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CHAPTER III

METHODOLOGY

Objectives of study of Physical Growth :

There are many reasons why the study of physical growth in children is undertaken by scholars in the field. These are : "(1) description of specific aspects of structural change in different cells, tissues, organs, and body regions, (2) systematization of accumulated series of morphological findings in ways to reveal principles of human ontogenesis, (3) discovery of variables that modify physical growth and exploration of each variable with respect to time of impact, direction of influence, and magnitude of depressing or accelerating effect, (4) investigation of relationships between sectors of the structural facet of child development and sectors of other facets of child development, (5) comparison of the developmental anatomy of children and other animal organisms, (6) provision of normative materials on physical growth to meet clinical, health education, and other service needs, and (7) contribution to a cumulative understanding of the attributes of desirable anatomic ontogenesis and of the conditions that will produce them

(Meredith, 1953)."[1]

Sources of Data :

Physical growth during childhood has been studied by different investigators in different ways. Some have concentrated on anthropometry, others on radiography or photography. Whatever the field of investigation, the data has been drawn from variety of sources like living subjects, cadavers, photographs, X-rays, (roentgenograms) silhouetts, contour tracings, histologic slides and plaster casts.

A principle of scientific method necessiates that extreme economy be practised in amassing data as this is necessary for attainment of the needed degree of precision. For example (as Potter and Meredith 1948[2] point out) taking the measurement of the head width to show its variability in children of a particular age, taking the measurement directly is just as valid as taking the measurement from the X-ray of the given child.

On the other hand, indirect sources like plaster casts, X-rays, etc., alone can give valid data for the

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1. Meredith, H.V.,(1970) in Mussen, Paul H., (1970). Handbook of Research Methods' in Child Development, Wiley Eastern Pvt.Ltd., New Delhi.
2. Potter, J.W., and Meredith H.V.(1948). A comparison of two Methods of obtaining biparietal and bigonial measurements. Journal of Dental Research, 27, 459-466.

study of problems like skeletal growth velocity or differences in increase of muscle tissue, or relative growth in the size of internal organs.

Human growth and development takes place in living individuals who move about and acquire standards of modesty. In the very young, they are not always in a mood to cooperate and please the data collector. All these characteristics pose problems in collecting data from the living child. A great deal of time, tact and patience are needed to solve these.

Samples of Data Collection :

There are two principal methods of collection of data. The cross-sectional where a large number of children are tested or measured only once and the longitudinal where the same group of children are measured or tested repeatedly at fixed intervals of time to observe their progress as growth takes place.

The cross-sectional method has the advantage of being less time consuming and the advantage of large samples. Depending on the purpose of the study, it can be employed to yield useful information on a short term basis.

The longitudinal method eventhough expensive in terms of time and money yields the valuable information about rates of growth which it is not possible to collect from the cross-sectional data.

Standardization of Measuring Technique :

A procedure is said to be 'standardized' when different laboratories and individual investigators employ the same technique in collecting data for a given measurement. The importance of standardization was recognized as early as 1906 and 1912 when the above mentioned international agreements were drafted; it has also been stressed more recently by Hrdlicka (1936)[1] and Steggerda (1942)[2]. Standardization should facilitate comparative and putting together of an integrated picture of findings on anatomical growth, and it should not cramp the development of new techniques and improvement of old ones. Only when standardized techniques and instruments are used, the researches by different investigators yield a rich harvest of findings.

According to Meredith, anthropometric precision instruments were largely developed during the period since 1830. Paul Broca's contribution to the improvement of these instruments was considerable.[3] The development of special instruments for measuring young children, started shortly before the end of the nineteenth century,[4] yet not much attention was paid to this important aspect of

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1. Hrdlicka, A.1936. The anthropometric committee of the American Association of Physical Anthropologists. American Journal of Physical Anthropology 21, 287-300.
2. Steggerda, M.1942. Anthropometry of the living. A study on checking of techniques. Anthropometric Briefs, No.2.7-15.
3. Hrdlicka, A.1920. Anthropometry. Philadelphia, Wistar Institute.
4. Chapin, H.D. 1894. A plan of infantile measurements. Medical Research, 46, 649-651.

research in this field prior to 1920. During 1920-1940 some progress was made. Recently, amongst others working on the problem of better and more efficient tools, Karpovich (1951)[1] has described a modified tape for measuring trunk girths. A flexible steel tape has proved more accurate for measuring girth of a section of the body, than the ordinary cloth tape, (McCloy 1936).[2] Platform - type scales are more accurate than spring balances for weighing infants. (Goldstein, 1937)[3]. Whitacre (1934)[4] reporting on his research on selection of adequate measuring instruments illustrates the principle that reliability is considerably increased if the posture of each segment included in a dimension is controlled. Whitacre (1934) came to the above conclusion after measuring the estature of 400 children by the two common methods of using the fixed rod or a fixed vertical board. She found that the measures by board in which the posture was controlled, were systematically larger and more reliable.

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1. Karpovich, P.V.1951. An improved tape for measuring the chest girth. Res.Quart., 22, 334-336.
2. McCloy, C.H.1936. Appraising physical status. The selection of measurements, University of Iowa Studies in Child Welfare, 12, No.2.
3. Goldstein, M.S.1937. Weight: A survey of differences in methods, instruments. American Journal of Physical Anthropology, 22, 437-465.
4. Whitacre, Jessie, 1934. Standing heights of school children as determined by two techniques. American Journal of Physical Anthropology, 18, 457-465.

Measurements of body structures are taken between specific points called landmarks (Meredith, H.V.1970). Two international agreements adopted at Monaco in 1906 and the other at Geneva in 1912, list about 100 body dimentions and recommend landmarks for obtaining them (Hrdlicka, 1920). These landmarks are defined in terms of bony projections and they specify the sites for applying the measuring instrument and give precise identification of the measurement.

Meredith, H.V.(1970) recommends that to control the variable of compression of tissues while taking measurements, the purpose of the procedure be clearly understood. For example, while taking a measurement whether, maximum width is required or a close proximation to the skeleton is required, should be clarified. Having done this, the compression required should be specified as objectively as possible, and the measurer should be well trained to its essentiality. Following these principles contributes greatly to the reduction of variation in measurements obtained.

It is necessary that the following criteria be satisfied while collecting data for anatomic growth and development, (Meredith, H.V.1970)."(1) A written statement

specifying each technique employed is prepared; (2) those who participate in a massing the data are trained to meet stipulated standards of dependability; and (3) there is frequent checking to assure that these standards are maintained."

Anthropometric Measurements :

Anthropometric measurements most often studied are weight, stature, stem length, head circumference and chest circumference.

Weight :

Weight is dependent on many minor and major factors that contribute to it. For example, weight is lost during the day time and gained at hight (Curtiss 1898). Weights taken before emptying the blandler and after in young children makes a substantial difference (Summer and Whitacre 1931). At best, it is a gross measurement involving varying amounts of muscular, subcutaneous adipose tissue and bone; besides it disregards the change in their relative proportions with increase in age (Reynolds E.E. 1948).

Stature :

In the infant, this measurement is taken in the supine position, and is referred to as crown-heel length, or total length. Lenght of the legs being referred to as the lower limb length. (Krogmen 1950).

Prior to 1780, the fact that "Stature is greatest following recumbent sleep and decreases after arising and with prolonged exertion",[1] was discovered. In 1886, Malling-Hansen[2] confirmed this, with a study. In the present century, investigations have been made on the pre-school children on this problem.

Hejinian and Hatt,[3] 1929 found an average decrease in body length of .08 centimeter in measurements of infants after sitting for one hour and 1.1 centimeter after standing for one hour. Palmer 1930[4] discovered similar losses on preschool children, during the first hour after getting up in the morning.

"Taken collectively, the accumulated studies support the generalization that at all ages beyond 2 years ambulant human beings typically are 2.4 centimeters

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1. Scammon, R.E., 1927. The first Seriatam study of human growth. American Journal of Physical Anthropology. 10, 329-336.
2. Malling-Hansen, R.1886. Perioden in Gewicht der Kin der and in der Sonnen warme. Kopenhagen : Tryde. as mentioned in Mussen, Paul H. Handbook of Research Methods in Child Development, Wiley Eastern Pvt.Ltd., New Delhi,1970.
3. Hejinian, Lucea, and Elise Hatt. 1929. The stem length: Recumbent - length ratio as an index of body type in young children. American Journal of Physical Anthropology., 13, 287-307.
4. Palmer, C.E., 1930. Diurnal variations of height and weight in the human body during growth. Anatomical Research, 45, 234-235.

taller when they assume the erect position in the morning than when they return to the recumbent position at night." [1]

It follows then, that while investigating problems related to stature, it is essential that diurnal and postural variation be taken into consideration. Failure to do this may introduce inaccuracies in the longitudinal record of a pre-schooler (nursery school age) comparable to the mean increase in stature of his group for two months.

Head Circumference :

Measuring the head circumference during infancy gives us important clues to the rate of growth of the brain - case which in turn reflects the size and rate of growth of its contents. viz., the brain. However, this measure is dependent on the different degrees of hair growth.

Chest Circumference :

Taking this measurement on the living child amongst others, poses a set of problems related to the science of perception of movement (Kinesiology) and physiology.

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1. Redfield, Janet E., & H.V.Meredith. 1939. Changes in the stature and sitting height of preschool children in relation to rest in the recumbent position and activity following rest. Child Development, 3,293-302.

Measurement of the chest alters with "inspiration and expiration, elevation of the shoulders, tipping of the head, and orientation of the trunk to the force of gravity".[1]

Hence the direct source of data, the living child, has been studied most often and its own individual methodologic problems and relative usefulness noted. No source (direct or indirect), seems to be satisfactory for all purposes and yet each has its importance depending on the facet of anotomical growth and development under study.

Norms :

Anthropometric measurements like any other measures are ultimately used to formulate norms or standards. Webster defines norms as "a set standard of development or achievement, usually the average or median achievement of a large group." Norms make it possible to (1) detect delay and arrest in the growth and development of infants; (2) distance and velocity norms help in nutritional assessment of a community at a given point in time, and lastly (3) norms make it possible for us to discern differences among individual members of any group.

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1. Mussen, Paul H., 1970 (Ed). Handbook of Research Methods in Child Development. Wiley Eastern Private Ltd.,Delhi.

In the last few years, two opposing views about norms for physical growth are being put forth in our country by the those interested in the field, mostly pediatricians.

According to Thompson, (1968)[1] "norms are not criteria for optimal growth. They are statistics for basic comparisons. They are mathematical devices to avoid the error of generalization from isolated cases."

According to Tanner, (1966)[2] "..... in underdeveloped countries children's growth is now widely recognised as a sensitive index of the health and nutrition of the population." This growth, according to Tanner should be answered by such questions as : is the child's size within normal limits for his age, sex, population, and socio-economic group ? Is the child's rate of growth over the past year (month) normal for his age, sex, population and socio-economic group ?

According to Garn (1966)[3], size standards for children must be applicable to the group in question. Thus, at least in the Western world there is agreement about norms, and this is understandable, considering the fact that there a certain minimum standard of living, guarantees a certain minimum standard in physical growth.

1. Thompson, Helen (1968). Physical growth. In Carmichael L.(Ed). Manual of Child Psychology., 2nd edition. Wiley Eastern Pvt.Ltd., New Delhi., p.296.
2. Tanner, J.M., Whitehouse R.H., and Takaishi M.1966. Standards from birth to maturity for height, weight, height velocity and weight velocity. British Children 1965. Archives of Disease in Childhood, 41,p.454-471, 613-635. p.454.
3. Garn, Stanley M. Body size and its Implications. The Fels Research Institute in Hoffman L.W. and Hoffman M.L. 1966. Review of Child Development Vol.II Russell Sage Foundation, N.Y.1966.

In our country, the picture is totally different. Two extremes of wealth, with the maximum concentrated with a small minority leaves the majority on mere substistence level of standard of living. Aware of these circumstances, the investigators here are currently debating the question of norms.

In 1968, while reporting on heights and weights, Dr.Pramila Phatak, raised the question of norms, as to " ..... whether the standards of growth be developed on the basis of existing conditions or they should be based upon ideally brought up babies so as to provide targets to be reached in clinical work".[1] She further suggests that considering the vastness of the country and the variety of the population, local standards should be encouraged.

Dr.Vimlesh Sheth (1972)[2], writing editorially, comments on the question of what should be our concept of norms of growth and development. Dr.Sheth feels that norms should serve as goals of excellence to be achieved. On the other hand, there are those who do not agree with her. Mehta and Merchant (1972)[3] found that there were differences in the measurements for the two socio-economic classes (higher and lower) and feel that there should be separate norms for the two groups. Furthermore, considering the

1. Phatak, Pramila 1968. Heights and Weights of Babies in Baroda from one month to thirty months. Pediatric Clinics of India 3, 2, 137-142. p.142.
2. Sheth, Vimlesh 1972. Norms for growth and development, Indian Pediatrics IX. Editorial.
3. Mehta K. and S.M.Merchant 1972. Physical growth of children in the first year of life in higher and lower socio-economic classes of Bombay City. Indian Pediatrics IX.

fact that 80% of our people live in the villages, and of the 20% in the cities only a minority belong to the 'upper' or 'higher' classes, it seems a mockery to setup standards "as goals of excellence to be achieved" especially, when these are based on the data collected on the small affluent minority of the Indian Child community. Besides, there are amongst the poor, those who are in sufficient good health to carry on with their work and to provide for their families with what is termed, 'reasonable' for their circumstances. This makes Dr.Sheth's argument for 'ideal' norms unrealistic.

In light of the evidence cited in Chapter II about differing effects of nutrition on size and rate of growth and shape and tissue composition, the burden of reconsideration falls on those who advocate standards "as goals of excellence to be achieved."

Besides, Byron Hughes[1] states that tissue quality has much stronger relationship to the organisms development of behaviour, than tissue amounts and proportions. Thus according to him quantity and quality of behaviour is basically related to quality of his tissue and not to quantity.

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1. Hughes, Byron O.(1969). The biological basis of development. Merrill-Palmer Quarterly, Vol.5, No.2. Winter 1959.

If we accept this thesis than how can we justify standards "as goals of excellence to be achieved" when these goals are based on heavier amounts and greater proportions of tissues, as anthropometric measurements are in absence of any measurable standards of tissue quality ?

To guard against the effects of malnutrition, disease and abnormality of physical status in the large majority of our population, norms for particular regions can be set up by a very carefully selected sample which excludes these conditions. Another safeguard would be to revise these norms every decade or so.

It is clear from the foregoing discussion that any study of anthropometric measures needs scientific approach and very critical consistent procedures of data collection. Sample also poses problems which should be anticipated and the nature of the sample pre-determined, especially when the objective is to use the information for practical purposes. Before undertaking to report the present study, a critical historical review of physical growth studies in other countries and in our own country is undertaken in the next chapter.