CHAPTER VI

SUMMARY

Nutrition research has concentrated on pre-school children as it is the vulnerable section of the population. Consequently, reported studies have investigated several issues. For example, most studies attempted to use and compare anthropometric indicators for estimating extent of malnutrition in different communities (Hagga *et al.* 1985: 331-346). There are also enough studies attempting to investigate factors associated with malnutrition (Visweswara Rao 1978: 233-244, Martorell *et al.* 1988: 57-73). An another important area is that of investigating synergistic relationship of malnutrition and morbidity (Scrimshaw *et al.* 1968, Rivera *et al.* 1988: 163-167). Most have used cross-sectional data sets, and only few have opted for longitudinal data sets.

One of the major issues, which has not received enough attention of the researchers, is that of variations in growth among children living in the same community. This is possibly because of paucity of longitudinal data sets. But even with available longitudinal data sets it is not possible to study the within individual variation. Thus Zumravi *et al.* (1987: 383-395) having a longitudinal data on monthly heights and fort-nightly weight records of newborns do comment on between

individual variability, but overlooked the within variability as arises from errors of measurements.

Secondly, almost all nutrition intervention studies which followed children over long-term period, use their data pertaining to only initial and final points to evaluate the impact of feeding programmes and the measurements recorded inbetween remained unutilized. Inspite of the fact that these studies do note the observation that, with similar supplement children from same age-sex group do not show similar gains, their data is not analysed for studying variation in growth.

It thus follows that understanding growth as a process, examining variations in growth (between as well within individuals) are some of the critical issues which are not studied in the past. In particular, variation within same individual which arises due to intrinsic factors should be viewed from the point of view of understanding the biological variation of an individual. Infact it is this variation which is essential for understanding the growth process with the help of longitudinal data. The present study therefore, attempts these issues in case of rural pre-school children.

In our study, initially, 376 pre-school (1-5 years age) children (203 boys and 173 girls) from four villages near Pune

were studied. Weights (upto 50 gm) and heights (upto 0.1 cm) were recorded every three months, by trained Field Enumerators, for a period of two years. Thus 277 children (149 boys, 128 girls) were observed longitudinally. A continuous morbidity data, using symptomatic approach was collected by recall method with the help of structured questionnaire. We have analysed this data for different aspects related to variations in growth of rural children.

Comparison of growth curves with NCHS std. (WHO, 1983: 63-101) revealed that rural children are below the 5th percentile throughout the pre-school age span with regard to both weight as well as height. Infact, the extent of underweight (W/A <75) and stunting (H/A <90) was as high as 50 % & 55 % respectively. However, the age group (2-3 years) appeared to be more sensitive with higher prevalence of malnutrition.

By using longitudinal data and Z-score approach, it was observed that Z-scores for weight and height revealed peak values (-2.8 for weight & -3.0 for height) in the age group 18-24 months in case of boys (as well as girls) confirming the observations based on cross-sectional data.

Application of Waterlow classification (1972 : 566-569) revealed that it was more the problem of stunting (50 %) and not wasting (2-3 %), in this rural community. Use of longitudinal data allowed us to estimate age of deterioration that takes place in the absence of any intervention programme in this community. Thus children in age group (2-3 years) were observed to deteriorate more in weight status while children in age group (1-2 years) showed higher deterioration in height status. This shows that age group (1-3 years) is critical age span with high risk associated with growth retardation.

The data on morbidity (GI + FEV) showed that prevalence increased from 13 % in case of normal children to 19 % among severely underweight children, while days of illnesses varied from 2.8 % to 3.3 %. The relation was more stronger in case of wasting, but no such relation was seen with stunting. These observations are in confirmation with those reported by H.C. Stetler *et al.* (1981: 888-893) for rural pre-school children in El-Salvator area.

It was interesting to see that differences in growth pattern of normal and malnourished children in this community, by comparing their growth curves. It revealed that underweight (W/A <75) children were also shorter in height than

normal children (W/A >= 75) and stunted children (H/A <90) were also lighter in weight than their counterparts (H/A >= 90). Further, comparison of velocity curves showed that underweight children try to regain weight (higher weight velocities) than height (lower height velocities), while stunted children try to catch-up in height than weight.

In view of the main aim of the study, variations in growth were studied using several approaches. Firstly, the examination of simple measure i.e. Coefficient of Variation (C.V.) in attained size and increments in weights and heights was done. Higher values of C.V. were observed for increments (30-50 % for annual weight increment and 20-30 % for annual height increment) than C.V. for attained size (10-17 % for weight and 4-6 % for height). This indicated the fact that increments are more sensitive to environmental perturbation. This observation is in confirmation with those reported by Harrison *et al.* (1989: 45-51).

A more sophisticated technique of analysis of variance was used to separate between and within individual variation in increments. Within individual variation was observed to be higher than between individual variation for both weight increment and height increment. Larger value of within

individual variation (σ^2_ω) is indicative of the fact that children during pre-school years are changing their growth channels.

Secondly, it was observed that the extent of within variation (σ^2_ω) was higher in normal children as compared to malnourished children, suggesting that normal children too do not grow with uniform rates. It implied that within variation is unlikely to arise out of measurement errors but more importantly seemed to have biological meaning. One of the possible explanation is that within variation reflects the capacity of individual to interact with environment. The reduced within variation among malnourished children perhaps indicates that malnutrition hampers this capacity.

The issue of seeking biological interpretation of within variation was further probed by analyzing the nature of within variation using longitudinal data.

Graphical representation of serial data on weight and height increments revealed cyclical fluctuations. The simple correlations of increments in successive 3 monthly periods appeared to be significant with certain period indicating the periodicity in weight as also in height increments (adjusted for decreasing time trend). Infact, crude estimates of

periodicities were larger for elderly children (3-5 years) compared to younger children (1-3 years).

Since growth in weight and height is related to each other simultaneous examination of weight increment and height increment was also attempted. Correlations between weight increment and height increment in each 3 monthly period showed significant positive correlation around age of 21 months and it reappeared around the age of 5th year, suggesting that two processes came closer with 3 year's periodicity.

The analysis therefore confirms that the within variations do not arise on account of measurement errors but infact arise as a result of biological variations within the individual.

Finally, technique of growth modelling was used to study variations in growth pattern of normal and malnourished children. Conventional models Jenss (Jenss *et al.*1937:556-563), Count (Count E.W. 1943:1-32) and Reed (Berkey & Reed 1987: 973-987) which were developed for individual fitting of healthy population were applied to grouped data for height of rural children. Differences in growth patterns were revealed by higher values of growth parameters viz. birth size and attained size at fifth year for normal children than malnourished children. Further, it was found that while Jenss model and Reed

model are suitable for modelling stature growth of normal children, Count model is suitable for malnourished children.

Growth modelling approach was also useful in confirming the critical age of malnutrition among rural community. Thus while examining the suitability of these models over short-term periods of two to three years, it was clearly seen that model could not be fitted for data sets covering age span of 1-3 yrs, 2-4 yrs and 1-4 yrs, while it was possible to fit the model for data sets covering age span 0-2 yrs, 3-5 yrs, 0-3 yrs and 2-5 yrs. It means that the short-term spans containing the age-group (2-3 yrs) was not suitable for model fitting and thus was infact identified as critical age with high risk of malnutrition.

Finally, the most important issue of growth models examined was it's application to grouped data rather than individual data. This was done for several reasons. Firstly, most of the data reported are of cross-sectional nature which can be used better by subjecting them to model fitting. Secondly, very often the growth comparisons of children from two socio-economic groups or two communities are reported only in terms of means. The application of growth models to grouped data will facilitate better and sensitive comparisons of

children from two groups/communities. Our analysis showed that the model fitting to actual empirical data on individual children and their group-means yielded comparable estimates of growth parameters. Thus variations in growth of children from different communities/groups can be studied with the help of model fitting approach.

Implications

We have analysed a longitudinal data on anthropometry and morbidity for rural pre-school children. It is necessary to discuss some of the major findings obtained in this study in view of its implications for policy and programme.

Our observation that the estimate of critical age for these rural children is (1-3) yrs. was estimated by various methods and is of importance for various reasons. Firstly, this the age where maximum growth retardation takes place in rural children. The important implication of this finding is for the supplementary feeding programmes, which are mainly implemented to combat malnutrition in pre-school children. Most of the programmes covered the entire age group (0-6) yrs, while some programmes are implemented only in Balwadies covering age group (3-5)yrs. Evaluation of feeding programmes show different results (Beaton and Ghassami,1982). The general

impression that feeding programmes failed to achieve results in terms of improving the nutritional status of children, can be explained on the basis of our observation. For example, It is not known that supplement is beneficial beyond 3 yrs i.e. once the damage is done between 1 to 3 yrs of age. Secondly, the participation of younger children, (0-3) yrs, is likely to be lower in most of these programmes for whom supplementation is essential. In view of this, our finding suggests that extensive efforts should be undertaken for covering of younger children, (1-3) yrs, as much as possible for achieving better results. This may need some kinds of incentives e.g. one way would be to start a creche for younger children in rural area to cover these children in feeding programmes. Another incentive would be to have palatable and easily digestible supplement especially, for younger children. The supplement should also be good in quality and quantity. Covering younger children especially, in the critical age, would thus result into better utilization of limited resources for achieving success of feeding trials.

Secondly, we have observed that this the age group, (1-3) yr, which is most vulnerable with respect to prevalence of morbidity as well. Morbidity is caused mainly due to poor environmental conditions, poor hygienic conditions, poor

housing conditions, lack of safe drinking water and so on. Therefore, our study also implies that nutrition programmes should be integrated with improving environmental conditions, as nutrition alone is not sufficient to achieve improved nutritional status.

Another important observation brought out by the analysis presented in this study that underweight children first try to gain weight, while stunted children try to regain height. This observation too has important implications in evaluating and planning nutrition programmes. Most of the feeding programmes are evaluated by comparing gains in weight and height (using initial and final measurements) of children in treatment and control groups. In view of our observation, evaluation of feeding trials should be attempted separately for children, who were initially underweight or stunted. Considering them together will not show the impact of feeding trial. In rural area, where about 55 % children are stunted, evaluation should be based of effective gain in height rather than weight. While in a slum community, where wasting or underweight is the major problem, the feeding programme should be evaluated to see the effective weight gain. Finally, our observation also suggests that communities where stunting is prevalent protein rich supplement should be provided, as height is known to be

affected by protein intake. While communities where prevalence of underweight is more, calorie rich supplements should be given for better improvement in their nutritional status. However, supplementary studies giving such consideration are yet to be reported and infact are required in view of their need of combating malnutrition in most third World countries.

While analysing incremental data, we have pointed out that within individual variation in increments (weight as well as height) is higher than between individual variation and infact it forms the major part of total variation in increments. Reported studies analysing serial measurements on weight or height ignored the within variation as arised from errors of measurements. Therefore our analysis offers the way of analysing longitudinal data and suggests not to ignore within variation as it represents the biological variation. Further, magnitude of within variation was observed to be lower in malnourished children, implies that malnutrition hampers the capacity of the child to interact with environment. Our observation that malnourished children have higher prevalence and duration of illness, infact supports this finding.

We have also examined the nature of within variation in increments and observed that it is non-random in nature.

Further, it was investigated that weight increments fluctuated in systematic manner i.e. cyclical in nature with certain periodicity about 1 to 2 years. This observation reveals that any intervention programmes of shorter duration i.e. less than one year are unlikely to bring out the impact of feeding. Therefore minimum duration for intervention programmes should be of one to two years, i.e. approximately the periodicity observed in weight and height increments. Secondly, we have noted the relationship between weight increment and height increment. Though we have longitudinal data for two years only and we can not predict exactly the periodicity of the two processes coming closer or departing from each other, our observation implies that longitudinal data on weight increment and height increment should be analysed simultaneously and not to be analysed in isolation as done in earlier studies.

Lastly, we have attempted the application of conventional growth models to describe the growth of rural children, as most of the conventional models used the data on growth of healthy children. Application of these models for short-term age span and also for grouped data will be beneficial for future researchers to use these models for cross-sectional data. It also offers the better and sound comparison between different groups or communities with the help of growth

parameters rather than using group means.

Thus the study underscores the importance of understanding growth as a process; approaches for analysing longitudinal data; utilities of growth modelling etc., in achieving better biological interpretation.