workers in allied fields began in some seriousness to chart the physical growth history of man.

Almost a hundred years went by since the construction of the standard meter bar, before the physical and mental growth of the child were studied together by Hall (1896)[2]. In spite of studying them simultaneously, the physical and mental aspects of growth and development were not correlated. It was during the twenty years around the turn of the century that the interest in a possible correlation between these two aspects began to emerge. The pioneer of psychological testing Binet, A., (1900-1910)[3] in France concerned himself with head and face measurements in the hope of finding in them, an index of mental development, without success. Similar unsuccessful results were reported from London, at about the same time.

1. Scammon, Richard E. as quoted in Meredith, H.V. The rhythem of Physical Growth, 1955. University of Iowa,p.7.

2. Hall, W.S.1896. The first five hundred days of a child's life. Child Study Monograph 2, Nos.6 & 7, p.332-342 and 394-407.

3. Binet, A., 1900-1910. Thompson. H.Physical Growth In Carmichael's manual of Child Psychology, 1968. 2nd edition, Wiley Eastern Pvt.Ltd.
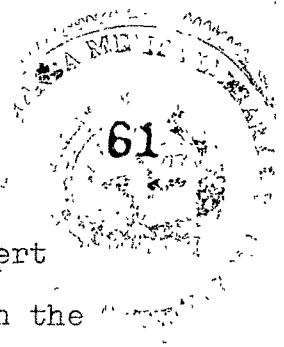
During the same period, Porter (1893), Gilbert
(1895) and others in U.S.A. were also interested in the
relationship between mental and physical traits. They
showed that size and mental brightness for the age were
correlated. Crompton (1908) reported that earlier maturing
boys were better students. With the publication of
Goddard's (1912)[1] study the physical growth of the feeble
minded attracted attention. Soon after, Binet, et al
(1914)[2] and Doll (1916)[3] published similar work. These
three investigations in Europe and America seemed to mark
the beginning of the study of mentally deffective children.
In all the three investigations the authors found the
mentally deffective children to be physically inferior
to the normal.

The year 1913 also marked the beginning of the use
of physiological measures in the study of human growth.
Canestrini (1913)[4] was the first one to use cranial blood
pulsation of the infant as an index of sensory function.
Respiratory and heart rates were also used by the early
investigators.

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1. Goddard, H.H.1912. The height and weight of feeble
   minded children in diseases. Journal of Nervous and
   mental.Diseases.
2. Binet, A., and T.Simon. 1914. Mentally deffective
   children. (Trans.) New York Longmans, Green.
3. Doll, E.A.1916. Anthropometry as an aid to mental
   diagnosis. Vine land, N.J.Training School.
4. Canestrini S.Uber das Sinnesleben des Neugeborenen
   (nach physiologischen experimenten). Gesamtgebiete
   Neurol. Psychiat., 1913,5, 1-104.

Reporting from the Iowa Child Welfare Research Centre, Baldwin (1921)[1], who initiated the long term programme of study of physical growth said that for each chronological age, the physiologically (as shown by heights and weights) accelerated boys and girls have a higher mental age than those of the average or below the average physiological age.

In spite of these similar reports, since the correlation of mental and physical traits was found to be small, the general interest in this field of study ebbed. Researches at Harvard and Iowa, however, continued in the field. In the middle twenties, additional research centres came into being and this revived the interest in physical development.

In 1928, for the first time, the classical anatomist Gray (1928)[2] suggested that as a reference standard for ideal weight, stature may not be very satisfactory because an inch of extra length in lower leg may have little contribution to tissues that primarily contribute to weight. Instead, bony chest breath or some other parameter involving total frame size may be a more appropriate reference standard.

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1. Baldwin, B.T.1921. The physical growth of children from birth to maturity. University of Iowa studies in child welfare, 1, No.1.

2. Gray, H. The relation of weight to stature, bi-cristel dimeter and age. Biometrika 1928, 20, 299-309.

At this point, in the history of study of physical growth during infancy, two names stand out, that of Arnold Gesell and Howard Meredith.

Arnold Gesell[1] put infancy on the map of investigations pertaining to human development with the publication of Infancy and Human Growth in 1928. Gesell studied motor development in detail, adopting innovations in methodology. He also made popular the term 'maturation' as referred to human development. He describes his concept of the process of reciprocal interweaving, as one which "functionally ..... results in a progressive spiral kind of reincorporation of sequential forms of behaviour".[2] This same concept of spiralling is also manifest in the purely physical growth of the human being. Infancy is the twilight zone of human growth and development, during which the physical and the psychological correlates are meshed together, resulting in the primarily disorganised human infant. Thus Gesell's work was also characteristic of the study of the whole infant. Every parameter that touched the life of the infant was scrutinized in detail by him. For example, the infant's sleep pattern, feeding, clothing, schedules, hygiene etc. In other words, Gesell,

1. Gesell, A.1928. Infancy and Human Growth. Mac Millan, New York.

2. Mussen P.H.(Ed.) Carmichael's Manual of child Psychology. Wiley Eastern Pvt.Ltd., 2nd Edition,p.342.

a paediatrician by profession, has used observation and description as his main tools of study. He focussed attention on the infant and his needs.

In 1929, at the third conference on Research in Child Development held at the University of Toranto at Toranto, in Canada, Scammon differentiated the increments in physical growth at different ages to constitute different tissues. To quote: " ..... equal units of increment at various stages of development often represent different entities. A Pound's gain in weight in an infant is quite a different thing from an equal gain in later life. In the baby, this increment represents a gain in brain substance and viscera, as well as in enlargement of other parts of the body, in an adolescent it is primarily an increase in bone and muscle − while in the middle age it is often nothing but an accumulation of adipose tissue." [1]

The programme of measurement of physical growth initiated at Iowa City by Baldwin as mentioned before was carried forward by Professor C.H.McCloy. Howard Meredith published the results of this study in 1935.[2] This is a

1. Scammon, Richard E. as quoted in Meredith, H.V. The rhythm of Physical Growth 1955. University of Iowa, Iowa, p.7.

2. Meredith H.V.1935. The Rhythm of Physical Growth. Vol.XI, No.3, University Iowa City, Iowa, U.S.A.

study of 18 anthropometric measurements. It gives means
and standard deviation and constitutes the tentative norms
for the male children of American born parents of
significantly above average socio-economic status. " For
certain measures they give the only normative material
published till then ..... but the main findings deal with
growth cycles in detail for each of the skeletal
measures." [1]   The eighteen measurements include stature,
sitting height, chest circumference and body weight, but
strangely enough not head circumference. This measurement
was studied and the results published at a later date. This
study covers the age period from birth to 18 years.
Measurements were taken at three monthly intervals beginning
at 1½ months through 3 years of age. Minot's [2] arithmatic
method devised in 1891 and first used to obtain acceleration
curve of weight for guinea pigs, was used by Meredith to
analyse the data. This method is described by Minot in his
1908 publication.

At about the same time, in spite of a persistent
and striking finding of individual regularity of certain
aspects of physical growth in anthropometric measurements

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1.   Meredith H.V.1935. The Rhythm of Physical Growth.
     Vol.XI, No.3-University Iowa City, Iowa, U.S.A.
2.   Minot C.S.1908: The problem of age, growth and disease.
     A study of cytomorphosis based on lectures at Lowell
     Institute, March 1902. New York : Putnam's, 1908.
     XXII, 280.

of the new born infant, Bawkin & Bawkin 1934 [1] and

Carter and Krause [2] (1936) demonstrated that physical

proportions of the human infant were not highly correlated.

At about the same time Nancy Bayley, who has done extensive

work on infancy and who has also published her infant

testing scale for the same, inconjunction with Davis,

gave a comprehensive review of work on measurements in

bodily size and proportions during the first three years

of life.

Soon after, Talbot et al (1937)[3], showed that basal

oxygen requirement in normal and non-obese children is

better expressed in relation to a weight standard than to

a stature standard.

These studies characterise the interest of the

workers in simple measurements of physical growth and

beginnings of their effort to relate them to other and

varied aspects of human development. They also reflect

the preoccupation with newborns, probably because of their

easy availability for study. Professionally the investiga-

tors represent artist, parent, pediatrician, and

psychometrist.

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1. Bawkin H. & Bawkin, R.M.1934. Body build in infants V.
    Anthropometry in the newborn Human biology, 1934, 6,
    612-626.

2. Carter, and Krause R.H.1936. Physical Proportions of
    the human infant, Child Development, 7, 60-68.

3. Talbot, F.B., Wilson, E.B.Worcester, J.(1937). Basal
    metabolism of girls' physiologic background and application
    of standards. American Journal of Disease in Childhood,
    53, 273-347.

1940

In 1940, describing the trend in this field of study, Krogman[1] reports the beginning of interest in the whole child, and his environment. Around 1940, the emphasis shifted from the cross-sectional to the longitudinal, and from the average growth trends to individual growth rates and patterns of maturing. Search began a new for a meaningful relationship between the physical and mental growth in the individual growth histories.

Pryor (1940)[2], like the anatomist Gray, (1928), suggested width-weight index instead of the customary height weight standards for body size.

Studies of physical growth began to acquire depth instead of mere descriptional measurements. Lasker (1946)[3] showed that the growth in stature had three components viz., (1) genetic (2) nutritional, and (3) disease caused. This was probably the beginnings of the effort to isolate the environmental and genetic effects on physical growth.

1. Krogman W.M. 1940. Trend in the study of physical growth in children. Child Development, 11, 279-284.

2. Pryor H.B.1940. Width weight tables (2nd rev.ed.) Stanford University Press.

3. Lasker G.W.1946. Migration and Physical differentiation: A comparison of immigrant and American born chinese. American Journal of Physical Anthropology, 4,273-300.

<u>1941-1955</u> :

In 1943, Dr.Meredith[1] reviewed and synthesized
North American researches on stature for the first two
years of life for the period 1850-1941. This volume is in
two parts. Part I presents an analysis of data relevant
to eleven specific problems of stature, viz., secular
change, sex, socio-economic and race differences, and the
effects of illness and dietary treatments. Part II is an
annotated bibliography of all studies. It includes a
large number of studies not otherwise available because of
their age or the obscure medium of their publication. For
every investigation the data on stature has been converted
to a common scale of reference. This is a monumental
and significant work. With it, Dr.Meredith dominated
the forties.

That same year Bayley[2] published tables for
predicting adult heights from present height based on her
California Study. She reported correlations above 0.50
between length at 3 months and height at 18 years. This
was also an indication of the changing style of research
investigations on children.

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1. Meredith H.V.1943. <u>Physical Growth from birth to two
    years</u>: I Stature University of Iowa Studies: Studies
    in child welfare Vol.XIX. Uni. of Iowa, Iowa City.
2. Bayley N.1946. Tables for predicting adult height from
    skelatal age and present height. <u>Journal of Pediatrics</u>,
    28, 49-64.

According to Kessen [1] et al, (1970) regularity of
this nature is a feature of stature only amongst the various
measures of physical growth and " is not even approached
by any measure of infantile behaviour. "

Late 50's to 1970 :

In 1951, Dean[2], reporting on his work with African
babies showed that undernourished infants were small and
grew slowly. In 1960 and 1962 he demonstrated the relation
between under and/or malnutrition in infancy and ultimate
growth achievement. He suggested that there may be a
falling away from expected development after age 4, inspite
of continuation of adequate diet.

Richmond and Lustman (1955) and Grossman and
Greenberg (1957) related newborn behaviour to vasodilation
in skin and to body temperature respectively.

Greulich[3] (1957) demonstrated that improved nutrition
will improve rates of growth. About the same time
Thompson, 1956 gave a fairly comprehensive review of work
on external measurements.

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1. Kessen et al 1970 p.290 in Mussen 1970.
2. Dean R.F.A.195?. The size of the baby at birth and the
    yield of breast milk studies of under nutrition.
    Wuppertal. 1946-49 Special report series Medical
    Research Council, London. No 275
3. Greulich, W.W. A comparison of the physical growth and
    development of American born and native Japanese
    children. American Journal of Physical anthropology,
    1957, 15, 489-516.

Dreyfus-Brisac 1962 and Engcel 1963 like their predecessor (Smith 1938) were amongst the first researchers to use electro encephalogram. Barnett and Goodwin (1965) and Weller and Bell (1965) assessed auditory potentials and related infant behaviour to basal skin conductance respectively. Dustman and Beek (1966) assessed visual potentials in infants. Stechler, Bradford and Levy (1966) related behaviour to skin potential, and Barnet, Lodge and Armington (1965) related infant behaviour to electro retinography. Eichorn (1963), (1968) and Steinschneider (1967) have revived the use of physiological measures in the study of early development. In the words of Kessen et al (1970)[1] "Measures of cardiac activity can illustrate the remarkable range of use of physiological indicators in the study of infants."

In 1969, Robinson [2] used standard anthropometric techniques involving five measures - five ratios, skelatal age assessments, and photographs. In this study, pre and post operative samples differed from the norm in that measurements were somewhat smaller and skelatal maturation,

1. Kessen, W.Haith, M.M., & Salapatek, P.H. Human Infancy: a bibliography and Guide. Chapter 5. I Mussen, Paul H. 1970. Ed.: Carmichael's manual of child Psychology, Vol.II 3rd Edition. John Wiley & Sons, Incorporated New York, London, Sydney, Toranto.

2. Robinson, Saul J. and Leona M.Bayer. Growth history of children with congenital heart defects. Effect of operative intervention Child Development, 1969, Vol.40, No.1, p.315-346.

somewhat delayed. As the children neared adolescence
this difference tended to become narrower. No marked
shift in pattern after surgery had thus far been
demonstrated, although where differences existed they
tended to be towards larger measures in the post-
surgical group of children. By the second year of life,
the measures on the children in this sample seemed to be
smaller than the norms and their skeletal maturation was
retarted. At all ages the ratio of sitting height to
stature was larger than the chronological age standards.
In other words the children were primarily short legged.
Apperently, the growth of children with congenital
cardiac lesions approached closer to norms in the post
adolescent years irrespective of the fact as to whether
they were operated upon or not. No obvious catch up growth
was demonstrated. However the rate of weight gain was a
little accelerated.

Thus, in the '70s, researches on physical growth
and development, have arrived at a precise and sophisticated,
cause and effect model over the long period of evolution.

B - <u>Review of Related Indian Studies on Physical Growth</u> :

In 1944,[1] Ghosh, Sen and Chandrasekher reported, what appears to be the first study concerned with heights and weights and other linear anthropometric measurements. This longitudinal study, of infants of North Indian communities residing in Calcutta was carried out in 1943. 51 male and 60 female infants were measured within 36 hours of birth, at 4 weeks, 20 weeks, and 50 weeks of age. The measurements of weight, stature and hip width were taken. Correlations of weight with height were calculated for both male and female, but at what age these correlations were calculated is not specified.

The study reported by Rao and Bhattacharjee [2] (1953-54) was a longitudinal study of 43 infants during the first year of life. These infants belonged to middle class Bengali and South Indian families residing in Calcutta. In the first part of the study they reported daily measurements from birth to one month, and in the second part of the study, they reported weekly

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1. Ghosh, L.M.Sen and C.Chandrasekhar. 1944. A study of development of Indian Infants in a community in Calcutta. <u>Indian Journal of Pediatrics</u>, 11, 1-14.

2. Rao M.N., and B.B.Bhattacharjee 1953. Physiological norms in Indians I Growth curves of children in the first month. <u>Indian Journal of Pediatrics</u>, 19, No.82. 249-260.

Rao M.N. 1954. Physiological norms in Indians II, Growth curves of children in the first year. <u>Indian Journal of Pediatrics</u>, 20, 249.

measurements from 1 month to 12 months. The measurements reported were heights and weights. The investigators compared their results with Ghosh et al (1944), in addition to European, American and Chinese studies.

In 1957, Paul S.S. and D.Ahluwalia [1] studied anthropometric measurements of healthly new borns in Delhi. They reported that younger mothers had lighter babies upto the age of 35 years, and that birth weight increased with parity upto the fourth parity.

The same year, Phadake [2] started a cross-sectional study of 1,335 infants and then abruptly discontinued it after 5 months. The measurements taken were weight, stature, stem height, head circumference and chest circumference. In addition, foot length, thigh girth and abdominal measurements were also taken. Data were collected on the mother's literacy level and her economic condition. These infants belonged to the low socio-economic group and the study was cross-sectional. No attempt was made to correlate income and literacy with these measurements.

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1. Paul S.S. and D.Ahluwalia 1957. Anthropometric measurements of healthy newborns in Delhi. Indian Journal of Child Health,6. 863-867.

2. Phadake M.V.1957. Anthropometric observations of Infants and Children. Indian Journal of Child Health 6, 868(a).

The same year, Gopalan [1] studied 1014 children
aged 1 month to 6 years coming from a low socio-economic
group at the Nutritional Research Laboratories at Cunoor.
This was a cross-sectional study of malnutrition. He
found that the mean weight at age 1 year was 6.7 kg. and
mean height was 67 cms, and the rates of growth were low.

In 1959, Udani [2] reported birth weights of 3000
new borns from different socio-economic classes in Bombay.
The next year, Uklonskaya et. al [3] reported on a
longitudinal study of 116 infants at the start of the study
and 42 at the end of study from New Delhi. This study was
of the 1st year of life. These infants were measured
during 1958-59. The measurements were weight, height,
head circumference and chest circumference; taken at 8
monthly intervals. They found that their conclusions were
similar to those of Ghosh et al (1944) and Rao and
Bhattacharjee (1953). They also concluded that a marked
retardation in physical growth of the Indian infants
appeared at 5 to 6 months of age in comparison to the
Russian norms. Amongst other factors, Uskonskaya et al(1960)

1. Gopalan 1957. Study of malnutrition. Nutritional
    Research Laboratories, Cunoor.

2. Udani P.M. 1959. A study of birth weights in Bombay.
    Indian Journal of Child Health 8, 38-40.

3. Uklonskaya, R., B.Puri, N.Chaudhari, N.Luthara, Dang,
    and Rajkumari, 1960. Physical development of infants in
    New Delhi in the first year of life. Indian Journal of
    Child Health, 10, 211-218.

felt that poor nutrition, and diseases like
gastroenteritis were important contributory factors.

Mira Shroff,[1] a pediatrician, in 1962 reported on
longitudinal observations of infants being looked after
by the Kherwadi Family and Community Health Centre in a
Bombay suburb. This centre was attempting to look after
the whole child and followed some children soon after
birth from the slum area it served.

Zinat Currimbhoy [2] in 1963 reported on the growth
and development of 1101 children of lower economic group
upto 16 years of age. Out of these 1101 children, 158
boys and 123 girls belonged to the 3 to 12 month age group.
Her sample included all communities, and religions. There
was no identifiable division of the sample. For example
Hindus, Muslim and Gujaratis were classified (Table XXIII
p.650) with no clarification as to whether Gujaratis were
all Hindus or included some Muslims and vice versa,
whether the classes of Hindus and Muslims included any
Gujaratis or not.

In 1963, Udani [3] also reported on the physical growth

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1. Shroff, Mira 1962. Growth and development of babies:
   a study. Indian Journal of Child Health 11, 207-209.
2. Currimbhoy, Zinat 1963. Growth and development of
   Bombay Children. Indian Journal of Child Health 12,627.
3. Udani P.M. 1963. Physical growth of children in different
   socio economic groups in Bombay. Indian Journal
   of Child Health, 12, 593-611.

of 5540 children ranging in age from 0-6 years and
belonging to different socio-economic groups in Bombay.
This was a cross-sectional study. He found wide
variations in weights and heights of upper, middle and low
socio economic groups. This difference was small but
statistically significant at birth and widened as the
measurements were taken on progressively older groups of
children. These differences in the socio-economic groups
were attributed to suggested factors of ancestral and
genetic malnutrition. The role of the latter is difficult
to understand.

In 1964, Swaminathan et al [1] from Hydrabad reported
on the anthropometric measurements of 40 male and 47 female
infants observed semi-longitudinally. These infants were
measured every 2 months $\pm$ 15 days during the first year,
of life and every 3 months $\pm$ 15 days there after upto
3 years. The measurements taken were weight, stature, stem
height, head circumference and chest circumference. The
growth in these measurements was correlated with role of
socio-economic status, illness, nutrition and recurrent
pregnancies of mothers. Growth patterns of the children
are classified on the basis of weight at different intervals.

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1. Swaminathan M.C., Jyothi K.K., Raghbir Singh, M.Shanthan
    and C.Gopalan 1964. A semi-longitudinal study of
    growth of Indian Children and related factors.
    Indian Pediatrics 1, 255-263.

In the same year Suchit Prasad (1964)[1] also
reported on anthropometry in the rural areas of Ranchi.
He observed sick children attending the Outpatient's
department during 1959-60. His observations were made on
children who were upto 6 months of age, between 6 and 12
months of age and between 1 and 2 years of age.

In 1965, Satyanandam [2] collected her data on the
birth weights and birth heights of 287 male new borns and
255 female new borns during the later half of 1964. She
measured the weight of the babies wearing the hospital
smock on a beam scale corrected for 0-error and than
deducted the weight of the smock from it. Birth height
was taken on the infantometer. Head circumference was
measured with a 'non elastic tape'. All the mean measurements
were least in the new borns of the primipara, but the
highest mean birth weight was noted in the 7th parity,
heighest mean birth length was noted in the 8th parity
and heighest mean head circumference was noted in the 10th
parity. She found the male infants to be larger than the
female infants. The group of mothers whose age was below
18 years had new borns whose mean measurements were
minimum and those mothers who were upto 27 years of age

1. Prasad, Suchit 1964. Pediatric anthropometry in rural
   areas. Ranchi Indian Pediatrics 1, 12.
2. Satyanandam E.Mary. 1965. Heights and weights at birth
   of a sample of children born in Baroda City. A disserta-
   tion submitted in Partial fulfilment of the requirements
   for the degree of Master of Science (Home), Department
   of Child Development, M.S.University of Baroda. Unpublished.

had given birth to infants whose mean measurements were maximum.

During 1967, Khanduja [1] et al reported on a small longitudinal sample they studied in New Delhi for the 1st year of life who were provided with optimum diet. They started with 8 infants and there were 23 in the sample at the end of the year. Since there were only 5 female infants in these 23, the sexes were combined. The measurements taken were weight, height and head circumference. Their conclusion was that irrespective of socio-economic and religious groups, infants receiving optimal nutrition approached comparable growth pattern of the infants of better developed countries.

1968 seems the year in which a very large number of children were studied in our country. Phadake [2] studied 15,000 children, half of them from the urban areas and other half from the rural areas. The age range under study was 0 to 7 years, and the study was carried out in Maharashtra.

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1. Khanduja P.C., Agarwal K.N., and P.N.Taneja 1967. Growth study in the first year of life on optimal nutritional conditions. Indian Pediatrics IV, 203-207.

2. Phadake M.V.1968. Growth norms in Indian Children. Indian Journal of Medical Research, 56, 851(b).

Phadake found that the mean values of measurements of
the urban infants were better than their rural
counterparts, and the Indian values were lower than the
Western standards.

Another study reported was that of Ghai and Sandhu.[1]
They studied 1146 infants, measured monthly for the first
three months, and quarterly upto 1 year of age in
New Delhi. The measurements taken were, weight, stature,
stem length, head circumference and chest circumference.
Distance achieved standards are given in the form of mean
values and their standard deviations and percentiles.
They advocate these norms for North West Indian Children.
The sex differences are correleted with economic status.
The dividing line between the higher and lower socio-
economic classes is per capita monthly income of Rs.50/-.
Ghai and Sandhu found that infants, of those families in
which monthly per capita income was more than Rs.50/- had
higher values of heights and weights than those who came
from families in which the monthly per capita income was
less than Rs.50/-.

1.   Ghai O.P. and R.K. Sandhu 1968. Study of Physical
     growth of Indian Children in Delhi. Indian Journal
     of Pediatrics, 35, 92.

The following year (1969) three studies were reported. Dikshit [1] et al from Varansi reported on the birth to 2 years age group; Gokalnathan and Verghese [2] from Kerala reported on the age group of 1 to 6 years, B.D.Patel et al reported from Bombay on the age group 6 months to 3 years and beyond.

Dikshit et al studied 204 healthy infants of middle class families. They measured these infants at 3 weekly intervals from 0-2 years. Measurements taken were heights, weights, and head circumference. Growth patterns in their study were analysed for different ages and sexes. They advocate their results as standards for North Eastern India. Finally, they compare the results with those of other workers, and with American and British studies.

Gokulnathan and Vergheese took heights and weights of 229 male infants and 161 female infants. They compared their results with those of Udani (1963) in an attempt to differentiate between the 'socio-cultural' malnutrition and 'socio-economic' malnutition as it affected the infants from an industrialised society like Bombay and a 'pre-industrialised' society like Varansi.

1. Dikshit S.K., S.Agarwal and V.N.Purwar 1969. Growth pattern of normal infants in Varanasi (U.P.), India. Indian Journal of Pediatrics, 36, 145.
2. Gokalnathan K.S. and K.P.Vergheese 1969. Malnutrition (Growth failure in children due to socio cultural factors). Journal of Tropical Pediatrics 15, 118.

The study reported by B.D.Patel [1] et al is aimed at ascertaining the impact of age on mental development in relation to nutritional states and environment, and to detect (if any) critical age of maximum influence. 1400 children of various nutritional status have been studied for their IQ pattern, of which 820 belonged to urban and 680 to rural set up. The data regarding age, weight, mental development, nutrition and environmental state have been analysed and discussed in detail.

It was observed that intellectual development runs parallel in healthy urban and rural children in the age group 6 months to 3 years, although in subsequent age groups urban children displayed better IQ performance, differences being significant. With the onset of malnutrition, the IQ falls below that of normal, both in urban and rural children, However, the impact is less felt in the urban group in comparison to rural ones. 1.25 years of age (15 months) appeared to constitute a critical age upto which nutrition plays a dominant role. Beyond that period, other factors such as environment influences the IQ materially.

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1. Patel, B.D., A.G.Desai, U.M.Ambedker, U.G.Patel, J.Shevade, N.A.Mankodi and M.K.Jain 1969. Influence of age on outcome. (nutrition and brain development). Indian Pediatrics 6, 253.

(1969)

Some year, Seroj Jha[1] followed 61 infants longitudinally from birth to 12 months of age. These infants came from low socio-economic group of the sweeper colony of the Municipal Corporation and their family monthly income ranged from Rs.150/- to Rs.200/-.

In 1970, Datta Banik[2] et al. (1970) reported on 1858 children studied from 0-5 years in New Delhi. They had classified the children according to their birth weights, in the following manner, less than 2000 gms to more than 3500 gms. at 500 gms. intervals. The measurements taken were weight, height, chest circumference and head circumference recorded within 48 hours after birth then repeated quarterly for 1 year, and half yearly there after. The measurements taken were weight, height, head circumference and chest circumference. They were taken ± 7 days of quarterly and half yearly intervals.

In 1970, Derasari[3] reported a study of the primary dentition patterns of 1402 infants aged 1 to 15 months belonging to the poor socio-economic group of Baroda City

1. Jha, Seroj 1969. A longitudinal study of infants belonging to a sweeper community in Bombay City. Part I & II. Pediatric Clinics of India 4, 49-56, 57-60.

2. Datta Banik, N.D. R.Krishna, G.I.R.Meno and Lila Raje 1970. A longitudinal study of physical growth of children of different birth weight groups from birth to five years. Indian Journal of Pediatrics, 37, 95.

* This paper was presented by the investigator of this thesis, at the VIIth National Conference of the Indian Academy of Pediatrics at Bhopal, Jan. 3-6, 1970. The sample in this dentition paper was the same sample under the present investigation.

3. Derasari A.J. 1970. Patterns of primary dentition in 1402 infants. Indian Pediatrics 7, 113-123.

and 27 surrounding villages. She studied the patterns
according to the residence of the infants (Urban or rural),
according to sex, and according to the socio-economic
class. She also studied the age of onset of primary
dentition. She found that the aggregate age of onset
was 8.98 months. The rural infants were late in their 6
mean age of onset by .61 months than their urban counter-
parts. At 15 months of age all the infants in the
cross-sectional sample had their first teeth (lower
central incisors). In the first 10 months of life, the
infants coming from the lower socio economic groups were 11
more advanced in their dentition as compared to the
infants belonging to the higher socio-economic groups.
She also found that Bayley's formula of adding 6 to the 19
number of errupted teeth to assess the chronological age
of the infant was very unreliable, and gave correct 16
answers in only 16% of the children.

The same year Shirole and Phadke [1] reported
weight, length, head circumference and chest circumference
amongst other anthropometric measurements on a 1000 new-
borns. Males were found to be larger in all the measurements
than the females, but the difference was not significant,

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1. Shirole, D.B. and Phadake M.V.1970. Anthropometric
   study of 1000 new born babies. Indian Pediatrics 7
   219-220.

The results of these findings were comparable to those
of other workers in the tropics.

Another 1000 rural preschool children from seven
villages in the district of Jabalpur were studied by
Shrivastava et al [1] for their nutritional status.
Anthropometry, including weight, height, circumference
of head, chest, arm and calf were recorded and
statistically analysed. The anthropometric observations
were critically analysed and compared with surveys carried
out in various regions of the country. The children
belonged to 1 to 5 years of age group. They belonged to
the lower socio-economic class of people. This large
sample included 59 boys and 58 girls in the age group
12-15 months. The investigators observed that the boys
were heavier than the girls but the differences were small.
They also observed that urban children, even if they
belonged to the low socio-economic group, were heavier than
the semi-urban and the semi-urban were heavier than the
rural. 69.6% had one or more abnormal clinical finding
other than congenital anomalies and neoplasms.

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1. Shrivastava, Arun K., R.K.Taluja, and K.K.Kaul, 1970.
   Nutritional status of rural preschool children around
   Jabalpur. I. Anthropometric observations. Indian
   Pediatrics, VII, 313-321.

The same year, growth pattern of babies attending

a well baby clinic have been studied by Ghosh et al [1] from

birth to one year by measuring weight, height, and head

circumference. These infants were studied between

1966-68. Measurements of weight were taken at birth, at

1 month ± 2 days, and every month ± 7 days till the age

1 year. Measurements of height and head circumference were

taken at birth at 3,6,9 and 12 months ± 1 week. The

investigators collected birth data on 5022 new borns. The

sample was 448 for 1 month, and 1251 for 3 months. At the

age of 1 year, there were 106 infants in the sample. Means

and standard deviations are calculated for the number

available at each age month. Quarterly increments are also

calculated. The results were compared with American growth

curves. Indian babies doubled the birth weight at 4

months, but after 5 months the curve became almost flat.

This is attributed to ignorance about nutritional requirements

of infants, poor socio-economic conditions and high

incidence of infections.

In 1970, Usha C.Parekh et al [2] published a very

interesting study in which they studied brain weight, and

1. Ghosh, Shanti, S.K.Bhargava and Vijaya Bhargava, 1970.
    Growth pattern in the first year. Indian Pediatrics,
    VII, 374-377.

2. Parekh, Usha C., Asha Kherwani, P.M.Udani and S.
    Mukherjee 1970. Brain weight and head circumference
    in fetus, infant and children of different nutritional
    and socio-economic groups. Indian Pediatrics 7,347-358.

head circumference in fetus[6], infant[5] and children of different nutritional and socio-economic groups. The study is in two parts. The second part, which is more relevant to the present study is reviewed. This study showed marked differences in the intrauterine pattern of growth in Indian children of low socio-economic groups compared to those of the West. These differences are probably related to nutrition. It was further shown that in the last 6-7 weeks of intrauterine growth, Indian babies have :-

(a) Weight deficit of 1053 grammes.

(2) Deceleration of growth, mainly weight but also length.

(c) Reduced rate of growth of head circumference (brain growth) (Indian 2.5 cms; Western 4.4 cms.)

(d) Markedly reduced rate of growth of chest circumference (Indian 2.2 cms; Western 5.2 cms.)

In this second study, the investigators studied 246 infants of different gestational ages. Anthropometric measurements were taken between 12 and 36 hours after birth. Intrauterine growth of chest circumference as studied by Usha Parekh et al, also shows periods of rest (no growth) between 26/27 and 28/29 weeks.   It also shows spurts of growth (marked increase) between 28/29 and 30/31

weeks. Deceleration in head circumference was most marked
in the 26/29 and 30/33rd week of in utero period; it became
more gradual then onwards. This unevenness of rate of
growth is also noted in the length measurements in the same
period of intra uterine growth in both the Bombay and the
Canadian Series.

In 1970, Pachauri and Marwah [1] reported on socio-
economic factors in relation to birth weight. They
studied the effect of certain socio-economic factors on
birth weight of 447 live births. They found that per
capita income and type of house appeared to be the most
important environmental factors affecting birth weight.

In 1971, Prasad et al [2] reported a cross sectional
study of 1002 preschool children of Agra and Bichpuri
Rural Clinic. The measurements taken were weight,
height, stem height, head circumference and chest
circumference. These measurements were related to sex and
socio-economic status.

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1. Pachauri, Saroj and S.M.Marwah, 1970. Socio-economic
    factors in relation to birth weight. Indian Pediatric
    VII, 462-468.

2. Prasad, R., R.Kumar and R.S.Dayal 1971. Physical growth
    and development from 1-5 years. Indian Pediatrics 8,
    105-119.

The same year, Khurana et al [1] from New Delhi
reported a longitudinal study of 28 boys and 27 girls from
0-5 years. The measurements taken were height and weight; [3]
head circumference was measured for only the first 3 years
of life. At least five observations were available for
each child. For height and weight total cross-sectional
observations were 293 and 206 respectively. For the head
circumference the total was 209 for boys and 157 for girls.
The authors have given growth per day using regression
analysis technique.

Sharma and Sabrinathan [2] reported a study on
potential indices of physical growth. This is a study [2]
from Lucknow of 100 healthy children aged 1½ to 3 years
of age coming from families with per capita monthly income
of 50 to 100 rupees or more.

The Indian Council of Medical Research (ICMR) [3]
also published the first part of the results of the
extensive study it had undertaken, on an all India basis.

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1. Khurana, V.K., N.Agarwal, A.H.Manwani and G.Shrivastava
   1971. Physical growth in first five years. Indian
   Pediatrics 8, 331-335.
2. Sharma, N.L. and K.Sabrinathan 1971. Potential indices
   of physical growth. Indian Pediatrics 8, 156-159.
3. Indian Council of Medical Research, (ICMR) 1972.
   Growth and physical development of Indian infants and
   children. Technical report series no.18. Medical
   Enclave, New Delhi.

The final report was published in 1972. The study was undertaken during 1957 to 1965. This study has brought forth the much needed information on growth norms and developmental standards of Indian Children. In this huge sample, there were 2,766 infants who made up 2.1% of boys and 2.2% of the girls of the total sample of 1,23,866. 27% of the total children had their birth dates and consequently their ages verified. How many of these 27%, belonged to the group of 2,766 infants is not specified. Though this study is extensive, and attempts have been made to represent most of the country, Assam, Bihar, Gujarat, Mysore, some parts of Maharashtra, Andhra Pradesh, and Union Territories except Delhi are excluded from it.

The anthropometric measurements of weight, height, head circumference and chest circumference were taken. The age group studied was from birth to 18 years. "In presenting the tables 'Plus (+)' sign affixed to each year of age indicates the interval between a year of age and next". * Thus the infant group 2+ includes all the infants of 25 months, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35 and 36 months. The mean values of standing height and weight of children belonging to different states were found to be significantly different from one another.

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* Ibid p.13.

The Research Unit *from the Child Development
Department of M.S.University of Baroda reported heights and
and weights of 237 infants measured longitudinally. Most
of the infants came from upper middle class and/or
educated parents. The data were collected in pounds and
then converted into kilograms. The height was measured in
centimeters. The data were treated cross-sectionally.
The age group covered was that of 1 month to 30 months.
Unexpectedly large deviations were noted at 18 months
in boys and 21 months in girls. This study found the
girls to be lighter than boys, and shorter.

The same year, Kumud Mehta and Merchant [1] reported
a longitudinal study from Bombay. Their sample consisted
of 1200 infants aged 0-6 months, and 680 infants aged
7 months to 12 months belonging to lower socio-economic
class. In addition, there were 380 infants aged 0 to 12
months from the higher socio-economic class. In the lower
socio-economic group the per capita monthly income was
of Rs.25 to Rs.40/-, whereas in the higher group, the
monthly per capita income was more than Rs.280/-. In this
longitudinal study, the measurements taken were weight,
height, head circumference and chest circumference. These

1. Kumud Mehta and S.M.Merchant, 1972. Physical growth in
    children in the first year of life in higher and lower
    socio economic class of Bombay City. Indian Pediatrics
    IX.

*   Research Unit (1968). Heights and Weights of Babies in
    Baroda from one month to thirty months. Pediatric
    Clinics of India, 3, 137-142.

measurements were taken every month ± 1 week for the
first year.

The same year Mathur et al [1] reported a study of
200 children from 0 to 4 years of age, of low socio-economic
group of the rural area near Hydrabad. The measurements
were taken at 6 monthly intervals.

Last year Mukherjee and Sethna [2] (1973) reviewed
the growth studies in India. This is an appraisal of
studies conducted in the last 50 years. The following
criteria were adopted for inclusion of studies in their
review -

(a) growth was synonymos with health and nutrition;

(b) only those studies concerned with heights and
    weights and other linear anthropometric
    measurements are included;

(c) those dealing with effects of nutrition and
    measurements of face and bones were excluded;

1. Mathur, Y.C., K.Bhaktavatsala, Gupta and N.Prahlad Rao.
   1972. Study of growth pattern in preschool children
   of low socio-economic status in rural area near
   Hydrabad. Indian Pediatrics, IX, 411-414.

2. Mukherjee, D.K. and N.J.Sethna, 1972. Growth studies
   in India; an appraisal of studies conducted in last
   50 years II. Birth to 5 years. Indian Journal of
   Public Health, XVI, 57-62 (b).

The same year, the same authors reported on the
ecology of growth in under priviledged children. They
studied the ecology of weight gain during the first 18
months of life of infants born of Bengali Hindu parents
residing in the slums of Calcutta. This group of 156
infants were measured every 14 days ± 2 days. The
environmental factors studied were (a) nutrition (b)
pattern of illness, (and (c) socio-economic and socio-
cultural factors. These infants came from families where
per capita monthly income was Rs.18/- and they had an
average of 5 siblings.

In 1973, Phadake et al [1] reported a study of infant
growth in urban and rural Maharashtra. They studied
4,721 infants from birth to 1 year. The age intervals were
as follows : 0-1, 2, 3, 6, 9, 12. The new borns were
measured within 48 hours, the 1 month olds within 2 days
and the others within 7 days (± 3 days ?). The infants
were grouped according to per capita income of Rs.50/-
more than Rs.100/- and less than Rs.100/-. Percentile
charts are given with urban and rural values combined but
separate for the sexes. This is not easily understood when
the investigators say that in general urban infants were
found to be better built than rural.

1. Phadake, M.V.(1973). Infant Growth in Urban and rural
    Maharashtra. Indian Pediatrics, X, 387.(c).

As evident from this review, in our country, the researches related to infancy and especially its normative aspects are picking up in tempo in the recent years. The investigators, chiefly pediatricians, are concerning them- selves with a wide variety of the factors that may affect the normal child.

Anthropometric measurements have been used by them as tools to investigate the effects of varying aspects of environments. Many have studied the anthropometric measurements and recommended their use as norms for their regions.

The report of heights and weights of Baroda babies already noted as a part of the review of Indian studies was an incidental outcome of a wider project of the study of mental and motor growth of Indian babies from the department of Child Development of M.S.University of Baroda. A longitudinal study was undertaken in 1962 and was supplemented with a cross-sectional study in 1966. The cross-sectional study was supported by PL 480 funds and the present investigator was actively involved in it as a Senior Research Fellow (1966-1970). With her professional * interest in the understanding of normal

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* The investigator besides being a research worker on the departmental team, has had experience of 1) working with well and sick children, 2) teaching normal growth and development of children at the children's Hospital, Washington University, St.Louis, MO, U.S.A., and Bai Jerbai Wadia Children's Hospital, Bombay. The professional qualifications of the investigator are : R.N.(U.S.A.), R.M., B.S., M.A.(Columbia, N.Y. U.S.A.).

physical growth and development she worked out in consultation with Dr.Pramila Phatak, the Chief Investigator, the programme of recording anthropometric measurements of infants brought for testing in the major project.

The study of the anthropometric measurements was undertaken with the following aims in mind :-

(1)   To calculate norms for the five measurements viz., weight, crown-heel height, crown-rump height, head circumference and chest circumference for the first fifteen months of life, for the lower socio-economic group of society in Baroda and surrounding villages.

(2)   To find out wherever possible how a typical infant grows in these measurements, and determine if significant sex differences, urban-rural differences or social class differences exist.

(3)   To study the relationships between these measurements.

(4)   To explore the possibility of establishing 'irrespective of age' standards for these measurements by employing the regression analysis technique and testing its validity.