CHAPTER VII

DISCUSSION, COMMENTS AND CONCLUSIONS

Introduction :

In the preceding chapters of the study, the fundamentals of physical growth as understood today, review of related literature on physical growth in other countries as well as in India, and relevant methodology have been dealt with in reasonable details. In the previous chapter the results of the statistical analysis of the data have been presented, depicted graphically and summerised. It is appropriate now to discuss these and make necessary comments and arrive at logical conclusions. This discussion is categorised on the basis of the presentation of the anthropometric measurements in the previous chapter. The discussion that follows is based on this study as a whole and would be of interest to persons concerned with child development, especially pediatricians as they are considerably involved in the physical well being of the infant, which is the focus of this study. An attempt is made to discuss the findings of the present study in the light of similar relevant studies in the field.

I Stature, stem height and lower limb length :

Stature is the most commonly used measure of the body size. Most length measurements like stature, stem length and lower limb length are normally distributed in the population. Recumbent length, as it was measured in the present study, is most exactly determinable when diurnal variation is taken into consideration and the positioning error reduced to the minimum. As regards the diurnal variation factor, the vast majority of the measurements were taken in the afternoon in the urban sample. The positioning error is assumed to be minimal as the measurements were taken by one person - a pediatrician in the vast majority of the cases.

The analysis of central tendency and its variability ~~of~~ for stature exhibit~~s~~ very wide variations for certain age groups in some of the control variables. This variability suggests the highly heterogeneous composition of these age groups as far as stature is concerned. ~~Thus~~ The urban group of male infants appears to be the most heterogeneous. In this group the 5 month olds, the 13 month olds and the 15 month olds exhibit the most variety. The female counterpart of this group comes next. The widest variations in th~~i~~se groups are noted in 7 and 15 month olds. The rural male infants show this variability only in the 10 month olds. The rural female infants were the most homogeneous group, as no wide variation in central tendency of stature was noted.

Rates of growth of stature :

Figure III compares the rates of mean monthly increments in stature of the higher and lower socio-economic groups of infants of both sexes measured longitudinally.

The general deceleration in the rates of increase is noted. Deceleration (according to Webster is "Retardation, slowing down, movement with decreasing speed".) In stature this is evident in all the four groups. This deceleration is sharpest in the group of lower class male infants in the first three months of life and then it seems to become more gradual. In the higher socio-economic class, the deceleration is more gradual than in the lower socio-economic class of infants.

The individual growth patterns depicted in Figure IV a,b,c,d,e of male and female infants show wide variations. The deceleration with advance of age is quite apparent.

This deceleration is much sharper in the ~~male~~ growth curves of the male urban group than in their female counterparts. In other words, Figure III a,b,c,d and e, demonstrate the velocity of stature, in constrast to the distance travelled, (as in Figure I a,b,c, and d) by these infants.

Velocity is the speed in a particular direction and speed is the rate of motion per unit time; therefore, when one speaks of velocity of growth, one speaks of the increase in growth per unit time. This is not to be confused with the distance reached at a particular time. For example, another look at Figure Ia ~~points out~~ shows that in the 14 month olds the mean stature of urban lower socio-economic class males was 71.5 cms. and in the 15 month olds it was 72.4 cms. In the 13 month olds the mean stature was 70.1. One can see that mean stature for this group has increased from 70.1 to 71.5 to 72.4 cms., from 13 months to 14 months to 15 months. Now, if one looks at Figure III d, which is the mean velocity in a longitudinal sample of the same group (urban lower socio-economic class males), one can see that the velocity of growth of stature has increased from 13 months to 14 months but has decreased from 14 months to 15 months.

According to Lasker (1946)[1], stature has three influencing components viz., genetic, nutritional and disease ~~produced~~.

In spite of its normality of distribution, its relative stability, and its linear growth, stature as a physical measure has its limitations, (Talbot, Wilson and Worcester 1937).[2] According to Talbot et al, stature is a wrong measure as a reference standard for metabolic activity e.g. basal oxygen consumption, or creatinine excretion, or caloric requirements. For example, basal oxygen requirement in normal and non-obese children is better expressed in relation to a weight standard than stature. As a reference standard for ideal weight it may not be very satisfactory because a couple of centimeters of extra length in the lower limb may have little contribution to tissues that primarily contribute to weight.

In spite of these limitations it remains the simplest and most easily calculable measure of body size. It can be taken with inexpensive equipment in the field or clinic, and it can be measured precisely with due care and attention.

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1. Lasker, G.W. 1946. Migration and physical differentiation a comparison of immigrant with American born chinese. <u>American Journal of Physical Anthropology</u>, 4, 273-300.
2. Talbot, F.B., Wilson, E.B., and J.Worcester 1937. Basal Metabolism of girls' physiologic background and application of standards. <u>American Journal of Disease in Childhood</u> 53, 273-347.

<u>Stem Height</u> : Means and standard deviations. In the present study, the general known trend of physical growth is evident in the increasing values with advance of age. As shown in Figure Va,b,c,d extremely wide deviations are noted in the urban male group of infants in the 3,5,13 and 15 month olds. In the female group of the same urban society, the same extremely wide variations are noted in the 7,10,13 and 15 month olds. These wide variations are also noted in the rural male group of infants in the 3 and 8 month olds. The rural female group 10
of infants shows no wide variations in the central 11
tendency ~~of the length~~ of stem height. As in stature, these 12
wide variations depict the heterogeneity of the age sub-groups. 12

As in stature, the rates of growth of stem height show a general deceleration in mean and individual rates of increase. This is evident in both the sexes of the urban lower class infants. This deceleration is quite sharp till 4 to 5 months of postnatal age and then 5
gradually flattens out. There is a wide variation of individual patterns of rate of growth of stem height. Some 7
of these graphs show periods of ~~spurts of growth~~ 8
~~characterized by~~ increased rate of gain in stem height and 9
periods of rest or no gain in growth at all.

In spite of the great individual variability, the graphs of increase in stature and stem height appear to be very similar for both the sexes.

Falkner (1958)[1] made a similar observation in his study. To quote, "while it is well known that boys are taller and heavier than girls, it is interesting to see how closely similar they are in increments (rate of growth) of recumbent length and weight in this age period" (in the first 3 years of life).

Stem stature Index :

This index varies remarkably little between widely different samples and decreases with age, as the lower limbs grow much faster than the stem height.

In the present study, this index in general decreases with age in all the four control groups. An examination of table II reveals the range of this index to be ~~within~~ 66-67.5 at birth. This finding supports the observations of other researches. It is interesting to note that stem stature indices at birth vary very little (between 66.0 and 67.5) amongst widely differing populations, as shown by Ito (1936)[2] in a Japanese study, Bawkin & Bawkin (1934)[3] in an American study, and Tatafiore (1935)[4] in an Italian study. This index is

1. Falkner, F.(1958). Physical measurements in the first three years of life. Archives of Disease in Childhood 33, 1-9.
2. Ito, P.K.(1936) American Journal of Disease in Childhood 52, 41.
3. Tatafiore E
3. Bawkin, H. & Bawkin R.M.(1934). Human Biology, 6,612.
4. Tatafiore E.(1935). Pediatria (Napoli), 43, 422.

influenced by age (decreases with advancing age), sex, race and constitutional type. Bean (1922) [1] stated that in different samples the female index was generally larger than the male, regardless of constitutional type and stature. Falkner (1958) [2] however, did not find such a difference in his sample in the first three years of life at least. Bean (1922) had also designated two geographical areas of very short stem length, viz. central Africa and native Australia, and two areas of very long stem length, viz. Central African pygmies and the Arctics.

The maximum standard deviation of this index was noted to be ± 1.6 from raw data by Falkner (1958). The observations of the present study do not fall in line with Falkner's observations. The standard deviations in the four groups under study are much wider. In the urban male group of infants the standard deviation ranges from 1.45 to 4.49. In the urban female group, it ranges from 1.27 to 3.21. In the rural male group it ranges from 1.56 to 3.98 and in the rural female group from 1.24 to 2.98. Several factors may be responsible for these wide variations. The same factors may also be

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1. Bean, R.B. 1922. American Journal of Physical Anthropology, 5, 349.
2. Falkner (1958) Physical measurements in the first three years of life. Archives of Disease in Childhood, 33, 1-9.

responsible for the large value of the maximum standard deviation, viz., 4.49. The chief factor responsible for this phenomenon appears to be the heteroginity of the cross-sectional sample, because examining the same indices for the small longitudinal sample (Table XXIII in appendix) one finds little variation in standard deviations at ages 2, 4 to 10, 13 and 14 months, where the range is from 1.22 to 1.88.

This index also has clinical value as shown by Falkner 1958.

In certain diseases, this index is altered. In cretinism, the dwarfism includes retardation of growth of the lower limbs and this shows up in the index. Falkner (1958) quotes a study of 5 cases of cretinism in whom the following values were observed:

at 1 month of age mean index value		69.0 (N=2)	These are high values.
at 3	-do-	68.1 (N=2)	
at 6	-do-	66.9 (N=1)	

Skelic Index :

The skelic index is the ratio of lower limb to stem height. Meredith and Knott (1938) [1] reported that this ratio reaches a critical minimum sometime after birth but before 8 weeks and there after increases rapidly. This 4
ratio is a differentiating feature of the sexes in as much as the females who are relatively more mature than 6
the males, have longer limbs at 8 weeks.
(Thampson, Helen, 1938).

In the present study, the mean skelic index is tabulated for male and female infants residing in urban and rural communities in and around Baroda. As mentioned by Thompson (1938), it is minimum in all the groups 4
except the rural males before 2 months of age. In the group of rural males it is minimum at 1 month and 3 6
months of age. The values for the female infants are higher than the males in both the rural and urban communities. The ratio demonstrates an increasing trend with advance of age in all the four groups of infants. There are some anomalies in the values which are probably caused by the cross-sectional sample, and/or by the demonstrated fact of spurts and rest periods in the

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1. Meredith H.V., and Knott 1938. Changes in body proportions during infancy and the preschool years,III. The skelic index Child Development 9, 49-62.

growth rates of stem height and lower limbs, which at a given point in age are reflected in the values of the ratio.

II Head Circumference and Chest Circumference

Head Circumference :

According to Todd (1935) [1] the growth centers of the head and face, like the rest of the body, have different periods of maximum activity; thus brain case (head circumference) growth is a characteristic of infancy and childhood. Head circumference, like other cranial dimensions, increases rapidly in intrauterine life, ~~and~~ continues to do so for two years postnatally, and then slows down. Head circumference increases more regularly than other head dimensions. This measure, however, is affected by different degrees of hair growth.

According to Falkner (1958) head circumference incremental data is most useful as a diagnostic tool for such illnesses as hydrocepelus, subdural hematoma and neoplasms. Falkner found a low coefficient of correlation (0.12) between cranial capacity as measured by head circumference and intelligence.

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1. Todd T.W.1935 : Anthropology and Growth Science,81, p.260-263.

Eichorn & Bayley (1962) [1], reporting on their California study, where all infancy measurements were taken by Bayley herself and birth measurements reported by the hospital, state that the rate of growth of head circumference declines more steeply during the first 6 months and within this period most precipitiously during the 2nd month.

In the present longitudinal sample ~~under study~~, since the N for each age interval was extremely small, (6 and less), one cannot compare the results reported by Bayley with the growth pattern of head circumference in Baroda infants. All that one would venture to say is that there is a gradual decline in the rate of growth, sharper before the age of 5 months and very gradual thereafter as seen in Figure XI a & b. Individual variation is large (Figure XII, a,b,c,d and e), and the pattern of spurts of growth activity followed by decrease in growth velocity or restperiod is noted. This is similar to the growth pattern of stature.

Chest Circumference :

As mentioned in the discussion of methodology, taking this measurement in the living child poses a set of

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1. Eichorn, D.H. and Nancy Bayley (1962) : Growth in Head Circumference from birth through young childhood. Child Development 33, 257-271.

problems related to Kinesiology (Science of perception of movement) and physiology. In the words of Meredith (1970) [1], measurement of chest alters with "inspiration and expiration, elevation of the shoulders, tipping of the head, and orientation of the trunk to the forces of gravity".

In the present study, Figure XIII a,b,c,d,e demonstrate the following points. Extremely wide variations are noted in the urban male group of infants of 9 and 15 months. In the urban female group of infants, the same deviations are noted in 15 month olds only. In the rural male group of infants no such variations are noted, and in the rural female group of infants, the extremely wide variation is noted in the 11 month old group ~~of infants~~. These wide variations depict the heterogenity of the groups as mentioned before.

Rates of Growth :

A Trend of deceleration in rate of growth is noted. At about the age of 4 to 5 months this deceleration flattens out. As in the other measurements, there is a wide variation in individual patterns of growth characteristic of periods of spurts of growth and periods of decreased growth activity or total rest.

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

Falkner's (1958)[1] found that mean head circumference values were larger (in the 1st year of life) than the mean chest circumference values but the mean increments were identical.

In the present sample ~~under study~~, the mean head circumference values are larger than the mean chest circumference values for both the sexes of urban lower class infants measured longitudinally (Figure XVII a & b). On examination of ~~the~~ Figure XVIIa (urban males) one may be tempted to state that the increments appear to be more or less identical, as the two curves appear to be parallel. However, looking at the raw data it is inappropriate to make such a statement as there is a wide variation in increments of head and chest circumference of the same infants. Tables XA and XB present the relevant measurements in details for 8 male and 8 female infants. Scanning the table critically one notes that this phenomenon supports the thinking that the mean may be misleading in interpretation of facts. Figure XIIa is a distance graph of mean measurements. It cannot be interpreted in terms of a velocity graph as noted in the discussion of stature.

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1. Falkner, F.1958. Physical Measurements in first Three years of life. Archives of Disease in Childhood 33, 1-9.

TABLE X A

Values of raw data showing increments in head circumference and chest circumference of 8 urban male infants of low socio-economic group measured longitudinally.

MALES

S.No.	Code No.	Age Inter -val	Increment in head circumference	Increment in chest circum- ference
1	2	3	4	5
1	0633	1-3	2.2	2.4
	"	3-4	1.6	2.5
	"	4-5	0.7	0.0
	"	5-7	0.2	0.4
	"	7-8	0.5	0.0
	"	8-9	0.1	0.4
	"	9-10	0.3	0.4
	"	10-12	0.3	0.4
	"	12-14	0.5	0.6
	"	14-15	0.2	0.7
2	0653	1-2	1.6	2.5
	"	2-3	2.4	1.5
	"	3-4	0.6	1.4
	"	6-7	2.1	0.0
	"	7-8	1.0	2.7
	"	8-9	0.0	0.0
	"	9-10	0.3	0.1
	"	10-11	0.7	0.2
	"	11-12	0.2	0.1
	"	12-13	0.3	0.2
	"	13-14	0.0	1.4
	"	14-15	0.6	0.0

Table XA- continued

1	2	3	4	5
3	0731	1-2	1.0	1.8
	"	2-3	2.4	2.6
	"	3-4	0.7	0.7
	"	4-5	0.3	0.4
	"	5-6	1.8	0.6
	"	6-7	0.5	0.5
	"	7-8	0.5	0.5
	"	8-9	0.0	1.3
	"	9-10	0.5	0.2
	"	10-11	0.3	0.1
	"	11-12	0.0	0.1
	"	12-13	0.1	0.5
	"	13-15	0.9	0.2
4	0773	1-2	1.6	6.1
	"	2-3	1.0	0.3
	"	3-5	1.4	3.1
	"	5-6	0.7	1.1
	"	6-7	0.4	0.1
	"	7-11	1.3	0.5
	"	11-12	1.0	0.2
5	0897	1-2	1.7	1.6
	"	2-3	0.2	0.8
	"	3-4	2.1	1.7
	"	4-5	1.7	1.8
	"	5-7	0.8	1.6
	"	7-8	0.2	0.0
	"	8-10	0.9	0.2
	"	10-13	1.4	2.8

Table XA- continued

1	2	3	4	5
6	0898	2-3	1.5	1.2
	"	3-4	1.7	1.2
	"	4-6	0.7	0.9
	"	6-7	2.1	1.6
	"	7-8	0.2	0.7
	"	8-9	0.1	0.2
	"	9-10	0.2	0.1
	"	10-12	0.2	0.5
	"	12-13	0.5	0.9
	"	13-15	0.4	0.2
7	0922	2-3	1.1	1.7
	"	3-4	0.7	0.8
	"	4-5	0.2	2.6
	"	5-6	0.3	0.5
	"	6-7	0.3	0.3
	"	7-8	1.5	0.0
	"	8-9	0.2	0.2
	"	9-10	0.3	0.0
	"	10-11	0.5	0.3
	"	11-12	0.7	0.2
	"	12-13	0.5	1.4
	"	13-14	0.0	1.0
	"	14-15	0.0	0.5

Table XA- continued

1	2	3	4	5
8	0956	2-3	1.2	1.8
	"	3-4	0.9	0.3
	"	4-5	1.1	1.2
	"	5-6	0.7	0.2
	"	6-7	1.3	1.6
	"	7-8	0.1	0.0
	"	8-9	0.1	0.0
	"	9-10	0.2	0.1
	"	10-11	0.3	1.6
	"	11-12	0.1	0.4
	"	12-13	0.8	0.1
	"	13-14	0.0	0.3
	"	14-15	0.5	0.2

TABLE X B

Values of raw data showing increments in head circumference and chest circumference of 8 urban female infants of low socio-economic group, measured longitudinally.

FEMALES

S.No.	Code No.	Age Interval	Increment in head circumference	Increment inchest circumference
1	2	3	4	5
1	0617	1-4	2.6	1.6
	"	4-5	1.3	0.6
	"	5-6	1.3	1.0
	"	6-7	0.2	0.8
	"	7-9	0.4	0.2
	"	9-11	0.2	0.1
	"	11-14	0.4	1.3
	"	14-15	0.6	0.1
2	0733	1-2	0.6	0.5
	"	2-5	2.9	1.4
	"	5-7	1.2	2.0
	"	7-8	0.3	1.5
	"	8-9	0.6	0.2
	"	9-11	0.7	1.3
	"	11-12	0.5	1.5
	"	12-13	0.4	0.2
	"	13-15	0.4	0.3
3	0779	1-2	0.6	2.1
	"	2-3	1.0	1.3
	"	3-5	1.4	1.1
	"	5-6	1.2	0.6
	"	6-13	2.4	2.3
	"	13-15	0.4	0.7

Table X B- continued

FEMALE

1	2	3	4	5
4	0789	1-2	1.2	1.4
	"	2-4	2.3	2.5
	"	4-5	0.5	1.2
	"	5-6	0.6	0.1
	"	6-7	0.4	0.0
	"	7-10	1.7	3.0
	"	10-11	0.9	0.1
	"	11-13	1.1	1.0
	"	13-14	0.6	1.0
	"	14-15	0.6	0.2
5	0897	1-2	1.7	1.6
	"	2-3	0.2	0.8
	"	3-4	2.1	1.7
	"	4-5	1.7	1.8
	"	5-7	0.8	1.6
	"	7-8	0.2	0.0
	"	8-10	0.9	0.2
	"	10-13	1.4	2.8
6	0921	2-3	1.3	1.5
	"	3-4	2.7	0.6
	"	4-5	0.1	1.2
	"	5-7	0.6	0.7
	"	7-9	1.3	0.3
	"	9-10	0.2	0.6
	"	10-11	0.1	1.4
	"	11-12	0.4	0.7
	"	12-13	0.3	0.1
	"	13-14	0.0	0.0
	"	14-15	0.0	0.0

Table X B - continued

FEMALES

1	2	3	4	5
7	6937	2-3	1.3	1.0
	"	3-4	0.5	1.0
	"	4-5	0.9	0.4
	"	5-7	1.8	2.9
	"	7-8	0.2	0.4
	"	8-9	1.5	0.3
	"	9-11	0.1	0.4
	"	11-12	0.5	1.0
8	1050	1-2	0.9	2.6
	"	2-3	2.2	1.2
	"	3-4	2.3	1.4
	"	4-5	0.5	1.0
	"	5-6	2.0	0.4
	"	6-7	0.7	0.3
	"	7-8	0.0	0.3
	"	8-9	0.3	0.5
	"	9-10	0.5	0.0
	"	10-12	1.2	2.0
	"	12-13	0.1	0.0
	"	13-14	0.0	0.0
	"	14-15	0.2	0.0

III Birth weight and weight

Weight represents a mixture of various components of the body; it is the most common and widely measured index of nutrition, health and 'quality'. Inspite of its wide popularity for these purposes, and in spite of it being somewhat useful as a health index it has serious limitations, if adopted as the only criterion of growth and health.

Amongst other things, statistically, weight is the most highly skewed of all commonly used measurements with the exception of subcutaneous tissue thickness. Most measurements have 'normal' distributions and breadths, depths, and some circumferences tend to be a little skewed in the same direction (positively) as weight. Therefore unless the population distribution is 'normal' or Gaussion the use of standard deviations division is erronously interpreted. Therefore percentile division has to be used to locate the desired point of the measurement in the population.

Birth Weight :-

Tanner et al, (1956) [1] have shown that birth size is only very slightly related to adult size, or even to

1. Tanner, J.M., M.J.R.Healy, R.D.Lockhart, J.D.Maikanzia, R.H.Whitehouse (1956). Aberdeen Growth study Part I, Archives of Diseases in Childhood, 1956, 31, 372.

the size of the two year old. The chief results of Tanner's study are as follows :

(a) Correlations of all birth measurements with later measurements are much lower than the intercorrelations of later measurements between themselves. This study by Tanner, like others, supports the conclusion that prenatal environment during the last two months of pregnancy is the major determinant of newborn size. This prenatal environment depends to a considerable extent on the hereditary characteristics such as uterine size of the mother.

(b) Cumulative multiple regression figures support these conclusions and add the information that the rate of growth from birth to 5 years has only a very small effect on adult measurements. Rate and size seem practically independent of each other.

(c) Some sex differences in measurements appear to be present.

In the present study, as mentioned before, the birth weights analysed were those reported by the mothers of the infants included in the sample. The mean birth weight of the urban lower class male infants was 2.73 kg. and that of the female infants 2.82. The female birth weight in the present study is slightly higher than that reported by Satyanandam. By and large, the female birth weight is lower than the male. The finding in this study may be a limitation of the data.

Satyanandam, (1965)[1] reported on Baroda data collected in the later half of 1964 on 542 newborns of which 278 were males and 255 femals. She found 2.75 kg. to be the median birth weight of the male infant and 2.72 kg. to be the median birth weight of the female infant.

Rates of Growth :

Neonatal growth rates are characteristic of the fetal period, and towards the end of infancy these rates enter the period of stable linear growth. This can be readily seen in prenatal and postnatal velocity of growths in weight and stature redrawn by Tanner in Mussen.[2]

It is well known that weight increase is a correlate of growth but "weight increase is not necessarily indicative of growth". Weight changes may be also due to, changes only in fatty deposits or in water content, which may be temporary changes (Hammett, F.S.1937).[3] Further, even though weight is an acknowledged indication of nutritional status, optimum weight is an individual requirement, since it depends on age, stature and body

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1. Satyanandam, E.Mary (1965). Heights and weights at birth of a sample of children born in Baroda City. A dissertation submitted in partial fulfilment of the requirements for the degree of Master of Science (Home), Department of Child Development, Faculty of Home Science, M.S.University of Baroda.
2. Mussen, Paul H.(Ed.) Carmichael's manual of Child Psychology 1970, 3rd Edition Wiley & Sons, N.Y. p.90-91.
3. Hammet, F.S.1937. Nutrition vs. Growth. Science, 86, 560-561.

build as well as on 'nutrition'. Therefore it is generally agreed that in addition to any standard of underweight or overweight clinical judgement also should be used in appraising any individual child.

As reported by Thompson (1956), [1] "there is a significant negative correlation between measurements at 2 weeks and subsequent increments. This suggests a strong tendency for the infants who are small at birth to grow more rapidly than infants who are bigger".

In the present study, a look at Figure XX a,b,c, and d convinces one that the first part of Thompson's (1956) statement above is borne out by the graphs of decreasing rates of growth of weight in all the control groups.

As far as the latter part of Thompson's statement is concerned, Figure XXI c lends credence to it. In Figure XXI b also the infant whose birth weight is 2500 gms. grows at a rate which is faster than the mean of his group. In Figure XXI e, the female infant with birth weight 3.295 kg. grew at a rate faster than that of the female infant whose birth weight was 3.409 kg. even though both of them grew at rates slower than the mean of their group.

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1. Thompson J. 1956. Infant Growth. Archives of Disease in Childhood, 31, 382-389, p.389.

Thompson (1955),[1] in his study of 1,737 males and 1,605 singleton healthy first borns, found that sex exerts an influence on the pattern of weight gain~~;~~ and that correlation coefficients between birth weight and postnatal weight gain were not statistically significant. They were almost uniformly negative. Thompson also showed that the prevalent idea of doubling and trebling of birth weight at 5 and 12 months respectively is not tenable.

In the same study, Thompson~~, J.~~ (1955) states "the idea that birth weight controls postnatal weight is of long standing and the statement that an infant doubles the birth weight by 5 months of age and trebles it at a year is to be heard in both lay and pediatric circles. Such statements are also to be found in pediatric literature and may be read in standard paediatric text books. Were such a statement true, the correlations coefficients would have been uniformly positive ..... the coefficient of variation of weight gain would have remained much the same through out the year.

In the course of human growth through infancy and childhood there is a progressive diminution of the coefficient

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1. Thompson, J.(1955). Observation on weight gain in infants. Archives of Disease in Childhood, 30, 152,p.325.

of variation of weight gain. This is a biological phenomena and is in harmony with the absence of a relationship between birth weight and post natal gain". 3 7

Probably this wide spread belief ~~was~~ originated, as Thompson (1955) suggests (p.325), in ~~due to~~ a "failure to appreciate one of the fundamental characteristics of the statistical approach, namely, that a "population" of observations may acquire characteristics which are not possessed by the individual observations which make up the population." 1 2

In other words, mean weight at 1 year may be approximately 3 times the mean birth weight but this is quite different from saying that the individuals in the one year old group are individually 3 times their respective birth weights.

In the present study, the investigator tested the belief that birth weight is doubled at 5 months of age and tripled at 12 months of age in 46 infants of both sexes belonging to higher and lower socio-economic groups of the urban community. 3

Table VI gives these values separately for these groups, plus the percentage error based on actual observed weights of the same infants at age 5 months and 12 months.

The means of the birth weights and observed weights at age 5 months and 12 months are also given. An examination of this table reveals that the range of percentage error in all the groups in quite high. That even the mean observed weight at 5 months in all the groups is generally more than 2½ times the mean birth weight of that particular group. The mean observed weight at age 12 months is close to 3 times the mean birth weight of only one group. One must also remember the fact that means are affected by N and also by the homogeneity or heterogeneity of a group; and therefore it is better to be cautious in attributing to individuals the characteristics of the mean of that group. In other words, the belief that birth weight is doubled at 5 months and trebled at 12 months is at least not tenable, as borne out by this study of 46 infants.

<u>Variability of the anthropometric measurements</u> : The variability in these anthropometric measurements is considered as it is affected by the control groups of residence, socio-economic class and sex. The absolute values of each measurement ~~is~~ are discussed first and then the rates of growth are considered.

<u>Sex</u>

Throughout the 15 months age group under study, the male infants have had larger values in all the anthropometric measurements in both the socio-economic classes and the rural urban communities.

As far as rates of growth are concerned, the females grow at faster rates than males. This distinction is more marked in the higher socio-economic class than the lower urban Baroda society. Probably this is so because it is well known that boys are more affected by malnutrition than girls. Further, examination of table No.XXIII, XXIV, XXV, XXVI and XXVII in the appendix show that differences in the means of all the anthropometric measurements ~~of~~ between the sexes have significant T-values at many months during the first fifteen months of life of the urban group. 8

In the dimension of weight the sexes differed significantly at 2,4,6,7,8, and at 11 months. In the dimension of mean stature, the differences in the mean were significant at 2,6,7,8 and 11 months. Similarly, in the dimension of the stem height, the significant T-values occur at 2,7 and 8 months. The differences in means of the chest circumference of the two sexes were significant at all months except 4,9,13 and 15 months. Similarly these differences of the mean head circumference are also significant at all months except 9 and 15 months. 5 6

At least in the lower urban socio-economic group under study, the fact that the differences in the mean values of the anthropometric measurements for both the sexes were statistically significant at majority of the months in the 1 to 15 months age group, lends justification for not combining the sexes for these measurements in this age group.

Socio-economic class

In the urban community weights of the infants differed in the following manner.

The higher class male 1 month olds were heavier than the lower class male 1 month old by 670 gms. The same group of 15 month olds were heavier by 1.866 kg. However, one month old female infants of the higher urban group weighed 100 gms. less than the 1 month old female infants of the lower socio-economic class. Amongst the 15 month old female infants, the higher class infants were heavier by 1.146 kg. than the lower class. Thus the infants belonging to the higher socio-economic group are heavier and taller than those who belong to the lower socio-economic class in urban Baroda, in both the sexes. This finding supports that of Kumud Mehta and Merchant (1972) [1]. They found that socio-economic class played a more vital role than racial or geographical factors in the dimension of weight.

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

Udani (1963) suggested that the differences in socio-economic groups were attributable to factors of ancestral and genetic (?) malnutrition. Studies by Graffer (1962) and Acheson (1959) also indicate that children of higher social classes tend to be taller and heavier than the lower socio-economic groups by the 2nd or 3rd year of life. The difference being more marked in the 2nd or 3rd year of life is probably due to the now well established fact of the genetic control of size being operative at the end of infancy.

Residence

As far as stature is concerned rural male one month old infants in the present study were shorter than their urban counterparts, but the 15 month olds were about the same. Amongst the females, one month olds differed in their mean stature by .5 cms, the rural females being taller. Amongst the 15 month olds the difference was more marked. The urban female group was taller by 3.3 cms.

In the dimension of mean stem height, the one month olds of the rural male group were shorter by .75 cms. than the urban group of the same age. Amongst the females, the one month olds of the rural community were taller by .5 cms. than the same group of urban infants. Amongst the 15 month olds, the urban group was taller by .6 cms.

The mean head circumference was identical in both the 1 month olds and the 15 month olds in the urban and rural communities of male infants. Amongst the females, the difference in both the age groups ~~were~~ was .5 and .6 cms; the one month olds in the villages being taller and the 15 month old girls of the city being taller.

In the dimension of weight, the one month old male infants of the city were heavier by 150 gms. than their rural counterparts. Amongst the 15 month olds the rural group was heavier by 720 gms. As far as the female infants are concerned, the 1 month olds of the urban community were heavier by 70 gms. only than their village counterparts and the 15 month olds were heavier by 11 gms.

This study supports the finding of Dr.Phadke (1973) that the urban values of anthropometric measurements, in the first fifteen months of life, where different, are higher for the urban group than the rural group of the same age, same socio-economic class and same sex.

Rates of Growth

According to Kessen et al (1970) after birth for the period of infancy, infants continue to grow at rates characteristic of their fetal life. Towards the end of infancy they seem to enter a period of stable linear growth till they reach adolescence. In the first two years of life they increase their status in stature from 30% at birth to 50% of adult status, and their brain weight from 25% at birth to 75% of adult status. "Changes in the nervous system are rapid enough to make the brain of the two year old child hardly discriminable in histological characteristics from the adult brain." (Dekaban, 1959; Gruner, 1962; Kennedy, 1961).

Udani et al (1970) [1] in a very interesting study of the physical growth of babies on humanised milk ~~of~~ 70 infants from age 3 months to 9 months ~~who were~~ measured every week, found that infants who were ~~of~~ ~~smaller~~ weight group at the beinning of the study put on weight at a much faster rate than those who were larger. He also found that in general the rate of growth decelerated as age advanced.

In the present study, examination of figures XXI a,b,c,d, and e shows how infants who weighed less at birth put on weight at a faster rate than those who weighed more at birth in both the sexes. This small longitudinal sample supports the findings of Dr.Udani (1970).

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1. Udani et al 1970. Physical Growth of Babies on humanised milk. Pediatric Clinic of India 5, 123-128.

Interrelationship of various anthropometric measurements

This relationship as designated by the coefficient of correlation 'r' by itself is difficult to interpret~~e~~. For example, a correlation of .6 is not twice as strong as a correlation of .3 because, when r = .6, 36% of the variation in the dependent variable is explained by the independent variable. But when r = .3, only 9% of the variation in the dependent variable is accounted for by the independent variable. Therefore an r = .8 is necessary before we can say that 64% of variance in the dependent variable is accounted for by the independent variable and ~~it does not account for~~ 36% is not ~~of the variability.~~

Besides, any simple correlation by itself is not too meaningful. For example, with an r = .99, where we can say that 98% of the variation in the dependent variable is accounted for by the independent variable and only 2% is unaccounted for, we cannot infer that the two variables are related by a cause and effect relationship, because a third unidentified variable may be related to both the independent and dependent variables and produces changes in both.

According to Yates (1950) [1] correlation analysis has proved to be of limited use, and is generally less informative than regression analysis. In addition to its descriptive function, a regression equation also has the much more concrete function of providing an equation by means of which knowledge of one or more characters can be used to predict the most likely value of another character.

In the present study, existence of the meaningful relationships is evident between all the five measurements. This is borne out by the fact that during the entire period of the first 15 months of life, correlation coefficients estimated by multiple regression technique and as presented in Table No.VIII are significant at .01% level.

Regression analysis as a tool of Prediction

According to Palumbo (1969) [2] "regression and correlation analysis were developed especially for use in situations where exact predictions are not possible but where the variables have been measured with a high degree of precision, that is, on an interval or ratio scale."

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1. Yates, F. 1950. The Place of statistics in the study of growth and form. Proceedings of the Royal Society of London, 1950.
2. Palumbo, Deanis J.1969. Statistics in Political and Behavioural Science. Appleton-Century-Crofts, Educational division, Meredith Corporation, New York, p.177.

Coefficient of correlation 'r' defined by Karl Pearson is a pure number that does not depend on the units of measurement and can therefore be used to compare correlations of data no matter what units are used to measure the variables. This coefficient ~~'r'~~ can also be viewed as a measure of our ability to predict 'y' with the knowledge of 'x' in regression analysis. According to Professor Draper [1] the predictive power of the regression equation is often stated as a percentage through the factor 100 R^2. The larger it is, the higher is the correlation between the dependent variable Y and its estimate as predicted by the independent variable X or variables X_1 X_2 X_3 etc.

When a dependent variable is estimated with the help of a number of independent variables the analysis is known as multiple regression analysis.

According to Ezekiel,[2] the multiple regression analysis serves to sum up all the evidence of a large number of observations in a single statement which expresses in a condensed form the extent to which the combination of independent variables affects the dependent variable.

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1. Drapper, N.R. and H.Smith. Applied Regression Analysis. New York: John Wiley and sons, 1966.
2. Ezekiel, Mordecai. Methods of Correlation Analysis. New York: Wiley, 1930.

Furthermore, the regression function does not depend on the frequency distribution of the independent variable.

For the above mentioned reasons and to overcome the problem of small N due to fragmentation from a large number of total observations mentioned before, the present investigator, employed regression analysis technique to test its feasibility in establishing 'irrespective of age' standards of the anthropometric variables under study, for the first fifteen months of life.

Following is the experimental equation arrived at by the technique of simple regression analysis of head and chest circumference of the urban lower socio-economic class male infants.

Estimated chest circumference in cms. = (.97453 x observed head circumference in cms. - .911136) cms.

The closeness to the observed values of estimation by this method is evident from Figure No.XXII. Thus the equation noted above seems to be more realistic for prediction than the central tendencies and their deviations.

<u>Conclusions</u>

The present study, as stated earlier, has been purely of an exploratory nature. The main aims have been to calculate norms for the five anthropometric measurements of stature, stem height, head circumference, chest circumference and weight, with the lower socio-economic community of Baroda and the surrounding villages as the focus. The second aim was to find out how the average infant of both the sexes grows in these measurements and to determine if any significant sex differences, urban-rural differences and social class differences exist. The third aim was to study the relationships between these measurements; and lastly, to explore the possibility of establishing 'irrespective of age' standards for these measurements by exploring the regression analysis technique and testing its validity.

In terms of the aims of the study, stated above, the following conclusions can be drawn.

I (i) The means and standard deviations for the five anthropometric measurements of stature, stem height, head circumference, chest circumference and weight for each month from 1 month to 15 months for the two sexes of the lower socio-economic classes of urban and rural communities of Baroda that are calculated may lead to tentative norms.

(ii) The percentile point estimations for the above measurements in conjunction with the means and standard deviations may be used to build up tools to help in locating the status of the infant with regard to these anthropometric measurements for the communities in and around Baroda.

II The anthropometric measurements are influenced by sex, socio-economic class and residence of the infant's parents.

III Lastly it is noted that the regression analysis technique yields more realistic values than the analysis of central tendency and its deviation.

Besides the above mentioned conclusions this study also yields the following information.

(1) All the rates of growth show a decrease in velocity as age advances. This decrease is sharpest in the first months after birth and then becomes gradual.

(2) The post natal month in which this decrease is sharpest differs with the sexes and with the anthropometric measurement in question.

(3) The wide variation in the mean values of the different anthropometric measurements at different

ages in the same group of children is suggestive of the different rates at which these measurements grow in the first fifteen months of life.

(4) The rate of growth of chest circumference is slower than the rate of growth of head circumference in the first fifteen months of life in these infants.

(5) The rates of growth of all the measurements are uneven in as much as there are spurts of growth exhibiting great velocity alternating with periods of rest of no growth or decreased growth.

(6) The belief that birth weight doubles at 5 months and tribles at 12 months is not fully supported by the present study.

Implications and suggestions

In our country, during the first fifteen months of life, making use of standards set up for chronological age invariably presents problems as the mothers are never able to correctly tell the age of the infant. In light of this, an attempt is made in the present study to test the feasibility of setting up standards of values of measurements of chest circumference in terms of the measurement values of head circumference rather than chronological age.

The apparent success of this attempt at setting up 'irrespective of age' standards or norms for head and chest circumference by applying the given equation, implies that should be tested widely, and further attempts be made with the help of the multiple regression analysis to set up such norms for the other anthropometric measurements under study. Such norms would offset the guess work about the age of the infant who comes up for assessment of his physical status and make it unnecessary to know the age of the infant.

B.D.Patel (1969) [1] has already shown that as far as intellectual development is concerned, malnutrition in the first fifteen months of life plays a crucial and dominant role. Work in the area of cause and effect on anthropometric measurements like Khanduja et al (1967)[2] who ~~where they~~ have shown that irrespective of socio-economic and religious groups, infants on optimum diet approached comparable growth pattern of infants in better developed countries, indicates that ~~also makes~~ the first year of life of our children is vulnerable.

1. Patel, B.D., et al (1969). Influence of age on outcome (Nutrition and brain development). Indian Pediatrics, VI, 253.
2. Khanduja et al (1967). Growth study in the first year of life on optimal nutritional conditions. Indian Pediatrics, 4, 203-207.

Yarrow (1963) [1] finds that developmental progress is highly influenced by maternal stimulation appropriate to the child's individual and developmental characteristics during the first six months of life; ~~that~~ Maternal behaviour significantly affects the infant's response to stress. It helps the infant to maintain equilibrium and avoid disorganization under stress.

It is also shown by Casler (1961) [2] that the critical period hypothesis ~~are~~ is illustrated by change in responsiveness occuring in humans between age 5-7 months.

In the present study, it is noted that all the five anthropometric measurements in the first fifteen months of life change as time passes, that all of them are interrelated, and that the rates of their growth differ from each other and are uneven for each individual measurement. It is also noted that in the first three months, there is more uniformity of absolute measures (as evidenced by absence of wide variations) and in the rates of growth of the different anthropometric measurements (as evidenced by the uniformly sharp deceleration).

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1. Yarrow, Leon J. Research in dimensions of early maternal care. Merrill-Palmer Quarterly : Behaviour and Development, April 1963, Vol.9, number 2.
2. Casler, Lawrence. Maternal Deprivation. A critical review of the literature. Monograph of the Society for Research in Child Development, Vol.26, No.2 Serial No.80, 1961.

In as much as, the physical being of the infant is the basis of all other aspects of development; viz., the intellectual, the emotional and the socio-cultural and in as much as so much physical growth and development takes place at such rapid rates on so many fronts of the human body, and in light of the above mentioned evidence it may not be inappropriate to suggest that the first fifteen months of life be treated as a 'critical period', which is characterised by "a certain stage of limited duration, during which a particular influence from another area of developing organism or from the environment evokes a particular response."

Further ~~the study of~~ these anthropometric measurements during ~~in~~ the first fifteen months of life should be studied in the frame work of a cause and effect relationship involving ~~with~~ the multitude of other correlates ~~of such as~~ environmental ~~factors~~ and physical factors such as ~~like~~ illness, sleep, emotional stimulation and lack of all these in the infants' life.