Chapter I

INTRODUCTION

Growth is a dynamic process which starts at conception and continues till the individual attains maturity. A single cell which weighs merely one gram in the beginning by the end of eighth week of gestation, gets transformed into adult weighing several kiloes. The phenomenon is the most complex and facinating process that has attracted attention of many research workers from all over the world.

Velocity with which growth is attained, receives an important consideration in the growth studies. It is the highest between birth to three months (45.8 cm/yr) which falls to nearly 14.4 cm/yr in the 9 to 12 month interval in case of boys (Johnston F.E, 1978). Thus the length increases by 25 to 30 cm during the first year of life. Further deceleration in the rate of growth takes place during the second year of life. The average child gains about 2.5 kg of weight and about 12 cm of length. The gain in these two measurements during the next three years, as well as early school years are again marked, by relatively steady growth (Nelson, 1979).

Deceleration in growth is interrupted once in a life i.e. during adolescence. The growth during this period is

very rapid and it is also a period of attainment of sexual maturity . Adolescence comprises of half of the growing period in man. Many physical, physiological changes such as, increase in growth rate of skeleton, muscles, viscera; sex specific increase in growth rates of shoulder and hip width leading to sexual diamorphism; changes in body composition caused by increase in muscle, and decrease in fat (in case of boys); development of reproductive system and secondary sex characteristics; general balance of endocrine system, take place during adolescence. (Satyavati K, Agarwal K.N., 1979). Thus this phase of human life is of great importance and the problems concerning adolescent growth need thorough investigation.

Adolescent growth spurt in height is a common phenomenon seen in all the children. It appears as a sharp increase in velocity which rises to a maximum and then immediately begins to decrease again. The maximum growth velocity has been observed to be between 7 and 12 cm/yr in stature for boys and 6 to 11 cm/yr for girls (Marshall W.A., 1978). The adolescent growth spurt in height is said to be an important landmark in the growth process and it is said to be related to many physiological changes that take place within a body.

Although, the process of adolescent growth is similar in different children, the age at which it starts or ends and therefore the velocity with which the growth process takes place widely differ from individual to individual. The intensity of the spurt also varies from individual to individual. Detailed examination of between as well as within variations in growth during adolescence and the factors responsible for it becomes crucial and is the main objective of the present study.

Variations in growth of individuals have been explained by genetic as well as environmental factors. The influence of genetic factors on growth can be assessed by the close relationship between the heights of parents and stature of their offspring. However, when W.H. Muller (1976) reviewed parent child correlation for stature and weight from 24 studies of school aged children, the author reported that the correlations were high for European samples and lower among the nonEuropean samples. The factors responsible for lower parent child correlations among nonEuropean samples were attributed to absence of assortive mating, reduced offspring environmental correlations and malnutrition indicating that role of environmental factors is equally crucial.

Similar observation was recorded by Marcia Russel (1978) while estimating the contribution of genetic factors on growth of children from Rural Mayan Families living in highlands of Guatemala. Father-son, Mother-son, Father-daughter, Mother-daughter correlation for weight as well as height were low when compared to those reported from developed countries. It was thought to be because of environmental factors. Thus not only the genetic factors but environmental factors also seem to play an important role in the context of growth.

The relative importance of these two factors has been investigated in detail at different stages of economic development by R. Martorell et.al (1988). The investigations were done with the help of various studies. In one study, nearly 1000 children from Hondurus, (which is one of the poorest countries in the Western hemisphere) less than 7 years of age were measured during December 81 to March 82. Various anthropometric measurements such as weight, length, head circumference, arm circumference, triceps and subscapular skinfold thickness together with information on housing conditions were recorded. It was found that poor house score was associated with z score for height for age.

Further, the authors compared heights of 7 year old children of high and low socio-economic class from number of countries such as Brazil, Costa Rica, Guatemala, Jamaica, Nigeria , India and Hong Kong. It was observed that there were large differences associated with the social class. Explanation given for these differences were that, these differences reflect consequences of poverty i.e. environmental conditions.

The comparison of mean heights of 7 year old children from industrialized countries and from highest socio-economic groups from developing countries revealed that, with a single exception of Asians the mean heights of samples of diverse ethnic groups centred around 50th percentile of NCHS standard. For Asians on the other hand, mean heights centred around 25th percentile. Thus from the available evidence the authors concluded that the maximal difference in stature at age 5 to 7 that can be ascribed to genetics is of the order of 3.5 cm, while poverty can result in the difference of 12 cm or more. Further, the authors concluded that where the level of socio-economic development is low, the stature is expected to be heavily influenced by poverty and in such cases environment largely explains population differences in stature. On the other hand, as the level of socio-economic

development rises, the environment becomes less and less a factor limiting growth in stature.

Earlier, it was believed that puberty had its onset earlier in hot countries, later onset in temperate countries and the latest in cold countries. However, when age at menarche in different regions were examined, it was found that there was only a slight difference between the region inhabited by Eskimo and for northern and western Europe. Age at menarche of Eskimo and Indian girls did not differ markedly (Bojlen K and Bentzon M.W., 1968). The frequency curves of onset of menarche for large cities were also in good agreement in spite of wide regional differences (Valsik J.A, 1965). It may thus mean that, climatic factors were less important, at least in case of onset of menarche, one of the important landmark of adolescent growth in case of girls.

The differences in development of body composition and body built in boys from various physical activity groups were investigated by Jana Perizkova (1968). The author reported that the differences were seen in the proportion and absolute amount of lean body mass and depot fat in the last year of study (i.e. Fifth year). The differences were also seen in the proportionality of skeleton as well as oxygen consumption. However, the groups did not differ from each

other either in the first or the last year in anthropometric characteristics such as height, weight, sitting height, skeletal age, chest circumference, bi-acromial and pelvic breadth.

As against these, the influnce of socio-economic factors seemed much more important in the context of adolescent growth. Adolescent growth is also said to be adversely affected by early childhood malnutrition. Hence it is essential that influence of current level of nutrition which is one of the major environmental factors, need to be examined. The main focus of attention in the present study is therefore to study growth differentials of children from different socio-economic classes especially using approach of growth modelling and assess influence of nutrition.

The cross sectional method approach of data collection in which an individual is measured at one time point only, is perhaps the most popular approach for studying growth differentials of individuals from different socio-economic backgrounds. As individuals are measured only once, this method is useful for comparing 'size attained'. There are number of such studies reported in literature, but the results appear to be varying. Thus, it was found that socio-

economic factors (income level) did not significantly affect heights and weights of secondary school girls in Benin city (Diejomuoh FME, Faul M.K.B., 1982). It has been reported that, in England and Scotland father's social class and his employment status had significant relationship with height of the child, but parents height and child's birth weight accounted for relatively more of the variance in child's height than father's social class and employment status (Rona R.J. et. al, 1978).

As against these, in developing countries like India, the poorer socio-economic status seemed to have badly affected the heights and weights of adolescent boys and girls (Vijayraghvan K. et. al; 1971, Sikri S.D. 1972, Datta Banik N.D. 1982).

In connection with physical growth and socio-economic background Lindgren G.W. and L. Cernerud (1992) have reported some interesting observations. The heights, weights and body mass index at ages 7, 10 and 13 of the Stockholm children born in 1933, 1943, 1953 and 1963 were analysed in relation to their socio-economic background. Father's occupation was used to describe socio-economic background of the child. It was observed that socio-economic class related differences in height, formerly present in Stockholm school children,

born in 1933 and 1943 were levelled out for children born in 1953 but reappeared again for boys born in 1963. These socio-economic differences for the 1963 cohort were of about the same magnitude as those for the cohort born in 1943 during the second world war. The authors feel that these reappearing of socio-economic differences in heights of stockholm children born in 1963 need to be followed up and analysed, taking more specific biological and social factors into account. The influence of the socio-economic variable on adolescent growth cannot be overlooked and has to be thoroughly investigated.

Eventhough the cross-sectional methods are mainly useful for estimating differentials in size attained, Raghbir Singh (1970) used these methods to estimate rate of growth of five anthropometric traits namely height, weight, sitting height, height-sitting height, and bicristal diameter of Punjabi, Hindu Khatri boys aged 11 to 18 years. The simple distance curves and velocity curves obtained by subtracting mean heights of the adjescent age groups were presented. Based on such 'velocities' two spurts in height were observed in case of the age groups 12 to 13 years and 15 to 16 years. Thus no definite conclusions could be drawn on the basis of velocities obtained from using cross-sectional methods.

Thus, the cross sectional methods can at best give an idea about the differences in size, attained from different socio-economic backgrounds. These methods do not give any idea about another important aspect of adolescent growth, namely the velocity with which growth is achieved. The age of maximum increment in height, which is a landmark in the growth process also cannot be estimated. As such, another method in which an individual is measured for longer period i.e. the longtudinal method will yield more useful information about adolescent growth.

The main advantage of longitudinal studies is that the mathematical models can be fitted to individual growth data and the information about the growth process can be extracted and condensed in the form of parameters of the growth models. The parameters obtained for one individual can be compared with those obtained for another individual or averages of parameters obtained for different communities can be compared and tested for statistical significance. Additionally, the biological parameters which are of main interest in the context of adolescent growth, namely, the adult height, age at take off of adolescent growth spurt,age at maximum increment in height, span of growth spurt etc can be computed from the parameters of growth models. These

biological parameters can then be compared for populations and can throw light on effect of various factors on growth.

However, the longtitudinal methods also suffer from limitations such as they are laborious, time consuming, needing huge financial support. Consequently,longitudinal studies reported are less in number. Whatever studies are reported are from outside India e.g. Harpenden growth study from London (Tanner J.M. et.al.1976) longitudinal studies carried out by Child Research Council from Denver (Deming Jean, 1957). Nojmegen growth study from Netherlands (Van't Hof Martin A. et.al.1976). Indian longitudinal growth studies have been rarely reported with an exception of that reported by Hauspie et.al (1980).

Thus in order to investigate the extent of effect of socio-economic condition on adolescent growth, longitudinal methods seemed appropriate choice as the velocities during adolescence can not be compared by using simple averages. At the same time it becomes exceedingly difficult to have pure longitudinal studies as follow up of children for longer durations such as 7 to 8 years is difficult. In such situation, there is need to explore the possibility of fitting growth models to average heights based on

semilongitudinal data . As such the present study attempts this issue through growth modelling.

Various mathematical models have been utilized in the context of adolescent growth e.g. initially Gompertz(Deming Jean,1957) and logistic models (Tanner J.M. et.al.1976) were mainly used to describe the rapid and sudden growth during adolescence. These two models have been useful for the data during 9 to 18 years of age. On the other hand, the models like double logistic, triple logistic, kernal estimation, smoothing spline functions and more recently developed Preece and Baines Model 1 (PB1) (Preece M.A.,Baines M.J.,1978) have been used to describe the entire span of growth, i.e. from early infancy to adulthood. The Gompertz and logistic models have been fitted to growth data of each individual seperately. However, the PB1 model has been fitted to individual as well as group data. As such, it will be worthwhile to examine suitability of these models to group data, in order to assess the impact of socio-economic conditions on the adolescent growth.

In addition to socio-economic factors, another important factor associated with better growth, is nutrition. Nutrition has been thought to be influencing growth not only directly but also indirectly e.g. in a study of influence of

three socio-economic factors namely number of inhabitants in the locality, occupational-educational status of the father, number of sibs, on heights of Polish military conscripts, the authors (Bielicki T. et al, 1981) attributted effect of these factors through nutritional factors. Thus it was commented that, yearly per capita consumption of principal food items declined with increasing number of persons per household and as number of persons in a household probably correlate with the number of children per family, it may mean that the sibship size may affect adult height primarily via nutrition. It was further commented that the mode of action of the factor, namely, occupational-educational status of father though seemed more complex may ultimately be related to difference in nutrition.

One of the causes for secular changes in body measurements over the years has been thought to be again better nutrition. Yet finding out the extent of relationship between nutrition and growth is very difficult . Most of the studies measure, either the dietary intakes of adolescents (Salz K.D. et al; 1983, Hackett A.F. et.al. 1984) or anthropometric measurements in isolation. In a study of 185 adolescent boys and girls living in rural areas of Andhra Pradesh, the intake was measured by 3 day weighment method

(Pushpamma P et.al. 1982). The anthropometric measurements such as weight, height were also recorded at the same time. The intakes were however compared with recommended dietary allowance while the anothropometic data was compared with the regional standards seperately without investigating the relationship between the two. It is therefore necessary to study the nature of relationship between dietary intake and growth of adolescents.

Dietary intakes as well as anthropometric measurements were considered in a cross sectional study of 611 adolescent school children by Durnin J.V.G.A. et.al. (1974). Purpose in this case was to measure the normal food intake and level of daily physical activity in a group of 14 year old school children from range of socio-economic backgrounds and not to find out the relation between nutrition and growth during adolescence.

Nelson M(1980) while assessing the dietary intake and its relation to growth in British children mentioned two anamolies in this context. The first one was that no consistent relation was found by the workers between individual intake and growth, the second one was about intake of the group of individuals from different social classes. He

observed that average energy and protein intake among children from the manual social class tends to be higher than that of children from nonmanual classes, at the same time manual workers children are on an average shorter than non-manual workers children . One of the reasons given for the obvious lack of relationship is the inability of taking into consideration the variability. Thus it appears that finding relation between nutrition and growth especially among adolescents needs due consideration to the large variability in intake as well as growth.

Thus the main objectives of the present study are i)to study the variations in growth of adolescent boys from different as well as same socio-economic classes using the approach of growth modelling and ii)to study the nature of relationship between growth and dietary intake among children from different socio-economic classes, taking into consideration large variations in dietary intakes as well as growth.

The work done is presented in various chapters. The first chapter deals with the importance and need for the problem, in the light of reported studies, while the second chapter deals with details of subjects selected for this study, their characteristics, observations recorded and

methods adopted. The third chapter essentially reports the growth differentials among the adolescent boys from different socio-economic classes. In the fourth chapter, mathematical modelling is attempted in order to have further insight into the growth differentials. The fifth chapter explores the nature of relationship between dietary intake and growth of adolescent boys taking into consideration the large variability in intake as well as growth. Finally the results are discussed and a summary is presented in the last chapter giving implications of the findings obtained in this study.