Physical growth is a complex phenomenon representing a continuous process of interaction between endogenous and exogenous factors. It is defined as progressive increase in size of various parts and organs of the body. It is the objective manifestation of hyperplasia and hypertrophy of the organism’s constituent tissues and is determined by postnatal body size. The increase is limited by the pre-established constitutional hereditary factors and influenced by exogenous factors (viz. race, climate, diet, environment etc.). Development is defined as that quality peculiar to a living matter that carries it through the process of progressive evolution to a state of perfect function. Development is evaluated by the perfecting of functional capacity and is always gradual, progressive and diversified in form according to the different periods of childhood. Development can also be understood as the maturation and differentiation of tissues and organs which are necessary for the formation and completion of the whole individual. The words growth and development are, however, often used interchangeably and convey more or less similar meaning.

Growth studies form the basis for comparison to know if the growth patterns differ between regions of a country and also if they are different in different segments of a population. Claparade (cf. Harrison et al., 1964) divided child
growth into four stages: early childhood, late childhood, adolescence and puberty. Scammon (1942) broadly divided growth into two stages. Prenatal, with four stages ovum, embryo, fetus and infant; and postnatal with five stages—childhood, puberty, adolescence maturity and senility. Factors altering human morphological type have been classified as (a) climatic, mineralogical and geological origin translated into favourable/unfavourable conditions for better human biological development viz. greater exposure to sun, improved harvests because of better soil or the opposite etc.; and (b) social origins implying a different economic and social status and consequently a difference in dietetic and sanitary conditions. Growth status of children is generally accepted as a good index of nutritional status of a community (Tanner, 1962).

The commonest method of collecting data on human growth is the cross sectional. In this method the individuals are measured once and mean values of a measure are found for various ages. Age differences are usually calculated by comparing mean values of different age groups, or using all individual measures and computing the regression on age. The greater majority of standards used in growth studies have been, and, are produced from cross-sectional study. Such studies are the very basis of the provision of standards of different measures in different populations. If measures of dispersion are added and the samples are reasonably large and representative, then such cross-sectional studies tell
us much about human growth and development; mainly as distance data—that is, average measurements attained at various ages. Cross-sectional studies are easy to perform, inexpensive and produce results of good quality.

In a longitudinal study, the same individuals are measured at specific ages over a period of time. Such a study could be carried out from birth to maturity or even beyond. Longitudinal study gives us the information regarding change of velocity in growth and development but the time factor of the study itself virtually prohibits study of an individual’s whole life span. It has rarely been possible to measure a group of new borns regularly until maturity and have complete data—that is, to observe each child at each age throughout this time period. The third method is the mixed longitudinal. In this, one group of subjects may produce data for few years only and another group for yet another few years. Another group may join the study while it is in progress.

In the present study cross-sectional method has been followed since it helps in establishing normal growth pattern of the population studied. Because of being less time-consuming the cross sectional studies outnumber the longitudinal and mixed longitudinal studies.

Garn (1980) in a review on human growth has taken three areas of growth in well-nourished children. First, the timing and magnitude of adolescent growth spurt, second;
changes in body composition during childhood and adolescence in the light of the need to account for the chemical immaturity of children and finally changes in fat distribution during growth. Normal growth and development of every living organism is a function of both genetic and environmental factors. Growth and maturity rates of children are very sensitive to environmental stresses (Malcon 1975) which means child growth is ecosensitive (Haas, 1983). In less advantaged environments, the growth status of children is a direct indicator of their environmental history and home, a valid indicator of the quality of the environments to which they have been exposed. Any deprivation in nutritional requirements causes physiological adjustments which lead to changes in growth rate and the rate of attainment of maturity. An organism is able to express fully its genetic potentiality if only the necessary requirements of nutrients are supplied to the organism implying thereby that genetic factors are interwoven with the environmental conditions.

Human body requires nutritive elements for the building up and proper maintenance of bones and muscles, arteries and nerves and all other constituents of the human body. Diet and nutrition are not synonymous though they are popularly used in that fashion. Diet consists of various articles of food which are ingested and converted for use in the body for building up and maintaining it in a vital condition, nutrition is the sum of the processes by which an organism is nourished by absorbing substances different from itself.
and assimilating them to substances identical with itself. Stress is laid upon the word 'sum' because the consumption of food is not identical with nutrition. As McCarrison (1936) puts it, food is the instrument of nourishment; nutrition is the act of using it. Nutrition is indeed synonymous with existence; or as Claud Bernard (1867) defined it, 'perpetual creation'. Human beings have shown a great deal of adaptability in relation to available foods. So long as certain minimum requirements are provided, he is able to maintain normal growth and health. Most cultures normally restrict themselves to only a limited variety of potentially edible materials demonstrating their numerous food dislikes and preferences. Food preferences usually have a negative effect on nutrient intakes and consequently on growth. In most cultures, one or two foods, are elevated to cultural superfoods. Nutrition is the end of the process by which these are assimilated and produce the desired results. Man's physical development and growth can be considerably improved by means of better nutrition. Nutritional deficiency in the body can be of two types - under-nutrition and malnutrition. Under-nutrition means quantitative inadequacy of food leading to under-nourishment. For proper growth and development of human body having sufficient food to eat is not enough. The food should provide all the elements which our body needs to grow and to maintain itself in a healthy state. To determine whether a person suffers from under-nourishment or not, the calorie value of the food he or she takes should be found out. Calorie needs, however, vary with
Nutritional anthropometry has been considered one of the important methods of assessing nutriture because it provides body measurements which are indicative of body fat stores and hence, of nutriture. In 1956, the committee of Nutritional Anthropometry published a list of the minimum number of measurements considered essential to indicate thickness of subcutaneous fat and skeletal build (Brozek, 1956). They were designated as the measurements of height, weight and skin fold thicknesses. Since then, efforts to standardise measurements have resulted in the formulation of several age related height-weight tables by Usdhew (1953), State University of Iowa (1943a,b) and Wetzel (1940). Jellifee (1969) used tables to measure growth in children which are age-independent in order to evaluate those children whose actual ages are unknown.

Measurement of skinfold thickness provides additional information to data collected during the nutrition survey. Methods for this have been developed by Keys and Brozek (1953) and Brozek et al. (1963). High correlation between pinch caliper and X-ray measurements of skin and subcutaneous fat has suggested that mass radiography can also be used as a means of assessing obesity (Garn, 1956).

During the past three decades, nine editions of the Recommended Dietary Allowances of the Food and Nutrition
Board have been published (1943, 1945, 1948, 1953, 1956, 1964, 1968, 1974 and 1979). The growth of body height and weight are also considered as measures of a population's health (Al-frayh et al., 1987). The most important child growth standards, their interpretations and some guidelines for their use have also been developed by experts in the field of auxology (Tanner, 1966; Waterlow et al., 1977; Goldstein 1972; and Jordan 1975). According to Malina (1985) body weight is more sensitive to environmental stress. Children born and raised in better-of circumstances are larger for age, and mature earlier than those from poorer socio-economic backgrounds (Eveleth and Tanner, 1976).

**REVIEW OF LITERATURE**

Significant studies on child growth were conducted towards the end of the 19th century and the first half of the 20th century. Amongst the pioneers, mention must be made of Bowditch (1877, 1880), Boas (1897, 1907, 1930, 1932, 1933, 1935, 1940, 1950); Devenport (1931, 1932, 1934, 1935, 1940). Most of the earlier work on human growth has emanated from United States of America and England. Stuart (1934), Vickers and Stuart (1943), and Stuart and Stevenson (1959) presented results on the American and North European children belonging to low and middle socio-economic strata. Wingred et al. (1971), Tudenham and Snyder (1954), Garn (1967) and Stuart and Meredith (1946) worked on children of higher socio-economic class, professional and managerial classes. Krogman (1970) and McCammon (1970) reported their
works on children belonging to middle class from birth to 25 years.

Johnson et al. (1973) have presented descriptive statistics on school going children in Guatemala city for the upper socio-economic status on (a) height and weight between 6 and 17 years and (b) whole year velocities centered on age as well as on peak velocities. Work on height and weight has also been carried out by Bogin and MacVean (1978; 1981); Johnson et al. (1975 and 1976). These studies show that upper class Guatemalan school children are taller, heavier than the children of lower socio-economic status.

Buschang and Malina (1983); Himes et al. (1976); Malina and Chumela (1980); and Malina et al. (1977) have worked on the measures of body size, comparison and maturation, and their relationships to environmental and secular variables in the Oaxaca Valley, Mexico.


According to Huss, Ashmore and Johnson (1985) growth differences between groups reflect environmental factors during childhood, however, during adolescent years, genetic
factors play a role and adult size results from a blend of hereditary and environmental factors, though environmental factors predominate. Fiawoo (1975) and Malcon (1975) have reported that environmental factors strongly regulate growth in size and composition and the rate of biological maturation.

Habicht et al. (1974) analysed the differences between mean height and weight of pre-school children from a number of published studies and reported that the differences among high SES studies from developed and developing countries showed a range of variations of 3 percent in height and 6 percent in weight; while differences between high and low SES samples within developing countries showed a range of 12 percent in height and 30 percent in weight; and concluded differences between samples reflected environmental factors associated with SES and that ethnic differences in growth potential on global basis were minor. Rea (1971) also presented clear evidence of socio-economic influences on the growth of children in Lagos under 5 years of age.

Himes and Muller (1977) worked on Columbian population and reported that among rural Colombians, adults of higher SES show a slower reduction in stature with ageing than those of lower socio-economic status. Socio-economic factors in growth in other populations have also been reviewed by Sausanne (1980). Studies carried out by Chang et al. (1963); Aschroft et al. (1966); Sabharwal et al. (1966); Bailey (1970); Raghvan et al. (1971); Amirkhakimi (1974); and Bogin
and MacVean (1978) show the relationship between socio-economic status and the prevalence of severe nutritional problems among African and Asiatic populations.

Johnston et al. (1976) reported on a longitudinal analysis of growth in height of Guatemalan children from highest levels of their society. The sample was subdivided into individuals of Guatemalan ancestry and those of European and North American heritage who had lived in Guatemala for their primary and secondary schooling. Third group consisted of North American ancestry. Of all the parameters, differences were found in only two, growth during childhood and adolescence. The western European/North America children growing up in Guatemala differed from their genetically similar U.S. peers in the amount of growth during childhood but not in growth during adolescence. Johnston et al. (1976) reported that growth during childhood was regulated by environmental factors.

Frisancho et al. (1980) carried out a similar study in Quechua and Mestizo children and reported that the results were similar to those of Johnston et al. (1976). During childhood, nutritional status differences were four to five times greater than differences by ethnicity.

Much work in the United Kingdom has come from J.M. Tanner and his associates from the Institute of Child Health, London. Tanner (1951, 1958, 1959, 1962, 1964, 1966) has published immense data on human growth, physical matur-

A lot of literature on child growth has been published from Finland. Cross-sectional studies reported by Tisala et al. (1964) Takkunen et al. (1964) and Backstrom (1964) have revealed the pattern of physical growth in finish children. Tisala and Kantero (1971) compared the height and weight distance curves based on longitudinal and cross-sectional data extending from birth to 10 years.

The effect of nutrition on anthropometric measurements are demonstrated in lower weights and heights of European school children in Paris (Gounelle, 1946) following severe wartime dietary restrictions. Records of changes in heights and weights of children giving the rate of growth are indicative of nutritive adequacy. Measures of skinfold thickness and limb size have also been used to assess nutritional status of children (Gran, Frinsancho, 1971).

Selinus et al. (1971) observed in Ethiopia that calorie intake of toddlers was below the minimum requirement and consequently part of the protein had to be consumed for energy production. McKay (1969) demonstrated that the mid-arm circumference and weights of higher income Malay children were greater than those of lower income Malay children. Wray and Aguirre (1969) reported that among
Colombian children there was much less malnutrition among those from families with incomes of 500 or more pesos.

In India earliest references on the subject can be traced back to nineteen thirties and forties and among these the works of Aykroyd and Rajgopal (1936), Aykroyd and Krishnan (1937), Aykroyd et al. (1938), Narinder Singh (1939), Shourie (1939) and Mitra (1940, 1941) are noteworthy. The first systematic attempt at providing growth norms on Indian children, however, was made by the Indian Council of Medical Research (ICMR) in 1956 to 1965; although the data provided by the ICMR are now about 25 years old but still remain the only large scale reference material on Indian children. A survey carried out by National Institute of Nutrition on about 2000 children of school going age indicates about 22 percent show one or more signs of nutritional deficiencies (ICMR, 1971). The mean values of the body height and weight were higher in boys than for girls in all age groups; Ghai (1970); Srivastava and Kaul (1970); Singh (1970) Rao (1970); and Neuman et al., (1969). Bajpai (1975) reported on growth of Rajasthan girls. Malhotra (1975) reported on growth of Kinauri children. Ghai (1979) studied the growth of the Rajput girls of Himachal Pradesh. Bhalla (1984) described the longitudinal growth of Punjabi infants from Chandigarh. Sharma (1963) studied the growth and development of Maharashtrian children from birth to maturity based on the cross-sectional data with special reference to changing body proportions with age.
Dutta Banik et al. (1972) studied physical growth patterns of two socio-economic groups of children between 1 and 5 years of age in different communities in Delhi and observed that 50th percentile height and weight of children of both series belonging to the higher socio-economic group corresponded with the 25th percentile of American children.

Gadre et al. (1973) in their study of anthropometric data of 1814 children ranging from 6 - 36 months concluded that the average for weight was 86 percent, body length 95 percent, head circumference 98 percent and chest circumference 101 percent of the standards provided by ICMR (1972).

Gupta et al. (1973) conducted anthropometric studies in 1001 preschool children in Delhi. The mean values for weight, body length and circumference of chest, mid-arm, mid-leg were lower in poor socio-economic subjects. The values of rural children, however, were similar to those of the urban children from poor socio-economic group.

Ghosh et al. (1974) conducted a longitudinal study of length, weight and head circumference from birth to 2 years among children of the higher socio-economic urban groups in Delhi and their data were, however, comparable to the 25th percentile of American figures.

Rathore et al. (1975) in their study conducted on 1000 children of the slum areas of Jaipur (Rajasthan) found that
the children of the control group who were given supplementary diet had anthropometric measurements equal to those of ICMR figures. The measurements of rest of the children of slum areas were significantly lower than the controls, indicating the effects of malnutrition.

Bhandari et al. (1975) conducted a study on 839 school boys and determined the nutritional and health status of the rural children. Dhamija et al. (1976) studied physical growth of preschool children of Varanasi and established growth norms for that region and observed that children belonging to higher socio-economic group (group I) were heavier and taller than those of middle socio-economic group (group II) and lower socio-economic group (group III).

Dyal et al. (1977) studied the growth of infants of Agra. Katyal et al. (1978) studied infants from urban slum area centers and concluded that male infants showed superior growth pattern than female infants; and the urban slum infants showed retarded physical growth possibly due to unhygienic environment and under-nourishment. Numerous cross-section growth studies were conducted by Dhamija et al. (1976), Gupta et al. (1978), Srivastava et al. (1978) etc. on preschool and primary school children.

Aggarwal et al. (1971) conducted studies on adolescent boys and girls and reported that the physical growth at adolescence is more rapid and precedes in girls over boys. A number of growth studies on adolescents showed that girls
were taller than boys up to the age of 14 years after that boys overtook girls and continued to be taller and heavier than girls. Sathyavathi et al. (1979), Little and Johnson (1987) studied, height, weight and skin folds of 160 nomadic Turkan pastoralists of northwest Kenya with subject’s ages ranging from less than one-year to 23 years.

Khurana et al. (1971) studied the velocities of physical growth of first five years in New Delhi and the results showed that gain in height was similar to British children only up to 6 months of life. The weight and head circumference measurements at all age periods were less as compared to British standards. Many approaches deal with body as a whole, that is, they identify the quality of lean versus fatty tissues in the total body. Such approach, however, provides little information on relative distribution or development of primary tissue components responsible for considerable variation in body weight and forms, namely, bone, muscle and fat (Malina, 1969).

Gupta et al. (1973) in their study on Delhi children also found no rural-urban differences. However, differences with the results obtained by other investigators (Srivastava et al. 1970; Chaudhary et al., 1972; Rao et al., 1969; Ghai et al., 1970) also on the Delhi children were largely due to the wide variations in the socio-economic conditions, dietary habits, child rearing practices and sanitary conditions. Udani (1963) on the basis of Bombay children and Sharma and Kaul (1970) on the basis of Punjabi children also
reported socio-economic factors responsible for growth differences. Gupta et al., (1978) conducted an anthropometric study on Rajasthan preschool children and concluded that not much differences were found between rural and urban children, however, females had lower values compared to males.

Kaul and Corruccini (1989), Sidhu et al., (1982) and Singh and Malhotra reported that living conditions bring about improvement in the growth of the people.

Other studies include those by Phadke et al., (1973); Biswas (1965); Vijaya Raghvan (1969); Singh (1970a, 1970b); Nath (1972); Singh and Meenakshi (1969); Ghai and Sandhu (1968); Bansal (1969); Houspie et al., (1980) which deal with the pattern of growth among the Indian children of school going age. There are also studies on growth from different socio-economic groups such as Bombay children by Udani (1963), Punjabi children by Sharma and Kaul (1970) and undernourished and malnourished tribal children of Orissa and Madhya Pradesh by Sharma (1982).

A cross sectional study of physical growth on 1002 preschool rural children was done by Prasad, Kumar and Dayal (1971). They used height, weight, head and chest circumference of every child as a parameter and compared it in relation to sex and economic status and found no significant difference in the mean height in the two sexes. No difference in the mean head circumference was noted to occur in
two different economic groups, whereas, height, weight and chest circumference were definitely influenced by economic factors. Studies carried out by Sharma (1986) on some of the tribes in central India namely Gonds and Konds clearly reveals that since these tribes were victims of malnutrition and infectious diseases, they had abnormal physical growth and development of children and under sized and underweight adults.

Vijaya Raghavan et al. (1971) carried out a study on 9000 school children belonging to well-to-do and low income group. The children belonging to well-to-do group demonstrated no deficiency signs but about 20 percent of the children belonging to low socio-economic group had one or more nutritional deficiency signs. Gupta and Bhandari (1972) studied the nutritional status of the tribal and non-tribal rural preschool children around Udaipur, when compared with ICMR averages, tribal children were more under-nourished than non-tribal children though all children suffered from malnutrition. Growth deficiencies were most marked in weight and chest circumference but they were less obvious in height and head circumference of the children. Mathur et al. (1974) also studied nutritional disorders among children below 5 years in a rural community and found that out of 202 children below 5 years, 61 suffered from nutritional disorders, 49 of the affected children were between 6 months and 4 years, PCM was found in 4 and severe anemia in 10 children. Merchant Abrahim (1975) conducted medical examination on 835
school children in Bombay and found that nutritional disorder topped the list of common elements. Rathore et al. (1975) studied the slum areas of Jaipur on 1000 children and found that the control group children had anthropometric measurements equal to those of ICMR figures. The measurements of children of slum areas were significantly lower than the controls indicating the presence of malnutrition. Naik et al. (1975) prepared malnutrition and anthropometric profiles of primary school children in Punjab and compared with Harvard and ICMR (1972) standards and found that the average body weight of primary school children was 72 percent of the Harvard standard. The comparative anthropometric data showed that rural primary school children in Punjab were heavier and taller than their counterparts in various other regions of India.

The National Nutritional Monitoring Bureau (NNMB) in a survey (1980) detected clinical forms of protein energy malnutrition in only 2.7 percent of 4025 children examined in 10 states of India while 85.2 percent of these children were judged malnourished (49.9 percent mild, 32.6 percent moderate and 4.7 percent severe) by the criteria of weight for age using Indian well to do children standards. Bedi (1975) studied Indian children from poor communities in Chandigarh and reported that these children fall below the third percentile on the Harvard standard charts (Stuart and Stevenson, 1963). The well to do Indian children fall around the 50th percentile for height and weight (Vijayaraghavan et
Naik et al. (1976) conducted a nutritional and anthropometric survey of 1670 preschool children in Punjab from 199 rural and urban areas. The survey showed that anthropometric measurements of their study compared well with ICMR averages but were quite inferior when compared with Harvard standards.

Growth studies on twins, however, have revealed that while genetic factors determine the growth and development of individuals and the final dimensions they will have at maturity, environmental factors have considerable modifying influence (Fischbein, 1977; Fischbein and Nordquist, 1978; Lung, Fischbein and Lindgren, 1977; Wilson, 1976; and Sharma 1975). It is desirable, therefore, to study growth and development of children from genetically homogeneous populations in order to understand the role of environment.

The present study is based on cross-sectional data derived from 1080 Rajput children, 1 to 18 years of age of both sexes from Rajasthan desert area of Jodhpur and adjoining regions. Rajputs of deserts constitute one of the largest endogenous population of Rajasthan and are, therefore, genetically a homogenous population. It was also thought worthwhile to investigate nutritional status of these people to study the effect of nutrition besides other environmental factors on the growth pattern of the children. The nutritional status of the Rajput children has been assessed in a
number of ways including the actual food and nutrient consumption, deficiency signs and nutritional anthropometry. Complete data on actual food and nutritional intake and deficiency signs which could be seen on these children were also recorded. Apparently, normal subjects alone were included in the study. Nutritional data were collected according to method suggested by National Institute of Nutrition.

The objective behind this study was to provide data on physical growth and age changes on body proportion on children of desert region for comparison with similar data on children from green belt of Rajasthan to highlight if desert environment besides nutrition has any specific effect on growth and changes in body proportion.