CHAPTER II
REVIEW OF LITERATURE

Healthy children beget healthy nation

The importance and relevance of a study that deals with physical growth parameters (indicators of health status), nutritional intake (significant determinants of health) and nutrition deficiency of children can hardly be overemphasized. Physical growth depends not merely on genetic potentials but also on environment, which include presence or absence of infection, poor environmental conditions, nutrition and economic constraints. Not many studies are available on growth pattern of urban school children, which examines all these extremely vital variables.

Malnutrition especially among young children is viewed in the modern age as one of the principal public health problems throughout the world, primarily for it affects large segment of world’s population. Insufficiency of nutrient can interfere with normal growth and development. The manifestations of under nutrition are most severe in the growing child whose nutritional needs are greater but whose capacity to adapt to deficiency state is most restricted.

According to WHO (1983) malnutrition though declining, continues to remain a major health problem in South-East Asia. Millions of people still lead sub optimal lives because of varied nutrition deficiencies and imbalances.

Similarly in recent years, the NFHS-2 (1998-99) report also emphasized the fact that India is facing a series problem of malnutrition more particularly among growing children and women. Paradoxically, in spite of initiation of many development programmes spread over the last five decades, about 30 per cent of population still live below the poverty line. The tragedy become more pronounced when we see this great mass struggling to find two-square meals in the backdrop where India has attained self sufficiency in food grain production and has even become an exporter. There are still several millions of malnourished children creating major concerned for health in the nation. A recent case study report observes that India has the dubious distinction of having nearly 75 million (63%) malnourished children below the age of five years (Sujatha, 1997).
Several studies have reported that a large section of children especially in urban India, are suffering from varying grades of malnutrition. (Verma et al 1998; Agarwal et al 1998; Kapoor et al 1991; Bhasin et al 1990). These studies revealed that protein energy malnutrition, anemia, vitamin A and iodine deficiency continue to affect the health of the school children. Indian school children who constitute about 25 to 27 per cent of the population, suffer more from stunting caused by protein energy malnutrition. (Ingale 1985; Verma et al 1998; Bhave et al 2001; Bhasin et al 1990; Goyal et al 1993).

2.1 Genesis of Nutrition Surveys

Nutrition surveys carried out in India prior to 1936 were few and sporadic in spite of its importance (Ingale, 1985). Early contribution in the field of assessment of nutritional status emerged mainly from Europe. Bavaria, in 1770 was the first country, which showed concern for the nutrition and health aspect of school children and started school lunch programme for the underprivileged. Johann Peter Frank 1747-1821, an eminent scientist published a series of papers on school children health. In course of times the concept of school children health was gradually extended to Sweden, Germany, United Kingdom, United State of America, Russia and ultimately India (Panja, 1993).

In India growth assessment of school children dates back to 1909, when medical examination of school children was carried out in Baroda city. Then on the recommendation of the Nutritional Advisory Committee of Indian Council of Medical Research that came into existence in 1936 that several nutrition surveys were under taken in different parts of the country. The Bhore Committee 1946 criticized the school health services in its report. In 1953, secondary education committee emphasized the need for medical examination of school children and school feeding programme. In 1960, Govt. of India formed the school health committee to assess the nutritional status and health need of the school children and in the year 1961, the committee submitted its valuable report with the recommendation that all children should be provided with school health services with preventive and curative measures and there shall be medical examination at the time of the entry and there after once in every four years. It also emphasized that modern era of school health should be based on the fundamental concept that
the child should learn what is necessary for his protection, preservation and promotion of health. Therefore to achieve these goals, regular monitoring of growth promotion to assess the school children nutritional status should be given high priority (Khadgawal et al 1998).

It was stressed that there should be yearly evaluation of height and weight of all children as normal growth is an indirect indicator of overall well being of a child. Data on normal growth pattern is essential to compare and evaluate the relative nutrition and health status of different groups of school children in different community settings. The need to conduct studies in different community set up is also emphasized by Rao et al (1998). In their study on height velocity and body fat of Indian girls they concluded that weight and height limits varies from community to community. Khadgawal et al (1998) in their study of growth charts suitable for evaluation of Indian children suggested that differences in weight and height of normal children should be evaluated selecting sample of children growing in an optimal environment.

2.2 Methodology of Measuring Growth

In the field of nutrition Wasantwisut (2000) observe that a major challenge is how to identify individuals and/or population who have nutritional problem. Nutritionist in their effort to find out the root cause for increasing cases of malnutrition despite mitigating measures and the possible role of school in the promotion of well being to a child, feel that proper implementation of nutritional assessment methods that systematically evaluate the nutritional status can solve the problem to a great extent by identifying the root cause which help in designing strategies for combating malnutrition.

The evaluation of nutritional status requires an understanding of the pattern and range of normal growth, the factors causing deviation from normal growth and an understanding of the methodology of measuring growth in human body. According to Robson (1972) growth is a phenomenon that is associated with an increase in metabolic tissue and in turn is dependent on the provision of adequate nutrients. In case of inadequate nutrients body and tissue store are depleted, the tissues themselves may be metabolized in order to maintain essential body functions with of course some disturbances. If the deprivation continues,
there will be tissues breakdown and lesions will develop that are recognized as the clinical sign of malnutrition.

2.3 Stages of Nutrient Deprivation and Identification Methods

The sequences that affect nutrient deprivation of body and tissues store and the development of different stages (clinical and sub-clinical) of malnutrition represents a continuum from the early to late stages. The sub-clinical stages and clinical signs of deficiency categorized by Wasantwisut (2000) are summarized as follows.

1. Nutritional deficiency is usually initiated by an inadequate dietary intake of one or more nutrient resulting from either a low content in indigenous food sources or the presence of exogenous factors that interfere with ingestion, absorption and metabolism of the nutrients. This stage of nutritional deficiency usually can be identified by dietary assessment.

2. When inadequate intake persists, the tissue store become gradually depleted in the nutrient, resulting in low levels in certain body fluids and tissues (tissues de-saturation) and/or in the activity of nutrient dependent enzymes. Often these changes can be detected by biochemical test.

3. Following nutrient depletion of body fluid and tissues, functional changes occur, leading to clinical deficiency signs. Therefore, clinical assessment may readily detect the late or severe stages of nutritional deficiencies, for example, angular stomatitis for riboflavin deficiency, and the lesions or xerophthalmia for vitamin A deficiency etc.

4. Finally moderate to severe form of malnutrition and possible chronic imbalances of protein and energy in the body can be identified by anthropometric indices such as weight for age, height for age, weight for height and measurement such as mid upper arm circumference and triceps skin fold.
2.4 Objectives and Purposes of Assessment

Nutritional assessment can be done by utilizing a variety of methods. These methods based on a series of dietary, laboratory, anthropometrical and clinical measurements can be used either alone or more effectively in a combination, depending on available resources and the study objectives. Studies can be designed to meet objectives at both the population and individual level. Wasantwisut (2000) emphasized that the implementation of appropriate nutritional assessment method can;

- Determine the overall nutritional status of an individual, population and sub population
- Characterize the extent and nature of the malnutrition within the population or sub populations, and
- Identify areas, population or sub population at high risk of chronic malnutrition.

The information from these assessments can also be used for formulating and implementing nutrition intervention programmes to improve the overall nutrition status and meet the needs defined by these assessments.

There is a growing realization that no single index of nutritional assessment provides a definite diagnosis at all level of nutritional status. To assess the nutritional status of individual or population, a combination of dietary, biochemical, anthropometrical and clinical methods are considered the golden standard (Wasantwisut et al 2000; Robson et al 1972).

National Nutrition Monitoring Bureau also supports assessment of nutritional status that takes into consideration dietary, anthropometrical, biochemical and clinical parameters. Changes in these parameters over a period of time provide a measure of change in nutritional status. Quantification of change is possible only when the information on these parameters is collected using identical methodologies on comparable sample of population.

The assessment of nutritional status involves various techniques. Proper evaluation demands a many-angled approach covering all the different stages in the natural history of nutritional disease (Park and Park, 1991).

According to Guthrie (1979) the techniques by which attempts are made to assess the nutritional status include physical or anthropometric measurement,
dietary evaluation, clinical observation and biochemical analysis. Davidson and Passmore (1963) have also listed the above methods for the evaluation of nutritional status of children.

2.5 Anthropometric Measurements

Nutritional anthropometry is concerned with the measurement of variations of the physical dimension and the gross composition of the human body at different age level and degrees of maturation. Nutritional assessment provides us with information concerning the nutritional profiles of the community, and can be of value in guiding public health programmes. For carrying out practical nutritional surveys in the field Jelliffe (1966) suggests:

1. To select the minimum number of relatively simple methods that can give useful practical information on community basis.
2. To understand thoroughly the practical techniques involved, and
3. To interpret the results and express them in a way that is understandable to workers anywhere in the World

Heights, weight, mid arm circumference and skin fold thickness are such valuable indicators of nutritional status in children. There is a progressive increase with age in the mean value, for height, weight, and mid arm circumference, skin fold thickness. Sequential measurement over a period of time reflects the pattern of growth and deviation from the average for that age and sex.

According to Sachdev (1995) for practical purposes, anthropometry is the useful parameter for assessing nutritional status of children. As the nutritional intake and environmental factors influence the body size and growth, the classical use of anthropometry serve as the most readily available method of nutritional assessment and therefore is logical. Anthropometric measurements such as height, weight, mid arm circumference, skin fold thickness are valuable indicator of nutritional status (Guthrie, 1979).

Macy and Kelly (1957) and Rao (1961) indicated that body measurement such as weight and height, if properly obtained and interpreted would serve as useful physical sign in the evaluation of nutritional status.

Davidson and Passmore (1963) state that body weight constitutes an index of whether the food is furnishing energy equal to or in excess or below the energy
requirement of the body. If anthropometric measurements are recorded over a period of time, they reflect the pattern of growth and development and how individual deviate from the average at various ages in body size, build and nutritional status (Guthrie, 1979). Brozok (1956) state that weight, height, measurement of subcutaneous fat are the irreducible minimum basic data. Bhasin et al (1990) also observe that anthorpometry offers a reliable method to assess the nutritional status of school children.

The mild and moderate forms of protein energy malnutrition manifest itself in growth retardation in later childhood and can be recognized only by anthropometric measurements. Lichton et al (1984) successfully used the anthropometric measurement to establish race specific growth standards and to serve for evidence of significance under or over nourishment with in any particular groups of Hawaii children aged 5-15 years attending private and public schools in Hawaii.

Frisancho (1984) states that anthropometric measurement has become an indispensable approach for the evaluation of nutritional status of children and adults. Anthropometric variable are indicators of body composition for which inferences about nutritional status may be made. In comparison to laboratory test based on blood or urine specimen anthropometric methods offer several practical advantages, costs are minimum and initiative may be taken by a variety of professionals. Further, while use of the caliper to measure skin fold may arouse some anxiety, especially for the inexperienced, the physical sensation involved are mild and anthropometric procedure are not invasive.

2.5.1 Weight

Weight is the anthropometric measurement most in use. In developing countries the prevalence of malnutrition appears to be best indicated by weight deficiency. Jelliffe (1966) has noted that body weight standard can best compared with locally prepared standard.

Bhasin et al (1990) studied weight and height of 4,405 school children in the age group of 5 to 15 year both boys and girls in Haryana. In their study they found that weight of boys and girls were uniformly heavier than their counterparts in comparison to ICMR (1972) study for all ages and the result were statistically
significant $P<0.05$ for all ages and for both sexes except male children in the ages of 13 and 14 years where the result were not significant ($P>0.05$). They found that the mean weight of boys ranged from 19.13 to 52.8 kg and of girls from 18.12 to 48.52 Kg.

Rath et al (1978) studied the anthropometric indices of children of 5 to 15 years of a privilege community in a cross sectional study in four public schools of Delhi. The growth parameters were lower at all ages as compared to American children and the difference was statistically significant. In contrast to many other studies, the study concluded that even under best of environmental and economic conditions Indian children failed to catch-up to the American standard. The mean values of weight observed in their study were comparable to those reported by Ragahavan et al (1971) till the age of 12 years. From 13 years onwards the values were higher.

Pareira et al (1983) has noted that the adolescent girls of upper socio economic groups in Varanasi showed a weight gain of 15.1 kg between 10 to 15 year of age as against a weight gain of 23.3 kg and 19.6 kg respectively reported by British and American investigators. Their study suggested that Indian girls are genetically lighter than their western counterparts.

Similar findings were revealed by Agarwal et al (1992) based on their study of physical and sexual growth pattern of affluent Indian children 5 to 18 years of age. They observed that weight of Indian children was less than their western counterparts. The difference was minimum at 5 to 6 years of age and increased with age up to 17 years. On comparison with Asian girls, the mean weight in their study was close to Chinese (Zhang et al 1988) Thai (Khanjanasthi et al 1987) and Japanese (Kikatu et al 1987) national data but were higher than the Hong Kong Chinese (Fung et al 1985) at 5 years of age. Japanese girls are heavier as compared to Indian girls by two to four kilograms at 17 years. The data collected by ICMR (1972) was much lower than the data reported by Raghavan et al (1971) and Agarwal et al (1992). The findings of the Nutritional Foundation of India (1989) for girls from Delhi and Calcutta were similar to that reported by Agarwal et al (1992) while those from Bombay and Coimbatore were marginally lower.
Mohaptra et al (1998) from Orissa conducted a cross sectional study in 4004 school children 5 to 15 year on health and nutritional profile of young children in Orissa. The mean weight and height of respective age groups were compared with data from well to do subjects from India, NCHS standards, it was observed that the mean weight and height of Orissa school children were lower than the referred standards.

Devi et al (1999) in a study of physical development of rural school children observe that weight of girls were marginally better than that of boys. The physical measurement gradually increased from 6 to 12 years. The boys were found to be heavier than girls up to 10 years and from 10 years to 12 years girls measured more than boys for weight.

Khadi et al (2001) in their comparative study of northern Karnataka also found the weight and height of children of the entire age group were below the NCHS standard (50 percentile). The difference between NCHS and the weight of children increased with rise in age.

Bhave et al (2001) studied the physical growth of children between 2.5 to 17.5 years from four convent schools of Bombay suburbs. The mean weight in girls in the age group of 5 to 15 years ranged from 17.1 kg to 47.2 kg and the mean weight in boys in the age group of 5 to 15 ranged from 17.2 to 47.3 kg. On comparing the anthropometric data they found that they are lower than NCHS, but similar or higher than ICMR norms.

In a cross sectional study of 6 to 18 years old school children in Shiraz, Iran, Ravanshad et al (1998) found the growth parameters were similar to that of NCHS reference standards. On comparison of the growth charts for boys and girls they found that charts for girls at age 14 to 18 years were shorter and thinner than boys. Adolescent growth spurt, which is evidenced as a sharp increase in velocity, occurred in girls at the age of around 11 years while in boys it occurred around 12 years. On comparison with reports from Libya, they found adolescent growth spurt occurred at the age 10 and 15 year in Libyan girls and boys respectively. Adolescent growth spurt in Shiraz girls and boys occurred at the age 10 and 13 respectively.

In a study of growth pattern of primary school children in Benghazi, Sharbati (2001) demonstrate that the growth pattern was similar to the
international standards at early school years for both sex but it dropped down with the advance of the age. For boys the decline started from the age of nine while in girls it began at the age of eight or even earlier.

Raghavan et al (1974) on the basis of a follow up study of the growth performance of well to do Hyderabad children found that 52 per cent of children remained in the same percentile channel for weight throughout a four year period while 28 per cent moved to a higher percentile channel over these four years and 13 per cent of the subjects shifted to a lower percentile channel. This observation along with that based on the increase in height showed that both the growth pattern and growth rate of Indian children belonging to well to do families are higher as compared to the growth rate of general population. It was also observed that their growth rate was similar to those of American children strengthening the suggestion in earlier studies that if provided with a satisfactory environment Indian children grow at similar rate as children in developed countries. Kaul et al (1976) studied the growth in height and weight of urban Madhya Pradesh adolescents. It was observed that the girls weighed more up to the age of 15 years and 5 month. After this boys were heavier. It was also observed that the growth spurt in girls was attained earlier (at the age of 12.5 years) and was shorter as compared to boys where the growth spurt was more wide spread between 13.3 to 15.5 years. The gain in weight ranged between 20 to 25 kg in this study. Rath et al (1978) recorded a positive skew distribution for weight. They observed distinct spurt from 11 year for boys and 9 year for girls. Maximum weight gain occurred between 11 to 15 years for boys and 9 to 13 years for girls. This study also revealed that girls were heavier than boys.

2.5.2 Height

School age is a period of growth and development. It is at this times that acceleration in weight and linear growth as well as further development takes place in children. It is well established that the time of maximum growth in height is closely correlated with sexual maturation. Several studies found that the menarche always occurs after the greatest increase in height (Bhasin et al 1990; Rao 1998; Anand et al 1999).
Bhasin et al (1990) in a study on height and weight of well to do school children in Haryana, observed that the range of mean height of boys extends from 112.68 cm to 116.17 cm with total increment of 53.49 cm. In case of girls the range of mean height extended from 111.9 cm to 161.25 cm with a total increment of 49.35 cm.

The height data of the children in the study conducted in Delhi by Rath et al (1978) showed that between 5 to 15 years, height gain for boys and girls was 57.07 cm and 48.62 cm respectively.

A study by Pariera et al (1983) on the adolescent girls of upper socio economic group in Varanasi showed a gain in height of 17.5 cm during 10 to 15 years of age. The maximum gain in height of 7.6 cm/year was observed in the age interval of 10 to 11 years as compared to this, gain in height in British and American girls between 10 to 15 years was 20.3 cm and 23.0 cm. respectively. Thus girls in India were observed to be shorter for age than their western counterparts (Merdith 1935; Tanner et al 1965). Earlier Satyawathi et al (1981) had reported 17.5 and 15.0 cm gain of height during this age interval in urban and rural girls respectively. The height gain during the adolescent growth spurt recorded in the study of Pariera et al (1983) was 7.6 cm/year while it was 9.0 cm/year in British (Tanner et al 1965) and 8.6 cm/year in American girls.

Agarwal et al (1992) on the basis of their study on the physical and sexual growth pattern of affluent Indian children between 5 to 18 years of age noted that there is a progressive increase in mean height with age of about 5 to 6 cm/year, the maximum being 7 cm at 10 to 11 years of age.

Devi et al (1999) in her study of school children in Andhra Pradesh indicated that stature of boys were shorter than well to do boys of ICMR by 5.10 cm to 8.45 cm with increasing age and were measuring 93 to 96 per cent of ICMR standard. With reference to NCHS standards the differences was between 3.12 cm to 6.45 cm with increasing age and was measuring 95 to 96 percent. They observed that the low weight and stature of children might be due to the low socio economic status. The growth performance in stature was found to be better as compared to weight.
Pushpamma et al (1982), also reported that rural children of Andhra Pradesh were found below in all parameters of anthropometric measurements when compared with local standards.

In a cross sectional study of children 6 to 20 of northern Karnataka, Khadi et al (2001) observed that the height of rural boys were below the NCHS standard and the differences decreased between 11 to 16 years. The height of the boys and girls increased steadily through out the years with a range of 4 to 5 cm/year. The gains were significantly high during 10 to 13 year.

Bhave et al (2001) studied children between 2.5 to 17.5 years of Bombay. They found the height of girls in age group 5 to 15 year ranged from 106.6 cm to 154.3 cm. On comparison with NCHS the age group 6, 8 to 11, 14 and 15 years fall in 25th to 50th percentile of NČHS and in comparison to ICMR, it was more or less similar, except at 12 to 15 year where it was found to be more. In case of boys they found that the height ranged from 108 to 159.40 cm. The increment was 51.40 cm. On comparing with NCHS and ICMR the trend was more or less same as in girls.

The finding of the above study was in similar line with the observation of Anand et al (1999), who carried a study in Haryana among 534 children in the age group 12 to 15 years and found the height of girls at 15 years to be 154.83 cm and the height of boys at 15 years to be of 160.57 cm.

Ravanshad et al (1998) found the mean height of boys and girls of age 6 to 18 years of Shiraz lie approximately on the 25th percentile of NCHS standards. An average gain in standing height, from the beginning of the adolescent spurt to the cessation of growth has been reported as 25 cm in girls and 28 cm in boys. Corresponding data in Libyan children Shamssain (1989) was found to be 20 cm for girls and 29 cm for boys. In the black South African children, Shamssain (1991) found the adolescent growth spurt was 24 cm in girls and 29 cm in boys. While in the study of Shiraz children, they found the relative figures were 23 cm in girls and 25 cm in boys. In Black South Africans, the highest gain in standing height in boys was 7.25 cm/year and this occurred between 13 and 14 years, while in girls it was 8 cm/year and occurred between the ages of 10 and 11 years. The rate of increase in standing height was 5.1 cm/year while in girls it was 3.76 cm/year. In a similar study in Libya, Shamssain (1989) found the highest gain of
7.04 cm/year in boys and occurred between 7 and 8 years, while in girls it was 10.04 cm/year and occurred between the ages of 9 and 10 years. Sharbati (2001) found that Benghazi boys height percentiles which starts off at the same level as the reference median of NCHS during the younger ages, however by the age of nine differences starts to appear, where as the Benghazi median starts deflecting down ward. Indeed, at the age of 12, the reference median curve approaches the 75th percentile curve of Benghazi boys. In girls also, the difference between Benghazi girl’s median height and reference population is minimal during the early years of the school, but it starts to appear at the age of eight years, and the curve goes down sharply at the age of 11.

Various investigators have studied mean height of Indian children belonging to different geographical and socio-economic groups of India in cross sectional or semi longitudinal studies. Results from these studies show contradictory findings in patterns of growth on a comparison with western studies. While Raghavan et al (1974) noted that increments in anthropometric measurements in well to do children over a 4 years period were comparable to American children, Kaul et al (1976), Rath et al (1978), Pareira et al (1983) and Agarwal et al (1992) have shown that growth performance of Indian children failed to catch up like that of their western counterparts even under the best of economic and environmental conditions. The finding of these authors are discussed in some details in the following few lines.

Raghavan et al (1974) studied the growth performance of well to do Hyderbad children in a follow up study in which heights and weights of boys attending a school were recorded twice at interval of four years. Each individual was classified at both points of time as belonging to one of the following percentile groups less than 10th, 10-25th, 25-75th, 75-90th and above 90th using American percentile value for corresponding ages. Child was classified as normal if he continued to grow in the same percentile channel, while a shift to a higher or lower channel was considered an improvement or deterioration in the growth performance respectively. About 57 per cent of children remained in the same percentile channel over the four-year period, 35 per cent moved to a higher channel and 13 per cent moved to a lower channel with respect to height. Thus more than 85 per cent of the children maintained either a normal growth pattern or
showed improvement in relation to the American percentile values. This showed that both the growth pattern and the growth rate of Indian children belonging to well to do families are similar to those of American children given a satisfactory environment.

Contrary to the above findings Rath et al (1978) in their cross sectional study of anthropometric indices of children of a privileged community observed that Indian children failed to catch up to the American standards even under the best of condition. They suggested that it might need generations of freedom from any constraint to achieve the full genetic endowment of a child thus the need to develop Indian norms of growth.

Similarly, Agarwal et al (1992) had observed that the anthropometric means of Indian boys and girls from 5 to 18 years of age were lower at all age points as compared to the NCHS and European standard. They observed that Indian children even during peak height velocity fail to over take their European counterparts. This data on girls’ height when compared to their Asiatic counterparts show that the Indians have a similar height to girls in China (Zhang and Huang 1988) and Hong Kong (Fung et al 1985) between 5 to 17 years of age. Japanese (Kikatu et al 1987) girls maintain marginally higher height up to 16 years of age. However the mean height at 17 year is similar. Taiwanese (Yaung and Lai 1988) girls are shorter by 1.0 cm when compared to the ICMR (1972) standards (which is representations of upper socio economic status group of children from all over the country.

2.5.3 Mid Arm Circumference

Measurement of mid arm circumference is used as an indicator of malnutrition. The mid arm circumference shares a progressive increase with age. The gain in the mid arm circumference is due to muscle mass development. Low mid arm circumference values indicate that the level of nutrition is lower than optimal, not allowing achievement of full growth potential.

Bhave et al (2001) in a study of school children of Bombay observed the range of mid arm circumference in girls aged 5 to 15 years from 15.4 to 22.4 cm the increment being 7 cm and in boys of age 5 to 15 year the mid arm circumference ranged for 15.2 to 22.8 cm. the increment being 7.6 cm. On
comparison with Agarwal study for girls they found the results to be similar from 6 to 8 years and marginally lower by about 0.5 cm for 9 to 16 year except similar at 10 and 14 year age. They found the mid arm circumferences of the boys, at consistently high level at all age groups by about 1cm.

For girls the mid arm circumference means were similar in most of the Indian studies (Banik et al 1973; Raghavan et al 1971; Rath et al 1978; Agarwal et al 1992). Tripathi et al (1976) observed mid arm circumferences in 10 to 17 years old school children of Delhi. They recorded a gain in mid arm circumference of around 5.0 cm both for boys as well as girls during this age interval. An increase of 2.55 cm in mid arm circumference was observed in adolescent girls of upper socio economic group in Varanasi by Pareira et al (1983). Pathak (1989) from Ludhiana observed a gain of 8.0 cm in the same age period.

A gain of 6.0 cm during 6 to 16 years was reported by Agarwal et al (1992) in a study of growth of affluent school children. The observed mean values of mid arm circumference increased with age in Indian children and were lower than their western counterparts thus suggesting that Indians have poor muscle mass development during adolescence. This has been attributed to inadequate nutrient intake.

Chaturvedi et al (1996) observed that mid arm circumference were significantly lower in those from the poor socio economic strata of society than the well to do group based on her observation of adolescent girls belonging to poor socio-economic group of rural Rajasthan.

Ingale (1985) in a study of Nagpur school children on nutritional status found that according to mid arm circumference, 24.1 per cent children are in the normal grade, 40.9 per cent are in grade I, 22.4 per cent are in grade II, 10.5 per cent are in grade III and 1.93 per cent are in grade IV. They found the majority of children are in categories of grade I and II, constituting about 63.3 per cent of the total children.

Lichton et al (1984) in a study of anthropometry of Hawai school children observe that mid arm circumference increased with age. On comparison with Somean children, they found the mid arm circumferences were consistently lower about 2 cm or more. In the same study they observe the mid arm circumference
for Japanese and Causasian children of both sexes. They found the mid arm circumferences of Japanese girls of age 5 to 15 years ranged from 17.4 to 25.4, the increment being 8 cm and in boys of age 5 to 15 years from 16.9 to 27.7 cm, the increment being 10.8 cm. In causasian girls of 5 to 15 year they found the mid arm circumference for 17.2 to 25.9, the increment being 8.7 cm and in boys from 17.2 to 26.7 the increment being 9.5 cm.

2.5.4 Skin Fold Thickness

Subcutaneous fat can be measured easily by means of skin fold calipers. (Guthrie 1979; Robson 1972).

Agarwal et al (1992) in their study of the growth pattern of affluent Indian children noted that the triceps, biceps, sub scapular skins fold thickness in girls were higher as compared to boys and this difference were more significant during adolescence for girls. Mean triceps skins fold thickness reported at different ages was close to the means reported in other Indian studies form Haryana (Bhasin et al, 1990), Delhi (NFI report 1989) and data reported by Raghavan et al (1971). Kapoor et al (1991) from New Delhi had reported a higher mean triceps skin thickness.

Kapoor et al (1991) studied triceps skin fold thickness in adolescents from schools of New Delhi. They observed the skin fold fat between high and low socio economic groups in both sexes. They found that with in the groups, the girls displayed significantly thicker skin folds than boys. Triceps skin fold thickness among girls showed a steady gain through out adolescence from one year to the next indicating a steady accumulation of subcutaneous fat through out adolescence.

The mean of triceps skin fold thickness of the well to do boys showed a dip followed by a slow rise, the girls thickness being somewhat lower than the prepubertal value. Adolescents belonging to the high socio economic group had significantly more thickness skin fold than their low socio economic group counterparts in both sexes.

In a study on nutritional status of Nagpur school children, Ingale 1985 on the basis of triceps skin fold thickness, observe that 33.2 per cent children are in normal grade, 13.01 per cent are grade I, 9.4 per cent in grade II, 43.8 per cent in grade III with only two children 0.5 per cent in grade IV.

Agarwal et al (1992) has noted that the gain for triceps and biceps skin fold thickness was 4.2 and 1.5 mm in boys during the age period of 6 to 17 years respectively. In contrast the girls gained twice or more for these parameters, the increase being 8.4 mm and 3.7 mm respectively. The triceps mean for boys in their study was higher as compared to those reported by Buckler et al (1990) in British children. However, for biceps the values were similar to those observed by Buckler et al (1990). Children from the Arabian continent Nofely (1978), Abounaja and Gilmour (1985), Musaiger et al (1989) also showed lower means for triceps as compared to those shown by Agarwal et al (1992) in their study. Data on mean sub-scapular skin fold thickness reported by Agarwal et al (1992) in affluent Indian children is also higher than that reported by Western studies.

The finding of Agarwal et al was lower in comparison to Japanese children whose skin fold thickness in girls of 5 to 15 years was 10.5 to 16.5 cm and in boys 8.8 to 11.30 mm. Lichton et al (1984), in a study of anthropometry of Hawaii children, observed a steady increase for 5 to 15 years in case of Japanese girls where in boys they observe the maximum increase was at 11 years, the skin fold thickness being 13.6 mm. In the same study they also observe the skin fold thickness of Causasion children for 5 year to 15 years age and found the skin fold thickness in girls from 9.1mm to 16.8 mm and for boys for 8.5 mm to 9.5 mm. In the case of Japanese girls they found a steady increase where as in boys the maximum skin fold thickness was at the age of 12 where the skin fold thickness was 12.9 mm. Lichton et al (1984), observe that;

- Triceps skin folds of girls were significantly greater than those for boys at all ages.
- There was an initial steady, slow increase of skin fold thickness with age for both boys and girls.
- Third, there was a small but clearly seen drop-off of values at the onset of adolescence. This commonly occurred between 12 and 13 years for boys and between 10 and 11 years for girls.
2.6 Stifled Growth

Evidence from the most compressive studies in school age children’s nutritional status indicates that this age group suffers from various levels of undernutrition and stunting and in some regions wasting that are comparable with preschool children. They consistently show very high prevalence rate of underweight and stunting among African, Asian and South American school children. In India the over all prevalence of underweight and stunting was found to be 62 per cent and 56 per cent respectively with the prevalence of wasting at 31 per cent in school age children (ACC/SCN, 2000).

2.6.1 Catch-up Growth

Rao et al (2001) stressed that the high level of stunting may be attributed to delayed puberty and catch-up growth in older children. Catch-up growth is known to be second opportunity for growth during the period of school age (adolescent) as it facilitates catch-up growth during this period for children experiencing nutritional deficits in their early life. However stunting appeared to be a persistent phenomenon beyond the 3rd year of life among children and it had significant impact at 10 year of age. They concluded that the majority of children enter adolescence with poor nutritional status.

In recent studies related to the adolescent growth of children Joshi et al (1998), Kanade et al (1999) and Rao et al (2001) observed that children who were underweight as well as stunted near take off have significantly lower attained values of weight and height as compared to their normal counterparts through out adolescence. In fact, the differences at the start (11 year age) weight (4 kg) and height (8 cm) almost increased to 12 kg and 10 cm by adulthood. Entering adolescence with poor nutritional status thus hamper the capacity for catch up growth and affect final body size.

2.6.2 Current Situation

The continuation of growth retardation as evident from the above studies is a matter of concern as it prevails in school children as undernourished, stunted and wasted children. Apart from this the low intake of nutrient and lack of health
care (if persist) further deteriorate the condition of school children particularly in
developing countries, emerging itself in the form of high prevalence of
underweight, stunting and wasting among them.

The high prevalence of these has been recorded in recent studies, which
were carried out on nutritional status of school children in developing countries
1999).

One of the largest and most recent studies into the nutritional status status
of school children in developing countries has been carried out in West and East
Africa (Ghana and Tanzania), in South and North Asia (Indonesia and Vietnam)
and the Indian subcontinent (India). It was found that the overall prevalence of
stunting and underweight was found to be high in all the five countries, ranging
from 48 to 56 per cent for stunting and from 34 to 62 per cent premise underweight.
The prevalence of wasting was found to be particularly high in Vietnam and India
affecting 21 and 31 per cent of children respectively but was much less common
than stunting or underweight. Children in Vietnam and India also showed higher
levels of underweight and stunting than children in the other three countries.
(ACC/SCN, 2000).

The high prevalence of stunting is also reported in a publication of
Nutrition Foundation of India (Agarwal et al, 1987) and also by the Central
Technical Committee of Integrated Child Development Scheme (Annual Survey,
1987) of the country, which stated that 45 to 90 per cent of children in different
states of the country are undernourished both by Gomez and Indian Academy of
Pediatrics classification of malnutrition. Large sections of children particularly
girls have been reported to be suffering from varying grades of malnutrition
(Banerjee et al 1968).

The technical report of WHO (1998) on regional consultation on
nutritional status of adolescent girls reported 45 per cent prevalence of stunting
among girls and 20 per cent among boys with an average of 32 per cent in both
sex.

Rita et al (2001) in a study which was carried out at nine states of India on
nutritional status of Indian school children found 83 per cent of children were
malnourished based on Gomez classification, in which 35.5 per cent, 39.5 per cent
and 8 per cent children were suffering from grade I, grade II and grade III degree of malnutrition.

A comparative study of Ministry of Human Resource Development (Govt. of India, 1998) has established that the children in Chandigarh had much better nutritional status when compared with the children in Delhi for their weights for age using Gomez classification. The proportion of children with normal nutritional status was higher in Chandigarh (28%) as compared to that in Delhi (21%). Further, as high as 8% per cent of total children were severally undernourished in Delhi in contrast to 4 per cent in Chandigarh. The percentage of moderate under nutrition was 19 per cent in Chandigharh and 27 per cent in Delhi. In Chandigarh, stunted children (42%) were much lower than in Delhi (51%). Prevalence of stunted children in the rural areas of Chandigarh (62%) and Delhi (54%) were higher than the respective urban areas (Chandigarh 38%, Delhi 51%). Proportion of severely stunted children (<Median-3SD) was much higher in Delhi (37%) as compared to those in Chandigarh (17%). In Chandigarh, wasted children were 17 per cent of the surveyed children as compared to 21 per cent in Delhi. Similarly prevalence of severely wasted children was almost three times higher in Delhi (9.4%) than in Chandigarh (3.4%). Wasting problem was more prevalent among rural children of Chandigarh as compared to urban children while it was reverse in Delhi.

Yadav et al (1999) in a study on nutritional status and dietary intake in poor children of Bihar also observed that about 60 per cent of children were stunted while 40 per cent were severely stunted. According to weight for age criteria, the overall prevalence of under nutrition was about 55 per cent.

Sujatha (1997) in her comparative study of children in municipal schools in Visakhapatnam city on health status of 2938 school children found that according to weight for age criteria 79.04 per cent children were undernourished and according to height for age 66.89 per cent children were stunted.

In a similar study of nutritional status of school children with special references to anemia in Nagpur by Ingale (1985) found the prevalence of underweight on weight for age criteria to be 48.2 per cent and prevalence of stunting (height for age) to be 15.5 per cent. On comparison with Harward
standards she found the prevalence of underweight to be 95.3 and stunting 71.1 per cent.

Das (1998) reported that in Haryana the prevalence of severe undernutrition in the age group of 6 to 9 years of school age children was markedly different than those of 10 to 13 years. Prevalence of severe undernutrition was 7 per cent in the age group 6 to 9 years while the corresponding prevalence was 17 per cent in the age group of 10 to 13 years. In contrast, moderate undernutrition was almost same in both the age groups, prevalence of mild undernutrition and normal children were higher in the age group of 6 to 9 years as compared to the 10 to 13 years, indicating improved nutritional status of children in the age group of 6 to 9 years. Sex differences in the various grades of undernutrition were not marked. The prevalence of severe and moderate undernutrition in the age group of 14 to 17 years were 12 and 41 per cent respectively. Girls in the age group of 14 to 17 years had improved nutrition status because of their lower prevalence of severe (10%) and moderate (37%) undernutrition and higher percentage of normal (9%) children as compared to boys severe (14%), moderate (44%) and normal (4%) in this age group.

In a study on nutritional status of urban school children of Jaipur, by Mukta et al (1998) 52 per cent of children were found to be malnourished based on the weight for age criteria. They found the height of most of the malnourished children was comparable with NCHS standards and only 6 per cent children were found stunted.

Agarwal (1999) in a study examined 1144 school girls form affluent section found under nourishment was common in younger girls of primary section though stunting was more frequently seen in older girls.

Rao et al (1984) also observed the same trend in their study on the nutritional status of children of urban slum around Hyderabad city. They also found that extent of weight deficit was of a greater degree than the deficit in height for age of the 102 subject studied, two had a normal height for age, six had a normal weight for height but no child had a normal weight for age. The analysis revealed that 92.1 per cent of the slum children were suffering from long duration malnutrition, 2 per cent were nutritional dwarfs while 5.9 per cent were suffering from current short term malnutrition. Corresponding figures for rural Hyderabad
children were 81 per cent, 17.3 per cent and 16 per cent respectively suggesting that dietary and nutritional state of urban dwellers particularly, children is unsatisfactory than their rural counterparts.

Devi et al (1999) in a cross sectional study on physical development of 1657 rural school children of Andhra Pradesh, calculated the growth profile by using body mass index formula. They observed that about 58.4 per cent of boys and 48.5 per cent of girls to be in the category of moderately malnourished. The overall prevalence of malnourished children was 53.45 per cent, the severely malnourished children were found to be 40.5 per cent in boys and 37.3 per cent in girls. The overall prevalence of severely malnourished children was 38.4 per cent. They concluded that nearly two third of sample children were in the category of moderately malnourished followed by severely malnourished and normal categories.

According to the recently conducted study on the nutritional status of adolescent school children in rural north India by All India Institute of Medical Sciences (Anand et al 1999), out of 505 school children aged 12 to 18 years studied, prevalence of underweight as per the NCHS norms among the boys to be between 31 per cent to 52 per cent without any clear trend of increasing or decreasing with age. In case of girls, it was from 4 per cent to 59 per cent. The prevalence of stunting was 37.2 per cent among girls and 41 per cent among boys with an over all prevalence of 38.5 per cent. Kurz (1994) also found a similarity in the prevalence of stunting in boys and girls from developing countries.

2.7 Child, Family and Social Factors

Growth is influenced by biological determinants including sex, birth order family composition and size and genetic constitution and by environmental factors including climate, season and unequal social structure like income, education, occupation, religion, customs, tradition like vegetarian and non-vegetarian and nutritional intake (Pottor, 1963).

Some of the well-documented studies have identified that the total environment in all its diversity exerts an influence on the growth and development of children. Various factors with in this environment have been measured as
inadequate nutrition, unequal social structure, socio-economic status of the family, like per capita income, occupation, education, family size and composition, type of family, birth order, gender etc are also shown to be important. These factors have a combined adverse influence on the development of children. This is because under nutrition or any other factor does not occur alone, it occurs in conjunction with other adverse environmental factors which influence physical and mental development. The ongoing developmental transition in India provides valuable opportunities for studying the impact of socio economic development on growth performance.

In a comparative study by Gopalan (1992) the striking differences in the growth performance between the poor children represented by the NNMB data and the affluent children represented by Nutrition Foundation of India data underscore the conclusion that dietary and environmental constraints and not genetic differences accounts for current wide difference in growth performance of children, not just with in India but in the world as a whole.

Verma et al (1998) in their study on prevalence of anemia among urban school children of Punjab found that the mean hemoglobin level showed a rising trend with improved socio-economic status. Most of the children belong to lower socio-economic groups were anemic. Among environmental influences, especially nutrition is of greater importance. The anthropometric comparison of different racial groups has been done by different investigation to prove this. Greulich (1957) studying the physical growth and development of American born and native Japanese children observed that Japanese children brought up in the United State of America were taller and heavier than their counterpart in Japan possibly because of improved standards of nutrition and environment. Raghavan et al (1971) supported that anthropometric measurement and psycho-sexual development of Indian children belonging to the upper socioeconomic section of the community in whom there are no constraints of food and who are not exposed to the adverse environmental factors, was similar to those seen in well nourished American children. This implied that the generic potential for growth and development of Indian children is similar to their American counterparts, if the ecological factors are constant. Banik et al (1982) also reported similar findings.
Studies conducted on assessment of physical growth in different socio-economic strata are aimed at assessing the growth potential of a particular community and also to evaluate the magnitude of existing problem in terms of failure to attain the potential because of unequal social structure, nutritional, health, social, economic, gender differences and other factors. The privileged sections of the society represent the growth potential of a community while the backward and under privileged section represent the magnitude of the problems faced by the community.

With regard to child and family variables Devi et al (1999) observed that age, class, parental education, occupation, caste and socio-economic status had significant relationship with physical development of children. Family size, family type and ordinal position of the children were not related to the child’s physical development. Contrary to these findings, Sellen (1995) in a bicultural study of child growth performance in relation to diet and social and nutritional status of children in Tanzania established that nutritional status of children was directly associated with age, sex and birth order.

Zalilah et al (2000) carried a cross sectional study in Malaysian school children and found that male children had significantly lower mean for height for age than female children and also children from higher income group had higher mean for height for age indicating that height was significantly related to household income. They found that none of the other factors like age, birth order, number of children, and household size etc show any significant relationship for nutritional status of children.

2.7.1 Age

Anand et al (1999) in a study observes that the prevalence of stunting (low height for age as per NCHS references) among boys showed a declining trend from 56 per cent at 12 year of age to 25 per cent at 17 year of age. If Indian norms are used, the prevalence of stunting comes down from 33 per cent at 12 years to 20 per cent at 18 years. The prevalence of stunting drops down sharply at 14 years of age. This may be due to the pubertal growth, which occurs at this age. The prevalence among girls was found to be along similar line though the number
of girls in each age group was smaller. They concluded that the prevalence of underweight in girls were lesser than in boys.

The degree and prevalence of stunting and underweight have been found to increase with age with older children diverging further from the reference median for height (Dolan, 2000). The findings of Zalilah et al (2000) also indicate that malnutrition is still prevalent among older children although a majority of them were mildly malnourished.

This is also evident from the cross sectional data which showed that the prevalence of stunting increased with age (14 per cent prevalence in 7 years old increasing to 83 per cent in 13 years old) which peaked in girls at age 12, then decline when they entered their pubertal growth spurt. In boys however the prevalence of stunting rise steadily up to age 13 years and slowly decline (Stoltzfus et al, 1992).

In Chile, a country undergoing the nutrition transition, height deficits have been compared among children entering first grade in 1987, 1990, 1993, and 1996. Overall, height deficits have declined in both boys (from 10.6 per cent in 1987 to 7.3 per cent in 1996) and girls (from 7 per cent in 1987 to 5 per cent in 1996) although the overall height deficit in boys was found to be greater in each period studied. As with the findings from East Africa, stunting was found to increase with age 2.2 per cent of 5 to 6 year olds were stunted compared to 13.1 per cent in children over 8 years old. (Kain et al, 1998).

2.7.2 Gender

A recent cross sectional survey of the nutritional status of adolescent boys and girls in Bangladesh found that 67 per cent of adolescents were thin (BMI <5th percentile of WHO reference) and 48 per cent were stunted. Where as thinness was found to decline in prevalence with age from 95 per cent at age 10 years to 65 per cent at age 17 years, 77 per cent of boys were found to be stunted by the age of 17 years compared to 34 per cent of girls at the same age (Shahabuddin et al, 2000). They also found that boys were also more likely to be thin than girls. These findings are in agreement to the formerly held evidence that suggest that boys were more likely to be stunted and underweight than girls. In some countries, boys were also significantly more likely to be wasted or thin than girls.
The reason for the apparent higher levels of stunting in boys is unclear and may be influenced by a bias in the school population. It is also suggested that it could reflect delayed onset of puberty, itself caused by under nutrition and the failure to reach their growth potential through slow compensatory linear growth.

Zalilah et al (2000) in a study in Kuala Lumpur found 52 per cent, 47 per cent and 36 per cent of the school children were significantly under weight; stunted and wasted respectively. Prevalence of under weight was 56.5 per cent in boys and 45.3 per cent in girls. In case of stunting and wasting it was observed as 50.7 per cent, 42.6 per cent and 38.3 per cent and 32.6 per cent in boys and girls respectively. Altogether more boys than girls were found to be experiencing some form of malnutrition. The findings indicate that malnutrition is still prevalent among older children although a majority of them were mildly malnourished.

Kotecha et al (1999) studied the children for malnutrition using Indian Academy of Pediatrics classification and by applying NCHS standard for weight for age, Indian Academy of Pediatrics showed 22.3 per cent prevalence of malnutrition with 1.68 times higher level of malnutrition in girls than in boys. When NCHS standards were applied on these data, the prevalence was as high as 51.1 per cent, but the gender differences disappeared completely, with both boys and girls showing an equally high prevalence. These data thus points out to the fact that looking at the magnitude of malnutrition or at the gender differences in the malnutrition depends more on the classification system used.

2.7.3 Birth Order

According to the National Family Health survey (NFHS-1992) under nutrition increase with increasing birth order and decreasing birth intervals. Children born at close intervals and 4\textsuperscript{th} and above born have the highest level of under nutrition. The report revealed that 56 per cent are under nourished in this category. In a recent study in Benghazi, Libya on growth pattern of primary school children, Sharbati et al (2001) concluded that the nutritional status of the school children, which was good before the beginning of schooling was negatively affected during the school years. They attributed, that this could be due to births in the family and consequent neglect possibly by reduced attentions from
mother as it diverted towards new born or younger children in the family. The same fact was also established by Sellen (1995) who reported that nutritional status of children was directly associated with birth order. Contrarily to this Devi et al (1999), Ray et al (1999) and Zalilah et al (2000) reported in their studies that ordinal position of the children has no significant relationship with physical development of the children.

2.7.4 Family Size

In a study of nutritional status of school children of Nagpur, Ingale (1985) observed that according to family size and nutritional status as per ICMR weight for age standard, children with family size up to six, were 58.1 per cent normal, 20.2 per cent were in grade I, 17.8 per cent in grade II and 3.9 per cent were in grade III. In families with size seven or greater, 51.2 per cent were in normal grade, 25.6 per cent in grade I, 18.2 in grade II, and 4.9 per cent in grade III category. In all families from 3 to 7 and above not a single child belonged to grade IV. In families with 3 to 4 member, only 24 to 26 per cent were in grade I and II and rest about 73 to 75 per cent, were in normal grade. While in families with family size from 2, 3 and 4, there was no child who belonged to grade III and grade IV. She concluded that family size is significantly associated with nutritional status of the children. Srivastava (1978) found significant association between family size and nutritional status of primary school children. Louise (1996) in her study also found that nutritional status was related to family size, income and ethnic origin. Where as Devi et al (1999) established that family size was not found to be related the child’s physical development. Zalilah (2000) in Malaysian children revealed that household size, as a factor did not have significant association with nutritional status of children.

2.7.5 Extended and Nuclear families

Doan (1989) in a study on nutritional status and family structure in Jordan found that children in extended families were shown to have lower weight for age on an average than children in nuclear families, after controlling. The other factors the effect was more intense for girls. In addition, the growth of girls was significantly lower than boys in crowded households. In his analysis he also
yielded a significant interaction between nuclear families and better nutritional status.

In a study on home environment and development, Vazir 1998 assessed that small family size was found to be important for positive development. He reported that nuclear families were significantly related to better nutritional status.

2.7.6 Education

Washi (1992), in a study in Sudan found that the children of mothers with higher educational achievement tended to perform better in school and to have lower absenteeism rates. Lower absenteeism was also associated with higher weight for height percentiles, fewer illness, and higher language scores. He established that girls of highly educated mothers scored significantly higher in mathematics and language than boys.

Zaki (1999), in his study in Sri Lanka found that mother’s literacy also shows a high positive impact on healthy growth of children, due to its modernizing and conscientious aspects. He also found a positive relationship between maternal employment and the nutritional status of their children. Though the main effect of maternal employment on the nutritional status is negative, however due to the existence of an interaction between maternal employment and the use of improved income facility (a manifestation of improved lifestyle) the impact of maternal employment on the nutritional status of children becomes a positive.

India Nutrition Profile (Das, 1998) in its report at National Level observed with respect to income, literacy level and dietary intake that per capita annual income and consumption of all food stuff except cereals showed positive relationship. Such a positive relationship of food consumption except for cereals and sugar was also observed with literacy level. Literacy and income are closely linked and various studies showed that cereal consumption decreases and other food intake increase with higher income. Literacy level also increases awareness to choose the food items in appropriate proportion, which is reflected in the food consumption pattern.
Kassouf (1993), in a study of estimation of health demand of children in Brazil concluded that mother’s education; household infrastructure and household income have a positive impact on children’s health. Children from less educated mothers benefit more from improvements in household infrastructure than children from more educated mothers, who are able to better protect their children against a lack of resources. The coefficients of the fathers and mothers estimated wage rate have negative signs indicating that less time is allocated to the child’s care as the opportunity cost of the parent’s time increases. Doan (1989) yielded a significant interaction between household income and mother’s education at low income levels, mothers education makes no differences, at middle levels, the effect was significant, but at high levels, mother’s education loses its importance.

2.7.7 Occupation

Rao (1984) in his study of efficiency of some anthropometric indices for the diagnosis of malnutrition reported that prevalence of under nutrition in children of parents with lower occupational level was higher than those in better off occupation. He also reported in 1978 in his study that children of parents with better economic status were taller and heavier than those in deprived communities.

Vazir (1998) in her study on development and home environment of children reported that among the other significant factors related to better nutritional status of children paternal occupation is also one of the significant factors.

Zaki (1999) in a study on maternal employment and nutritional status of children found a positive relationship between maternal employment and the nutritional status of their children.

Ogden (1993) in his study on maternal activities and the child nutrition in Rwanda, Africa, derived the conclusion that mother’s work had a negative impact on weight for-age in the poorer households, but had a positive impact in the richer households.

The dominant mechanism through which maternal employment is thought to affect nutritional status is mother-worker roles incompatibility. This implies that working mothers may not be able to provide adequate care for their children.
However, as a greater proportion of the income earned by a woman observed to spend on food items, this tends to offsets the anticipated negative effect of a working mother’s allocation of less time for childcare.

2.7.8 Income

The standard of living of the family is an important factor determining the health of the individuals. Children from well to do families have better height and weight. Banik et al, (1982) show that the mean 50th percentile height of children of both sexes aged 0-14 years belonging to higher income group compared well with the 50th percentile of American children, whereas children from the lower income group corresponded with 25th percentile of the American standard. It was further observed that the mean weight of the children of the sexes coming from higher income group corresponded with 50th percentile of the American children. The mean weight of the children belonging to lower income group corresponded with 10th percentile of American standards.

Studies among adolescent girls, conducted by Tripathi et al (1985) and Agarwal et al (1992) have observed that the height, weight mid upper arm circumference and triceps skin fold thickness were significantly lower in those from the poor income group than the well to do group.

Chaturvedi et al (1996) observed a deficit in the height and weight of the adolescent girls of rural Rajasthan and attributed it largely to dietary insufficiencies. Similar findings were reported earlier by Gopalan et al (1984). Common causes of malnutrition among adolescent girls in poor community are less access to food and inadequate knowledge about dietary requirements. Varying social customs and common beliefs against females are other reasons of high prevalence of malnutrition amongst girls. There is thus a need to take up nutritional intervention measures to improve the nutritional status of the future mothers to be.

The study by Chaturvedi et al (1996) on the nutrient intake amongst adolescent girls belonging to poor income group of rural areas of Rajasthan revealed that the diets were deficient by 26.36 per cent in calories with respect to the recommended daily allowances as advised by ICMR.
Gopalan (1992) compared the data collected by Nutrition Foundation of India on height and weight of children by affluent section of the population for five large cities of India viz. Ludhiana, Delhi, Varnasi, Calcutta and Bangalore, with the data collected by NNMB on height and weight of the general run of poor children in the country, showed striking difference in the growth performance. The height and weight of poor Indian children were much lower than the affluent children.

Pariera et al (1983), Tripathi (1985) and Agarwal et al (1992), have shown that anthropometric values were higher in girls from upper income group when compared to lower and middle income group and, were also significantly lower than those of British and American girls. As against this Raghavan et al (1974) has noted that increments in anthropometric parameters in well to do Hyderabad children over a four year period were comparable to American children. Bishbandhu et al (1980) showed that anthropometirc measurements of lower income class children were lower than their upper income class.

Pushpamma et al (1982) in her study on nutritional intake and anthropometry of children living in rural Andhra Pradesh noted that the girls in Andhra Pradesh were lighter in weight than their counterparts from high income groups, however their mean weight was in close agreement with the regional values. These findings were similar to the earlier reports by Satyavathi et al (1981) who had observed weight gains of 13.0 and 12.0 kg respectively in urban and rural girls of middle-income group in the age interval of 10 to 15 years.

In an investigative study of the Nutrition Foundation of India on growth of Indian adolescent girls drawn from the most affluent section of the population free from various dietary and environmental growth constraints showed that the height attained by the Indian girls at their 12th year was almost identical to those represented by NCHS standard. However between the 12th and 18th years there was a divergence between the NCHS and the Indian growth pattern, Nutrition Foundation of India attributed this fact to the wide differences in population group. It is understandable that difference in the time of onset of puberty could account for difference in pattern of the growth spurt during adolescence.

Pareira et al (1983) in their study on physical growth characteristics of adolescent girls of upper socio-economic group have seen that Indian girls are
comparatively lighter and shorter than British (Tanner, 1966) and American girls. These findings were in agreement with the earlier findings of Satyavathi et al (1981). Pariera et al (1983) has suggested that the difference in growth could be mainly a reflection of the genetic potential or to some extent due to study stress resulting in spending more time reading indoors with no participation in outdoor sports. He did not considered nutritional constraints had in any way affected growth in those girls.

2.8 Diet Survey

Indian Council of Medical Research in its diet surveys reports that nutrition is one of the major factors responsible for the maintenance of health and physical fitness and in turn the status of nutrition of any community or group of people depends to a very great extent on the quality and quantity of food consumed (ICMR, 1951). The actual amount and the type of food consumed by the different age, sex, occupational, social or economic groups were essential to improve the nutritional condition of the people.

The value of nutritional assessment is greatly enhanced when it is supplemented by an assessment of food consumption. Direct assessment of food consumption involves dietary surveys, which may be household inquiries or individual food consumption investigations (Park and Park, 1997). The analysis of food intake as part of an assessment of nutritional status is useful in providing evidence of nutrition intakes that may be suggestive of inadequacies. (Guthrie, 1979).

Aykroyd (1948), Davidson and Passmore (1963) report that the quantitative information about the food eaten by a people or a community if compared with physiological standards of human needs can serve as tool for the assessment of nutritional status.

According to Eppright et al (1952) food habits of the people, the kind of food eaten, the distribution of food among meals and the estimate intake of nutrient will be shown by dietary studies.

National Nutrition Monitoring Bureau in its valuable finding about the dietary pattern in different states of India found that consumption of food increase with increasing income, except cereals and roots and tubers. The mean
consumption of pulses, green leafy vegetables, milk, meat, fats and sugar were far below the recommended allowances. Recommended dietary intake is the minimum average daily intake of a nutrient over a period of time that would assure good health in the community (Banerjee 1968). Although the average nutrient intake increases with increase in income, intake of iron and vitamin A seen to be used far below the recommended values even in higher income groups.

Dietary surveys help to uncover current nutritional status of a particular population over a period of time it also help to find out the dietary habits and lifestyle and to assess the impact of changing environmental conditions like drought, famine etc. All these important facts help to provide guideline for improvement.

Government of India in its report India Nutritional Profile (Das, 1998) which was focused on the dietary intake of the population at the national level reported that overall average food consumption per consumption unit per day was adequate for cereal, roots and tubers and other vegetables in comparison to the recommended allowances. Consumption of other foodstuff such as pulses, green leafy vegetables, fruits, milk, fats and oils, and sugar was inadequate.

On comparison of interstate intake of food consumption in northern region, it reported that while Himachal Pradesh and Rajasthan revealed higher dietary intake of cereal, Haryana. Punjab and Rajasthan showed lower intake of cereal than recommended daily allowances. Average intake of pulses, green leafy vegetables were inadequate in Haryana, Punjab and Rajasthan, while intake in Himachal Pradesh was above the recommended daily allowances (RDA). On an average vegetables were consumed at a lower level than recommended daily allowances in all four states ranging from 38 to 47 g/day. The intake of other foodstuff was comparable with the RDA except for fats and oils. Average intake of fats and oils in Punjab was as low as 7g/day, which was also lowest among all the four states. The study revealed that considerably higher amounts of milk and its products were consumed in Haryana and Punjab than that in Himachal Pradesh and Rajasthan but the consumption of flesh food was almost negligible in these states. It also reports that in the urban areas of Rajasthan, average consumption of cereals, green leafy and other vegetables as well as sugar was substantially below the recommended allowances.
In the same study, it was revealed that the food consumption pattern in Chandigarh and Delhi was almost similar. Average intake of cereals and green leafy vegetables was inadequate and pulses was adequate both in Chandigarh and Delhi. On an average, consumption of roots and tubers were more than twice its recommended allowances while average intake of other vegetables were comparable with the recommended allowances. Average intake of milk and its products as well as fats and oils was quite high, being almost twice the value of recommended allowances in Chandigarh, whereas their intake was marginally above recommended allowances in Delhi. Flesh food consumption was also not common among the people of the two areas. Average sugar intake was inadequate in the state of Delhi only.

With regard to the frequency of food intake, the study report that cereals, that constitute the bulk of the diet, were consumed daily by all the households (99.5%). Millets were consumed daily by 11 per cent, weekly by 10 and seasonally by 17 per cent of the households surveyed. Pulses were consumed either daily (31%), weekly (62%) or fortnightly (6%) by majority of the households. Average roots and tubers were consumed by 70 per cent households daily and 27 per cent weekly while other vegetables were consumed daily by 52 per cent and weekly by 40 per cent households. Green leafy vegetables were taken daily by 30 per cent and weekly by 38 per cent households. Generally, fruits were consumed monthly (24%), or fortnightly (23%), though 20 per cent of the households also took it weekly. Another 22 per cent took fruits either daily, seasonally or occasionally. The households in most of the districts did not consume flesh food. A total of only 12 per cent of the households consumed it on different frequencies in a few districts. Fats and sugar, however, were daily food items in all the households.

Yadav et al (1999) observed the food consumption by age and sex categories in a study of a nutritional status and dietary intake in tribal children of 1 to 6 year of Bihar. They observed that consumption of cereal, pulses were almost same in younger age group of boys and girls. The consumption of milk product fats and oils were higher for boys as compared to girls. They further noted that protein was in broad line with the recommended dietary allowance in all age groups, where as energy intake was about 80 per cent of recommended
daily allowances. They found that intake of fat and other nutrient was also lower as compared to recommended daily allowances in all age groups. The calorie deficiency among children was 38 per cent, protein deficiency was 19 per cent and both calorie and protein deficiency was 19 per cent. The study concluded that the children who were calorie adequate were also protein adequate.

Surveys on dietary intake by various investigators (Sataynarayana et al 1981; Gopaldas et al 1983; Thakore et al 1989) have shown that diets of low-income groups were inadequate when compared to recommended daily allowances. Bishbandhu et al (1980) had earlier noted significant differences in nutritional status of urban children of different socio-economic classes. Kapil et al (1993) in a study of the dietary intake among school children from upper socio economic class in Delhi concluded that both in girls and boys the calorie intake was deficient by 26 to 27 per cent.

### 2.8.1 Vegetarian and Non-Vegetarian

Sanders (1988) had carried out a longitudinal study of the growth development of children born of vegan mothers and reared on a vegetarian diet. All these children had been breast fed for at least the first six months of life. The majorities of these children grow and developed normally, but they did tend to be smaller in stature and lighter in weight than standards for general population.

Verma et al (1998) in a study of 2000 school children aged 5 to 15 years in Ludhiana revealed that at almost all ages significantly (P<.001) more vegetarian children (65.9 %) were anemic.

Sachdev et al (1995) observed that the risk of iron deficiency is greater with purely vegetarian diets as compared to non-vegetarian diets.

Tayter et al (1989) have compared the anthropometric measurements and nutrient intake of non-vegetarians with those of vegetarian children of the same age. They observed that mean height for both groups were above the 50th percentile values; mean weights were above the 50th percentile for non-vegetarian children and above the 30th percentile for vegetarian. On the basis of the weight for length index, while 17 per cent of non-vegetarian boys were considered obese, none of the vegetarian boys fall in the obese category, however, in case of girls vegetarian diets were apparently not as protective against obesity as in the case of
boys. They concluded that while vegetarian diets promote linear growth (height increment), just as well as non-vegetarian diets, they are less likely to promote obesity. This must be considered an advantage.

2.8.2 Nutrient Intake

Nutrition influences growth and development before and after birth. The period between 5 to 15 years is of peak growth for both boys and girls and nutritional requirement in relation to body size are more during this period. Under nutrition during this phase of life will influence the nutritional status of young adults.

Ministry of Human Resource Development (Das, 1998) in its report India Nutritional Profile revealed that at national level, the average intake of nutrient was adequate for protein, calcium, thiamine, niacin and vitamin C in all the age groups. Average energy and fats intake was adequate in the higher age groups while in the younger age groups from 5 years to 12 years, intake was marked by below the recommended daily allowances. Average intake of iron, riboflavin and vitamin A was deficient almost in all the age groups.

National Nutrition Monitoring Bureau, showed that the height, weight and growth rate of adolescents of low socio-economic groups were about 70 to 80 per cent of those of well to do adolescents because of chronic deficit of nutritional intake. Studies reported earlier revealed that a large section of Indian population suffers from varying grades of malnutrition. Banerjee (1968); Gopalan (1961).

Das (1998) reported that in northern region, in urban areas of Rajasthan the average energy intake was below its recommended allowances. Average intake of protein, calcium, thiamine niacin and vitamin C was adequate in Himachal Pradesh, Haryana, Punjab and Rajasthan. Riboflavin and vitamin A intake was however inadequate as compared to their respective recommended allowances. The inadequate intake of vitamin A could be attributed to extremely low intake of green leafy vegetables in these four states. Average iron intake was comparable with RDA in Punjab and Rajasthan whereas it was inadequate in Haryana and Himachal Pradesh. Average total fat (visible and invisible) intake was lowest in Punjab, followed by Himachal Pradesh, Rajasthan and Haryana.
In the same study she reports that average daily intake of energy per consumption unit was adequate where as in Delhi, it was much below its recommended allowances. Average intake of protein, calcium, thiamine, niacin and vitamin C was above the recommended level in both the areas. Average total fat intake in Chandigarh and Delhi was quite high. Iron, riboflavin and vitamin A intake was deficient, which could also be attributed to extremely low intake of green leafy vegetables.

The dietary survey of Pushpamma et al (1982) in Andhra Pradesh showed that the anthropometric measurement of rural adolescents of Andhra Pradesh were lower than those of the higher income group. This was mainly attributed to the continuous nutrient inadequacy during the growth period. They observed that the diet was also inadequate in all nutrients including iron, proteins, calcium and calories. This study showed that the adolescent girls of Andhara Pradesh have a deficit in height and weight largely because of dietary insufficiency. Analysis of the nutrient intake showed that requirements of vitamin C and vitamin A were most inadequately met. Requirement of calories, proteins and niacin were met up to 80 to 85 per cent while requirement of calcium and thiamine and riboflavin were met up to 40 to 50 per cent of recommended daily allowances. Though fats and oil, sugar and jaggery were the important sources of energy, which were consumed in small amount because of their costs. Cereals contributed to 75 to 85 per cent of both calories and proteins in the diet. Similarly Sarupriya et al (1988) in a study on nutrient intake of rural adolescents of Rajasthan found that nutrient intake was below recommended daily allowances with the exception of proteins.

Kapil et al (1993) in a study of nutritional intake in adolescent well to do boys and girls in Delhi found that the dietary intake was less in case of both boys and girls when compared with recommended daily allowances. In the age group of 13 to 15 years in case of boys the deficit in calorie intake was 23 per cent while in case of girls it was 27 per cent. Protein intake was in deficit by 16 to 18 per cent in both boys and girls. They reported that the reason for inadequate intake of calories was due to ignorance about nutrient requirements. Another reason for poor nutrition in well to do girls was skipping of meals to maintain their figure. The higher prevalence of malnutrition especially among girls was also due to various social customs and common beliefs against females, (Bhatia et al, 1993).
Tayter et al (1989) in their study on intake of vitamin C by school children found that mean intake of vitamin C was less than 30 mg/day in 12 per cent of boys and 13 per cent of girls in 7 to 12 year old children and 14 per cent of boys and 20 per cent of girls in 13 to 18 year old children. For both age groups, 21 per cent of boys and 27 per cent of girls consumed between 30 mg and 60 mg of vitamin C.

In a detail report on nutritional profile of Haryana by Ministry of Human Resource Development (1998) observed that the average daily intake of energy (2336 kcal) and vitamin C (39 mg) was comparable to the recommended allowances, while over all intake of protein, calcium, thiamine and niacin was in excess of the respective recommended allowances. Calcium and thiamine were consumed double the amount of recommended allowances. On the other hand, average iron, riboflavin and vitamin A intake was deficient as compared to the recommended allowances by 8 per cent, 22 per cent and 31 per cent respectively.

Mukta et al (1998) in their study on nutritional status of urban school children observed that the average intake of energy, protein, iron and vitamin A was lower than recommended daily allowances, while the mean intake of calcium was found to be satisfactory.

2.9 Clinical Examination

Clinical examination is an essential feature of all nutritional survey since their ultimate objective is to assess levels of health of individuals or of population group in relation to the food they consume. It is also the simplest and the most practical methods of ascertaining the nutritional status of a group of individuals (Park and Park, 1997).

Clinical observation, the least sensitive approach, lend themselves to use in nutritional survey of population groups because they involve an assessment of the health of those parts of the body that can be readily observed in a routine physical examination and do not involve obtaining blood, urine or tissue samples. The most commonly observed tissue are the eyes, mucous membrane, skin, hair, mouth, teeth, tongue, thyroid gland and lower extremities (Guthrie 1979).

Davidson and Passmore (1963) view that the difference between the well and poorly nourished children can be assessed through clinical examination.
However the usefulness of clinical examination can be greater when carried out in conjunction with a family dietary, social and economic survey. According to Plough (1962), of all the procedures that may be employed in the evaluation of human nutritional status, the simplest and most basic is clinical examination. Gopalan and Rao (1961), remark that clinical assessment of malnutrition has gained particular important in India due to the wide spread signs of frank deficiency. Behar et al (1960) 'opine that three types of findings, clinical, biochemical and dietary complement one another and together make possible an evaluation of the nutritional status, which cannot be achieved without all the three.

Nutritional deficiencies were widely prevalent in rural and urban school children due to poverty, ignorance and high incidence of infection (Agarwal 1999). He established that under nutrition, anemia and vitamin A deficiency were common even in higher socio-economic strata. The significant health problem at this age need prior attention as any deviation from normal health in this age group is likely to have adverse consequences in future. This may be possible, if periodical clinical examination of school children is adopted to combat it.

Vazir et al (1998) suggests that despite the complicated nature of the problem of nutritional deficiencies much can still be done if developmental delay (or nutritional deficiencies symptoms) are detected early and the required stimulation (treatment) and training are provided for children suffering from nutritional deficiency living in deprived environment.

Clinical examination bring to light symptoms of several deficiency states such as;


- A pale colour of the mucous membrane on the underside of the eyelid. (Conjunctive pallor) is suggestive of iron deficiency anemia as observed by Agarwal et al (1999), and Verma et al (1998). Anemia, iron deficiency in the
form of pallor can be detected as conjunctive pallor. The colour of the mucous membrane particularly those on the underside of the eye lid, in which blood supply is close to the surface, provides an opportunity to observe the pigmentation of the blood.

- Goitre as manifested by enlargement of the human thyroid gland, resulting in a permanent swelling at the front of the neck, due to an inadequate intake of iodine can be easily detected by clinical examination as reported by Guthrie (1979), Stanbury (1994), Kapil (1995), Brahmbhatt (2001).

2.9.1 Nutritional Anemia

A pale colour of the mucous membrane on the underside of the eyelid (conjunctive pallor) is suggestive of iron deficiency anemia as observed by Agarwal et al (1999) and Verma et al (1998). Anemia, iron deficiency in the form of pallor can be detected as conjunctive Pallor. The colour of the mucous membrane particularly those on the underside of the eye lid, in which blood supply is close to the surface, provides an opportunity to observe the pigmentation of the blood.

In a study on prevalence of anemia among urban school children of Punjab, Verma et al (1998) found that diligent clinical observation for pallor correlates well with the estimation, as only 7.5 per cent of the anemic children were not detected clinically. Out of two thousand school children studied, clinical pallor could be detected in 44 per cent of the total children while 51.5 per cent were anemic as per hemoglobin estimation. They observed that the prevalence of anemia was inversely proportional to age, 77 per cent children below and 34.3 per cent above 11 years had anemia. They found a significantly higher number (P<0.01) of girls were anemic at all ages except at 5 years and at 10 to 12 years of age. In this study a higher (36.4 %) proportion of menarchial girls had anemia. The mean hemoglobin showed a rising trend with improved socio-economic status. Most of the children belonging to lower socio-economic groups were anemic. The striking finding was that 38 per cent of children of upper and upper middle class had anemia. They further found that the prevalence of anemia was high (71.5%) in the under nourished children but among well-nourished group
also nearly half (47.6%) were anemic. Even the mean hemoglobin of both these groups was lower than the WHO standard for the age.

In a study on adolescent girls, Vasanthi et al (1994) also observed a high prevalence of iron deficiency among menarche girls of urban and rural areas. She assessed the prevalence of anemia, which were 28 per cent in girls who attained menarche and 22 per cent in girls who had not attained menarche. Kapoor and Aneja (1991) noted that 47 per cent of adolescent girls of high socio-economic group had anemia although under nutrition was not a major problem in the group. In the lower middle socio-economic class 56 per cent prevalence of anemia was noted.

Agarwal et al (1999) in a study of school girls aged 5 to 15 years from affluent population of Mumbai found pallor was relatively more common in older girls.

Anand et al (1999) in a study on nutritional status of adolescent school children in Rural North India observed that prevalence of anemia was 27.8 per cent in young boys (12 years to 14 years) compared to 41.3 per cent in older boys (15 year to 18 year). Anemia was present in 51 per cent of young girls compared to 38.5 per cent in older girls in both the age groups. The overall prevalence of anemia in girls was 48 percent.

Sheshadri (1997) in another study of 1500 girls of age 10 to 19 years from 10 villagers in Gujarat reported the prevalence of anemia to be 60 percent.

Joshi et al (1998) in her study of anemia and adolescent growth among rural children aged 8 to 18 years in Pune found the prevalence of anemia was higher near the age at the take-off (up to 12 years) but decreased as age advanced in both genders. Attained weights and heights were significantly lower throughout adolescence in boys when hemoglobin was below 11g/dl, and were also smaller for anemic boys (161.7 cm) compared to normal (164.7 cm). Such differences between anemic and normal girls were not noted. However, they noted the age at menarche to increase with decrease in hemoglobin level. They suggested that differential impact of anemia on adolescent growth in boys and girls needs further investigation.

In a study on nutritional anemia across socio-economic boundaries among high social economic school children in the age of 6 to 15 years of Gujarat, Iyer
et al (1998) found prevalence of anemic to be 21 per cent. They also observed that the prevalence was higher in younger age group (< 10 years) as compared to older children (≥ 12 years) they noticed none of the socio-economic factors studied showed any association with hemoglobin level. However he observed that the mean dietary iron intake was low in relation to the recommended daily allowances and attributed that could be one of the major causes of anemia in high socio-economic group children.

Mohaptra et al (1998) in Orissa in a study on nutritional status of school children aged 5 to 15 years investigated that the prevalence of significant anemia was 32.3 per cent in boys and 37.2 per cent in girls.

Ingale (1985) in a study on nutritional status of school children aged 6 to 12 in Nagpur noted the overall prevalence of anemia for both sexes and all ages to be 73.1 per cent. The overall prevalence of anemia in male and female was more or less similar, 72.8 per cent for boys and 73.4 per cent for girls. The prevalence showed a decreasing trend with increasing age of children. In the age group of 6 to 7 year prevalence was 80.6 per cent where as in the age group of 11 to 12 year the prevalence was 53.8 per cent. She also observed that the prevalence of anemia varies according to socio-economic status. She noticed a well-defined upward trend in the prevalence with deteriorating socio-economic status with regard to distribution of anemia according to grades of nutritional status, she found that the proportion of anemic children rises steeply from normal grade of 58.8 per cent to 96.2 per cent in grade II category.

Sujatha (1997) in a comparative study of school children revealed the overall prevalence of anemia in boys to be 16.91 per cent and in girls 14.5 per cent. She also reported that the prevalence of anemia was 29.86 per cent, 10.15 per cent and 4.26 per cent in municipal, private and rural schools respectively.

2.9.2 Vitamin A Deficiency

Agrawal (1999) in a study of 1144 school children of Mumbai observed that sign of vitamin A deficiency was limited to conjunctival xerosis as bitot’s spots and none had night blindness, with overall prevalence of 7.2 percent.

In Orissa, Mohaptra et al (1998) recorded the prevalence of vitamin A deficiency to be 10.6 per cent and the prevalence of Bitot’s spots was noted to be
6 per cent in school children aged 5 to 15 year. They also noticed 15.3 per cent of prevalence of vitamin A deficiency among the semi urban school children.

Mukta et al (1998) in a study on nutritional status recorded the prevalence of vitamin A deficiency to be 5 per cent in the urban school children aged 6 to 9 years from low socio-economic group of Jaipur city.

In a study of nutritional status of school children of age 6 to 12 years in Nagpur, Ingale (1985) observed that signs of vitamin A deficiency like conjunctival xerosis and Bitot’s spots were seen in 16.6 per cent of children, out of which Bitot’s spots was found in only 7.69 per cent of children. She quoted Gupta et al (1977) who in their study of 1000 rural and 1000 urban school children found 12 per cent of children suffering from vitamin A deficiency and Indira et al (1976) in their comprehensive study of school children of Tripati found 17.5 per cent suffering from vitamin A deficiency, Sundarsam (1978) also reported 10.7 per cent to 24.8 per cent of school children suffering from vitamin A deficiency.

Vitamin A deficiency in the form of Bitot’s spot and corneal xerosis in particular, was found in 3.6 per cent and 1.3 per cent of the population in Mizoram as revealed by Das (1998) in India Nutritional Profile in North Eastern Region.

In a comparative study on health status Sujatha (1997) revealed the overall prevalence of vitamin A deficiency to be 4.44 per cent. She found the over all prevalence in boys to be 3.28 per cent and in girls 1.16 per cent. On comparison of children in municipal, private and rural schools she observed the prevalence of vitamin A deficiency to be 2.49 per cent, 1.47 per cent and 4.26 per cent respectively.

National Nutrition Monitoring Bureau (1991) in its report on diet and nutritional status of urban population, reports that conjunctival xerosis and Bitot’s spots were not seen in infants. However, in children of preschool and school age the prevalence increased with age. It reported that the highest prevalence was seen in school age children from all income groups, and found the income trend was discernible in their prevalence, the highest prevalence being in slum children (7.8 %) followed by industrial labor (6.8 %), lower income groups (4.1 %) and middle-income group (4.7 %) children.
2.9.3 Vitamin B Complex Deficiencies

The common sign of vitamin B complex deficiency angular stomatitis, cheilosis, glossitis, and atrophic bilingual papillae were observed in different studies (Das 1998; Ingale 1985; Sujatha 1997; NNMB 1991).

Riboflavin deficiency was revealed by cheilosis, followed by redness swallowing and ulceration in areas other than the corner of the lips. Loss of papillae on the tongue and a scarlet and raw appearance of the tongue are associated with a niacin deficiency as revealed by ICMR (1953), Swaminathan et al (1960) and Rao et al (1961). Mohaptra (1998) recorded the high prevalence of B complex deficiencies. The sign of vitamin B complex deficiency like angular stomatitis, cheilosis and glossitis were observed in 15.2 per cent of children of age group 6 to 12 year of Nagpur by Ingale (1985). She also observed that B complex deficiency was higher in 7 to 8 year age group children.

Das (1998) in a comparative study of North Eastern region reported that vitamin B complex deficiency in the form of angular stomatitis (1.1 per cent) and glossitis (2.1%) prevailed in a relatively high proportion in Mizoram as compared to other states of the region.

Sujatha (1997) in a comparative study on health status of school children aged 5 to 13 year in Visakhapatnam revealed the prevalence of vitamin B complex deficiency to be 2.26 per cent, 4.74 per cent and 9.22 per cent in municipal, private and rural school respectively. She found the overall prevalence of vitamin B complex to be 8.94 per cent. The overall prevalence in boys was 4.76 percent and in girls 4.18 percent.

In a study on nutritional status of urban children in the age group of 6 to 9 years from low socio-economic status in Rajasthan, Mukta et al (1998) found the prevalence of anemia to be 32 per cent, protein energy malnutrition at 36 per cent, vitamin A deficiency at 5 per cent and iodine deficiency disorder at 16 per cent of the children. NNMB survey data (1996) showed high prevalence of Bitot’s spots, angular stomatitis and dental fluorosis in Gujarat and Maharashtra states.

Das (1998) in state nutrition profile of Haryana reported corneal xerosis and Bitot’s spots were prevalent among 0.03 and 0.05 percent school age children.
(5 to 12 year) where as no sign of vitamin A deficiency was observed among the older children (12 to 18 year). Similarly B complex deficiency and glossitis were found between 0.36 and 0.09 percent and 0.27 per cent and 0.16 per cent in younger and older school age children respectively. Prevalence of Goitre and dental flourosis were comparatively higher 0.40, 0.32 per cent and 0.86 and 0.83 per cent in younger and older school age children respectively.

National Nutrition Monitoring Bureau (1991) noticed a definite age trends in the prevalence of oral lesions of angular stomatitis, red raw tongue, cheilosis etc, indicative of vitamin B complex deficiency, with highest prevalence being in school age group. Although no clear cut income trend in the prevalence, as seen in case of vitamin A deficiency were observed, maximum prevalence was seen in school children in slum 15.3 per cent with industrial labour, low income group and middle income group having 7.1 per cent, 7.9 per cent, 6.5 per cent respectively. In high-income group, the prevalence was about 1.2 per cent. It further revealed that about 13.2 per cent of adolescent and 5.4 per cent of adults from slums had these signs. The report observed that in general, school age group had higher prevalence of B complex deficiency signs as compared to adult counter parts.

The report further states that in respect of vitamin deficiencies more school age boys seemed to suffer than girls. It observed the similar sex differences in other age groups also.

2.9.4 Dental Caries

The incidence of dental caries an indication of nutritional status is usually associated with osteoporosis and high phosphorous/calcium rates. Dental caries though cannot be considered strictly a nutritional deficiency sign, its relationship to the quality of habitually consumed diet of all the populations is well known. Nutrition Monitoring Bureau (198491) report that its prevalence was seen in all the age groups of all the socio-economic classes and tended to be directly related to socio-economic status of population i.e. prevalence were higher in economically better segments than the poorer groups It reports that the peak prevalence was observed in the school age groups. It also observed that in general, the male seem to suffer more than the females.
During childhood dietary factors may influence dental health through their effect on both tooth formation and the characters of the oral environment (Guthrie 1979). According to a study 79.62 per cent of children aged 5 to 15 years had caries in Bombay. Another study in 1981 reported that 97 per cent of people in Bombay in the age range of 15 to 56 had caries.

In his study on oral health status of children Itoo (1994) quoted that in Orissa, the prevalence of caries was higher among children of both sex of low socio-economic status than those of middle and high economic groups with prevalence of 75.4, 58.8 and 58.9 per cent respectively. In Ludiana (Punjab) the prevalence of dental caries was 82 per cent in children aged 7 to 17 years. Prevalence was 61.96 percent at the age of 7 years and highest i.e. 89.11 per cent at 17 years of age. Another survey on dental disease of school going children in Calcuta reported that the prevalence of caries was more in children of low socio-economic status (52.5%) as compared to those with high socio-economic status (43 per cent).

Agarwal (1999) in a study on health status of school girls aged 5 to 15 years from affluent population of Mumbai, found that dental caries was common in younger girls. He observed dental fillings in 26.1 per cent of girls with caries mostly prevalent in secondary class girls. The overall prevalence of dental caries was found to be 46.8 percent, with the prevalence in primary section 61 per cent and in secondary section 29.6 per cent.

In a comparative study Sujathha (1997) observed a reverse trend i.e. prevalence of dental caries being more in girls than boys. She reported that prevalence to be 17.56 per cent in boys and 22.18 per cent in case of girls. On comparison in municipal, private and rural schools she observes the prevalence of dental caries to 34.16 per cent, 15.33 per cent and 7.80 per cent respectively.

2.10 Iodine Deficiency Disorders

Iodine is an essential micronutrient. It is required for synthesis of thyroid hormones. Iodine is essential in minute amounts for normal growth, development and well being of all human beings. The term “endemic goitre”, is now replaced by the term iodine deficiency disorders (IDD) to refer to all the effects of iodine deficiency on human growth and development which can be prevented by
correction of iodine deficiency (Park and Park, 1991). The disorders include lowering of intelligence quotient and impaired learning, energy loss and reduced milk, egg, meat and wool yields in animals, reproduction failure in animals. Iodine deficiency disorder is a condition in which an organism does not take in enough iodine, an element that directly affect thyroid gland secretion. The gland is unable to secrete sufficient amount of thyroid hormone and in an effort to produce an adequate amount of hormone, the thyroid gland grows larger (Encyclopedia Britannica, 2000). Anatomical enlargement of the thyroid gland without any functional alteration is called euthyroid or simple goitre. By convention it is regarded as a compensatory phenomenon of factors interfering with the optimal formation of the hormones of the thyroid gland (ICMR 1989). According to Guthrie (1979) simple goitre enlargement of the thyroid gland resulting in a prominent swelling at the front of the neck is the most common form of iodine deficiency disorder and the first clinical observation to be correlated with nutritional factors. A normal human thyroid gland weight 20 to 30 gms (about 0.75 ounce), and a goitrous gland as much as 1 kg (more than 2 pounds). A very large or extensive goitre may produce sensation of choking and can cause difficulty in breathing and swallowing. In simple goitre, when the supply of iodine is moderately deficient, in order to secrete sufficient amount of that hormones, the gland works harder to synthesizes hormone in normal quantities but the affected individual may continue in general good health despite the possible presence of goitre. In cases of severe and prolonged deficiency, however, there may be a deficit of thyroid hormones, resulting in myxedema, a condition characterized by dry skin, loss of hair, puffy face, flabbiness and weakness of muscles, weight increase diminished vigor, and mental sluggishness. Goitre is five times more common in women than among men.

The average daily requirement of iodine for 1 to 6 years is 90 μg, 7 to 12 years 120 μg and for an adult is 150 μg. However this little quantity of iodine is required by the thyroid gland everyday for the adequate production of thyroxin. The best sources of iodine are seafoods (e.g. sea fish, sea salt) and cod liver oil. The daily requirement of iodine is fulfilled mainly by food (90%) and from natural water. Unlike nutrient such as iron, calcium or the vitamins, iodine does
not occur naturally in specific foods. The iodine content of the soil determines its presence in both water and locally grown foods.

2.10.1 Occurrence and Treatment

It occurs most frequently in inland or mountainous regions where the iodine content of the drinking water and the food is exceedingly low. It is prevented by the use of iodized salt in one’s diet. In the early stages of endemic goitre regression of the gland may be complete if iodine is ingested in adequate amounts. The most effective treatment in more advanced cases is the administration of thyroid hormone. Surgical removal of the thyroid gland may be necessary if the gland has grown so large that it is obstructing breathing.

2.10.2 Stages of Disorders

Hetzel (1987) marshals evidence to show how, at each stage of the human life cycle iodine deficiency has serious effects other than thyroid enlargement. The details are given in the following table along with further explanation of disorders and levels of severity as stipulated by Park and Park (1991).

The Spectrum of Iodine Deficiency Disorders

<table>
<thead>
<tr>
<th>Stage of Development</th>
<th>Disorder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fetus</td>
<td>Abortions, still births, congenital anomalies, increased prenatal mortality, neurological cretinism (mental deficiency, deaf mutism, squint) myxoedematous cretinism (dwarfism, mental deficiency) psychomotor defects</td>
</tr>
<tr>
<td>Neonate</td>
<td>Neonatal goitre, neonatal hypothyroidism</td>
</tr>
<tr>
<td>Child and adolescent</td>
<td>Goitre Junvenile hypothyroidism impaired mental function Retarded physical development</td>
</tr>
<tr>
<td>Adult</td>
<td>Goitre with its complications, hypothyroidism</td>
</tr>
<tr>
<td>All ages</td>
<td>Increased susceptibility to nuclear radiation.</td>
</tr>
</tbody>
</table>

(Hetzel et al, 1987)
The Spectrum of Iodine Deficiency Disorders in Approximate Order of Increasing Severity

<table>
<thead>
<tr>
<th>Disorders</th>
<th>Level of severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goitre</td>
<td>Grade I</td>
</tr>
<tr>
<td></td>
<td>Grade II</td>
</tr>
<tr>
<td></td>
<td>Grade III</td>
</tr>
<tr>
<td></td>
<td>Multinodular</td>
</tr>
<tr>
<td>Hypothyroidism</td>
<td>Varying combinations of clinical</td>
</tr>
<tr>
<td></td>
<td>(depending on age of onset, duration and severity)</td>
</tr>
<tr>
<td>Subnormal intelligence</td>
<td></td>
</tr>
<tr>
<td>Delayed motor milestones</td>
<td></td>
</tr>
<tr>
<td>Mental deficiency</td>
<td>Variable severity</td>
</tr>
<tr>
<td>Hearing defects</td>
<td></td>
</tr>
<tr>
<td>Speech defects</td>
<td></td>
</tr>
<tr>
<td>Strabismus (squint)</td>
<td>Unilateral</td>
</tr>
<tr>
<td></td>
<td>Bilateral</td>
</tr>
<tr>
<td>Nystagmus</td>
<td></td>
</tr>
<tr>
<td>Spasticity (extrapyramidal)</td>
<td></td>
</tr>
<tr>
<td>Neuromuscular weakness</td>
<td>Muscle weakness in legs, arms, trunk.</td>
</tr>
<tr>
<td></td>
<td>Spastic diplegia</td>
</tr>
<tr>
<td></td>
<td>Spastic quadriplegia</td>
</tr>
<tr>
<td>Endemic cretinism</td>
<td>Hypothyroid cretinism</td>
</tr>
<tr>
<td></td>
<td>Neurological cretinism</td>
</tr>
<tr>
<td>Intrauterine death</td>
<td></td>
</tr>
<tr>
<td>(Spontaneous abortion, miscarriage)</td>
<td></td>
</tr>
</tbody>
</table>

(Park & Park, 1991)

2.10.3 Goitrogens

"Goitrogens" are the chemical substances leading to the development of goitre. They interfere with iodine utilization by the thyroid gland. They may occur in food and water. The brassic group of vegetables (e.g. cabbage and cauliflower) may contain goitrogens. (Park and park, 1991). Goitrogenic potency of some of the common vegetables namely cabbage, turnip, lady’s finger, sweet potato, cassava has been studied in experimental rats (Sarkar et al, 1987). Excessive intake of goitrogens (e.g. through eating cassava) interferes with the normal intake and metabolism of iodine and may amplify the effect of iodine deficiency (WHO, 1997). Experimental goitres were produced by Chesney in rabbits by feeding them with cabbage and by purves in rats by feeding them with brassica seeds (Satoskar and Bhandarkar, 1987). However their effects on human beings
are yet to be studied. In the presence of environmental iodine deficiency, these may possibly play a contributory role in the causation of endemic goitre. The importance of dietary and environmental factors which are potentially goitrogenic is best understood if endemic goitre is present even after the eradication of iodine deficiency.

### 2.10.4 Iodine and Intelligence Quotient

Thyroxin plays a very important role in the development of the fetal brain and body. The optimum development of the human brain from the early embryonic stage to the adult stage is critically dependent on thyroxin. Since 90 percent of the human brain growth and development is completed by the second birthday, thyroxin deficiency during the earlier stage of life leads to permanent and irreversible brain damage. Thus thyroxin is necessary not only for the upkeep of the body’s energy and activity but also more importantly for the optimum development of the human brain. Absence of the hormones of thyroid gland affects the development of brain in the fetus, neonates, infant and child. Depending on the degree of the iodine deficiency, the brain does not develop and the child is mentally retarded. Lack of iodine interferes with the brain development of the fetus and results in the birth of iodine deficient babies who may be cretins (Salt Department, 1994).

Recent studies on school children living in iodine deficient areas in a number of countries indicate impaired school performance and intelligence quotient as compared with matched groups from non-iodine deficient areas. Studies have indicated that iodine deficiency can impair school performance even when the effect of other factors, such as social deprivation and other nutritional factors, has been taken into account (WHO, 1996).

A less obvious but more serious condition affecting millions of iodine deficient children includes impaired mental function, poor intellectual performance, lower I.Q., muscular disorders and impaired co-ordination and sluggishness.

Current research showed that iodine deficiency results in lowering the average intelligence of the entire school age population by as much as 10 to 15 I.Q. points. The number of primary school age children in endemic areas is
estimated to be 40 million. The total I.Q. points lost in these children amount to 400 million. (Salt Department, 1994).

Iodine deficiency in fact interferes in the educability of successive generation. The results of the intelligence quotient (I.Q.) evaluation in primary school children in an area with 80 per cent goitre prevalence and 13 per cent incidence of neonatal hypothyroidism which is diagnosed by the sophisticated investigation, showed a clear shift to lower I.Q. These finding indicate mental sub-normality in more than half of the school children in the study population (Kochipillai et al, 1982). Thus, even as iodine deficiency perpetuates social and economic deprivation, it also lays waste the already scarce national resources invested in primary education (GOI; UNICEF, 1995). Therefore, it is well understood that preventing iodine deficiency raises the learning capacity of school children and improves school performance.

2.10.5 Iodine Deficiency in the World

In the sixties there were 200 million goitrous persons world wide (Kelly and Snedden, 1960). Twenty years later figure for the less developed region of the world was 329 million and this was probably an underestimate (Matovinovic, 1983).

In 1994, Salt Department in India revealed that 1005 million people of the world are at risk of iodine deficiency disorders, some 225 million people are having goitre, 6 million are cretins and 20 million are suffering from mild neurological disorders.

According to a report of the World Health Assembly (1994), about 1600 million people are at risk of IDD because they live in iodine deficient environment. Of these, 656 million have goitre and 43 million have some degree of mental defects including 11.2 million overt cretins. Giving region-wise distribution, it states that the number of people at risk of iodine deficiency are 181 million in Africa, 167 million in America, 486 million in South-East Asia, 141 million in Europe, 173 million in Eastern Mediterranean region and 423 million people in Western Pacific region and the number of people having goitre are 89 million in Africa, 63 million in America, 175 million in Eastern Mediterranean and 139 million in western pacific region (WHO, 1994).
Kibambe et al (2001) in an evaluatory study of iodine deficiency disorder at West Africa in 4,039 school children aged 6 to 14 years assessed the prevalence of goitre to be 22.4 per cent in Burkina Faso, 13.2 per cent in Mali and only 4.2 per cent and 1.2 per cent respectively in Toga and Benin.

In another evaluatory study in school children aged 6 to 14 years of Kiga, Tehran found that grade II goitre was 42 and 9 per cent in male and 49 and 18 per cent in females in 1989 and 1999 respectively and tested the relationship to be significantly associated $P<0.001$. But at the same time they revealed that grade I goitre increased from 7 to 51.5 per cent in male and 4.4 to 48.6 per cent in female. The study observed that intelligence quotient before and after ten years of iodine supplementation was $89 \pm 11$ and $94 \pm 10$; the association between them was $P<0.01$.

In a cross section descriptive study among school children aged 8 to 12 years in Chiangmai Province of Thailand, Singh et al (2001) found the total goitre rate was 10.7 percent. They found the prevalence rate of goitre was almost equal among male and female 11.2 per cent and 10.2 per cent respectively.

### 2.10.6 Iodine Deficiency in India

In India there is increasing evidence of wide spread distribution of iodine deficiency not just restricted to the Himalayan mountainous areas. The prevalence was also reported from the sub Himalayan mountainous areas, sub Himalayan flat lands (Terai region), plains (especially those subjected to annual flooding) river line areas, deltas and even costal region (Clugston et al, 1987). It was observed that the world’s most intense goitre belt is in India stretching 2400 kms. from Kashmir in the North West to Naga Hills in the East. About 150 million people are living in this belt and around 55 million people suffers from endemic goitre. No state in India was free from the ill effects of IDD and surveys whenever taken, were continuously identifying new pockets of iodine deficiency. According to salt Department statistics (1994) it was estimated that in India, 167 million people were at risk of IDD, 54 million were suffering from goitre, 6.6 million were having mild neurological disorders.

According to a publication of WHO (1997) out of 457 districts in the country 275 districts have been surveyed for IDD and 235 districts have been
found to be endemic. These districts cover all the states and union territories of India.

Kapil (1998) reported that research surveys were conducted to evaluate the status of iodine deficiency in selected identified districts of 10 states and 2 union territories of the country. The goitre prevalence in primary school children aged 6 to 12 years was documented to be as high as 20.5 per cent in district Bikaner, Rajasthan, to as low as 0.8 per cent in district Pour, Uttar Pradesh.

Sachdev (1997) reported that in Delhi, the goitre prevalence rate in school children declined from 55.2 in 1980 to 8.6 percent in 1996, the salt iodisation programme was implemented in 1989. The routine surveys conducted by the Directorate General of Health Service indicate a significant decline in total goitre prevalence rate in 17 out of 21 districts from different states in which repeat information was available. The magnitude of decline ranged from 6 to 35 per cent (general values above 30 per cent in the Himalayan region and Uttar Pradesh) for repeat surveys performed six to forty years later.

In an intervention study among 1243 adolescent school girls in rural, urban and resettlement Delhi, Narula (1999) revealed the overall prevalence of goitre was 60.66 per cent. The study explored that the number of girls having grade II goitre were maximum in resettlement colonies 8.6 per cent followed by urban 4.66 per cent and rural area 4.33 per cent.

In another survey in the National Capital Territory of Delhi shows prevalence of goitre to be 8.6 per cent in 6911 school children in the age group of 8 to 10 years. This signifies that IDD is a public health problem in NCT of Delhi (Kapil et al, 1995) among them 91.4 per cent were in O grade, 8.5 per cent in grade I and 0.1 per cent in grade II, on the basis of gender they found the prevalence was 92 per cent, 7.9 per cent, 0.1 per cent and 90.87 per cent, 9.10 per cent and 0.03 per cent in boys and girls respectively.

A study conducted in four villages of rural South Delhi among 1075 school children reported goitre prevalence of 16 per cent (Chaturvedi et al, 1996). In a cross sectional study in nine hundred and forty school children in the age group of 8-10 years of an urban slum in East Delhi, Bhasin (2001) found the prevalence of goitre to be 6.5 per cent. The predominant goitre 6.2 per cent was present in grade I category.
Zargar et al (1995) present findings from Kashmir in a study on prevalence in goitre of 10,196 school children in the age group of 5-15 years, (5676 boys and 4520 girls). He summarizes that 4609 (45.2%) had thyroid enlargement and found that the prevalence was 16.1% in OB grade 21.7 per cent in grade I and 4.4 per cent in grade II. Only 2 children had grade III goitre and none had grade IV. They also observed that the overall goitre prevalence increased with age, from 30 per cent in the age group 5 to 12 years to 51 per cent in those more than 12 years old.

In a survey carried out on 5449 school girls aged 10 to 16 year in Mewat area of Haryana for prevalence of goitre, Gaur et al (1989) found the overall prevalence of nearly 29.5 per cent. They also revealed prevalence of 20.3 per cent in grade OB, 11.2 per cent in I grade and 1.5 per cent in grade II and none in grade III and grade IV in urban area and 18.3 per cent in OB grade, 7.5 per cent in grade I, and 0.4 per cent in grade II and none in grade III and grade IV in rural area. The prevalence data in urban and rural girls were 33 per cent and 26.2 per cent respectively.

Kapil et al (1998) studied 2065 school children in the age group of 6 to 12 year to examine the prevalence of iodine deficiency disorder in Pondicherry. The study assessed goitre prevalence to be 2.6 per cent. Fifty four children had grade I goitre, none had grade II enlargement. The prevalence was highest among children of 10 year old age group.

In Bikaner, Rajasthan a total of 527 children from three high schools in a rural block in the age group of 6 to 12 years showed goitre prevalence to be 20.5 per cent (Bhardwaj et al 1997).

Sohal et al (1998) conducted a study in the district Hamirpur of Himachal Pradesh. A total 6897 school children (3411 boys and 3486 girls) in the age group of 8 to 10 year were examined. The goitre prevalence rate was found to be 8.8 per cent. They found the prevalence in boys to be 9.1 per cent in grade I goitre and 0.4 per cent in grade II goitre. The prevalence in girls was 7.9 per cent in grade I goitre and 0.3 per cent in grade II goitre. No significant difference was found in goitre prevalence amongst the boys and girls. They concluded that Hamirpur district appears to be in a transition phase from iodine deficient to iodine sufficient as a survey conducted in 1956 reported a goitre prevalence of 41.2 per
cent in the district. The study recommend that in district Hamirpur, Himachal Pradesh, mild iodine deficiency existed and to achieve elimination of IDD from the district there was a need of further strengthening the existing monitoring system for the quality of iodised salt in the district.

Jayashree et al (2001) in a study on iodine status of families from endemic and non-endemic areas of goitre in Karnataka found 5.14 per cent prevalence in endemic and 0.39 per cent in non endemic area. Maximum prevalence of grade I 2.21 per cent and 0.74 per cent in grade II was observed in forty plus age. They detected the goitre only in females. The study also reveals that anthropometric measurements viz. height, weight, mid arm circumferences and skin fold thickness of goitrous subjects were lower compared to normal subjects.

In an intervention study to assess iodine status in 770 school children of 10 to 12 year old by Mittal et al (1998) revealed that goitre prevalence was 34.5 per cent in the studied population. Significant difference was found in the socio-economic status and housing and sanitary conditions of families of deficient and normal children. Dietary intake pattern revealed that the diet of children was low in calories, iodine and carotene.

Brahmbhatt et al (2001) in a study in rural and tribal school children from Gujarat on assessment of iodine deficiency disorder reported goitre prevalence rate (GPR) in 5 to 15 year school children as high as 30 per cent using palpation and almost 100 per cent of children had enlarged thyroid volume for body surface area (> 97the percentile of adopted WHO international reference values) using ultra sonography.

To assess the extent of iodine deficiency disorder a survey was conducted in randomly selected sub-centers of 5000 population of PHC in Gonda. The prevalence of goitre was found to be above 50 per cent and that of cretinism to be 2 per cent (Lal et al 1991). A cross sectional prevalence based on study in rural Mehsana Gujarat, revealed the goitre prevalence was 3.5 per cent and 7.3 per cent in community and school surveys respectively.

2.10.7 Socio-Economic and Cultural Factors

Socio-economic and cultural factors have direct effect on the problem of IDD. In many countries the improvement in the socio-economic status led to decrease in the problem of IDD.
The change in the problem was due to an increase in the dietary iodine intake through improved social and economic conditions. This also explains why, in an endemic goitre areas and without any systemic prophylaxis, goitre is often less prevalent in towns than in rural districts. Town dwellers have a certain numbers of manufactured foods where as the country people depend entirely on local produce (Becker, 1985).

The Tarai districts of Uttar Pradesh and Bihar have goitre prevalence ranging from 22 per cent to 90 percent. A study, conducted in Shahdol district of Madhya Pradesh, revealed that goitre was found in socio-economically poor people. Endemic goitre (20.68%) was found to prevalent mainly in social class V (Dwivedi, 1978).

The correction of iodine deficiency also leads to improvement in the socio-economic status. There was a very great social impact as indicated by the observations made in the Chinese village of Jixian in Heilongiang province. In 1978, there were 1313 people in Jixian with a goitre rate of 65 per cent and 11.4 per cent of them were cretins. The village was known as the “Village of idiots”. The economic development of the village was retarded e.g. no truck driver or teacher was available. Girls from other villages did not want to marry and live in this village. The intelligence of the student population was known to be low. Children aged ten had a mental development equivalent to those aged seven elsewhere. Iodized salt was introduced here in 1978, after which the goitre ratio was dropped to 4 percent. No cretins have been born since 1978. the attitude of the people has changed greatly. The average income has increased. Gross agricultural produce of the village rose. Before iodization, no family had a radio, now 55 families have TV sets, 44 girls have come from other villages to marry boys in Jixian. Seven men have joined the people’s Liberation Army where as earlier they have been rejected because of goitre (Pandav et al, 1988).

By and large, people do not perceive small and moderate goitre as health problem. Large goitres are seen as disfigurement. Since large goitres are painless even these are not really considered as a health matter. In some communities in U.P. and Bihar, goitre in young girls is seen as a sign for her to get married. Some communities in Himachal Pradesh, Jammu and Kashmir and Uttar Pradesh have designed ornaments to cover the enlarged thyroid. Many women associate goitre
with pregnancy and childbirth. When questioned in depth, a surprising number ascribed the presence of goitre to the woman having screamed too much during childbirth or having been too vociferous during pregnancy. The drinking of water with the head thrown back especially during pregnancy is also mentioned as cause of goitre by several women.

In Baguio city of Philippines, a study was conducted regarding community perception of IDD. The respondents said that disorder was not contagious and thus, for instance a mother with goitre could still breast feed her baby. Those afflicted were not segregated or ridicules. However, the younger respondents aged 15 to 28 years, felt embarrassed by their condition, particularly if it was grade 2 and 3, when they attended social gatherings. One 28 year old female factory worker claimed she had to wear clothes with turtle necks to hide her goitre. (IDD News Letter, 1995).

Socio-economic status of the people is also related with the general awareness regarding IDD. Improvement in the socio-economic status will lead to greater awareness regarding the problem.

A study was conducted in a group of 300 pregnant women coming from lower socio-economic strata, residing in urban slums of Bombay. The study revealed that none of the women surveyed was aware of any aspect related to symptoms, cause, effects of iodine deficiency or of iodized salt and its significance. Similar observations were made in another non-working women of different socio-economic strata with awareness negligible in women of lower socio-economic strata but increasing with improvement in socio-economic status probably attributable to better exposure from media and to expected improved levels of literacy.

The source of information was TV (20.6 per cent in high income group and 2 per cent in low income group), radio (6.6 per cent in high income group and zero per cent in low income group) paper and magazine (10 per cent in high income group and zero per cent in low income group) and hospitals (2.5 per cent in low income group and 1.25 per cent in high income group). Only 8.5 per cent school children in Bombay were aware of the iodized salt and in those who were aware of it, the source of information was media (7.4%) and relatives (0.1%).
Only 0.85 per cent were aware of the fact why one should consume iodized salt (Dodd and Madan, 1993).

In the study of Baguio city of Philippines, it was found that only 30 per cent of the people recognized that goitre resulted from iodine deficiency, 31 per cent thought it came from drinking water, 10 per cent found that it was due to drinking ice cold and hot water alternatively, 7 per cent thought it came from eaten foods, 3 per cent found it a natural occurrence. The source of information in rural areas was midwives or older residents.

**2.10.8 Epidemiological Survey Techniques**

Epidemiological surveys are conducted in order to achieve various aims. In some cases the purpose is to estimate the magnitude of the problem; others are more specifically designed to correlate regional variations and some epidemiological surveys are conducted longitudinally in order to evaluate the efficacy of iodine prophylaxis programmes.

Two principal techniques are used for surveys:

1. Studying a selected population such as school children or army recruits:
2. Studying entire population of villages, districts or other administrative units.

Advantages of surveys of school children are that they:

   i. Require little preparation
   ii. Provide high participation rates,
   iii. Permit a good estimate of the prevalence of the disease in a fairly extensive region from which the people are drawn.

Their main drawback is that they cover a selected population from which the main attendant disabilities of endemic goitre i.e., cretinism, deaf-mutism, and other neurological defects are absent. A WHO study group in 1952 had recommended that school goitre survey results can be projected directly to the general population of the localities to which the surveyed schools belong (ICMR, 1952).

Therefore surveys might begin in schools and continue with complete population whenever more than 5 per cent have grade I or when more than 30 per cent of the school children are assigned to grade OB or above (ICMR, 1989).

The Pan American Health Organization (PAHO) has made the interesting
suggestion that survey might begin in schools and continue with complete populations whenever, school prevalence exceeds 10 per cent (Thilly et al, 1997).

2.10.9 Techniques of Goitre Examination

The aim of thyroid examination is to estimate the scale of public health problem posed by the disease on the basis of an evaluation of goitre frequency in a well-defined group. Examination must be rapid and include standardized methods of inspection and palpation. Examination on volume is too subjective and too time consuming. The only practical approach is to group the different degrees of hypertrophy into small numbers of categories based on arbitrary classification. The following circumstances of the examination are suggested. The subject start walking towards the examiner from a line marked at a distance of approximately 2 meters. This enables the examiner to have a look at his gait, body proportion and the enlarged gland, if any i.e. (Grade III & IV).

The subject stops walking and faces the examiner at a close distance with the front of subject’s neck well exposed to light. The presence of visible goitre is detected straight away with the neck in normal position (Grade II). If the goitre is not detected by this method the subject is then requested to extend his neck and asked to swallow which helps to note the visible enlargement of the thyroid (Grade I). The thyroid gland is then palpated by the examiner with the subject turning his back to the examiner; either in a standing or a sitting position. The palpation confirms and supplements the result of inspection. The consistency and nodularity of the gland are assessed by the four fingers of the examiner with hand along the trachea. (ICMR, 1989).

Very young children are examined in supine position. The examiner raises the child slightly by placing his left hand under the shoulder blades, with the child’s head resting on the examining table. The examiner then palpates the thyroid areas with his right forefinger (ICMR, 1989).

2.10.10 Biochemical Examination

The excretion of iodine in urine, iodine content of drinking water and salt are the main biochemical parameters mostly used in detecting the iodine status in area specific studies.
It has been recommended that from a maximum of 10 per cent of the school children being surveyed urine sample should be collected. (WHO/UNICEF/ICCIDD, 1994).

Urine iodine determination is the key biochemical indicator of iodine deficiency because thyroid size by palpation is difficult when size is not large. Most of the body’s iodine is excreted in the urine usually over 90 percent. Thus, the iodine level in urine reflects the subjects intake. Iodine in urine is stable and can withstand collection and transport even under field conditions.

The ICCIDD/WHO/UNICEF consultation on indicators Geneva (1994) has recommended staging the severity of IDD endemics on the basis of urinary iodine, as follows:

<table>
<thead>
<tr>
<th>Stage</th>
<th>Median urinary iodine excretion (µg / dl)</th>
<th>Need for correction of iodine deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (no iodine deficiency)</td>
<td>≥10</td>
<td>—</td>
</tr>
<tr>
<td>1 (mild)</td>
<td>5-9.9</td>
<td>Important</td>
</tr>
<tr>
<td>2 (moderate)</td>
<td>2-4.9</td>
<td>Urgent</td>
</tr>
<tr>
<td>3 (severe)</td>
<td>&lt;2</td>
<td>Critical</td>
</tr>
</tbody>
</table>

2.10.11 Urinary Iodine

Iodine in urine generally occurs as the iodide ion. While iodine may be ingested in food or water in variety of chemical forms, most of it is broken down to iodine in the gut and absorbed into blood stream in that form. Virtually all of the iodine in blood is either taken by the thyroid and converted into thyroid hormones or excreted in the urine. The iodine trapped by the thyroid which may approach 100 per cent of ingested iodine in areas of iodine deficiency, is converted into the thyroid hormones. Iodine may escape the body in faces and in breast milk. However, over 90 per cent usually comes out in the urine.

Most of the methods depend on the role of iodine as a catalyst in the reduction of ceric ion (Ce⁴⁺) to the cerous ion (Ce³⁺) coupled to the oxidation of arsenite. This reaction is called the Sandell Kolthoff reaction. The ceric ion (Ce⁴⁺) has a yellow colour while the cerous ion (Ce³⁺) is colourless. Thus, the course of
the reaction can be followed by the disappearance of yellow colour as the ceric ion is reduced. The speed of this colour disappearance is directly proportional to the amount of iodide catalyzing it. Because of its specificity and high sensitivity this reaction has been the basis for almost all chemical methods for the detection of iodine in urine (Dunn, 1993).

The median urinary iodine was 3.2 µg/dl in a survey in Guatemala, 6.9 µg/dl in preschool children in Byelarus, 6.2 to 7.3 µg/dl in Moscow (IDD News Letter, 1993). Median urinary iodine was 4.8 µg/dl in children from Serbrenica (Tahirovic et al, 1995).

In an evaluative study of iodine deficiency disorder at West Africa by ICCIDD, Kibambe (2001) in 4039 school children aged 6 to 14 year revealed median urinary iodine concentration varied from 114 to 289 µg/dl in the four counters studied. Only 24.4 per cent of the values were in the normal range of 100-200 µg/dl 32 per cent were below the lower limits of normal of 100 µg/dl and 44 per cent were above 200 µg/dl indicating iodine excess.

The median urinary iodine excretion was found to be 3.00 µg/dl and 200 hg/dl before and after the years in another evoluatory study in school children aged 6 to 14 year of Kiga, Tehran (Elmadfa, 2001).

In an extensive research project in national capital territory of Delhi, Kapil et al (1995) among 6911 school children of age 8 to 10, found that the median urinary iodine level was <2 µg/dl in 2.1 per cent, 2-4 µg/dl in 8.4 per cent, 5-9 µg/dl in 17.6 per cent cases. 71.9 per cent children had normal iodine excretion of 10 µg/dl.

Bhasin (2001) in a study on nine hundred and forty school children in the age group of 8-10 year in urban slum in East Delhi, found the mean urinary iodine levels to be 9.4 µg/dl with a standard deviation of 5.4 only 40.1 per cent children had normal urine iodine excretion levels of more than 10 µg/dl mild and moderate degrees of iodine deficiency revealed by low UIEL levels was present in 41.7 per cent and 18.2 per cent school children. No child had severe degree of iodine deficiency.

In a cross sectional study of prevalence of goitre in Kashmir valley urine sample was collected from a sub-sample of 202 children in the age group 5 to 15
years irrespective of sex or thyroid size by Zargar et al (1995). The result of mean urinary iodine excretion showed that Kashmir valley has moderate iodine deficiency and needs prompt measures to correct this major public health problem.

Kapil et al (1998) presents findings from a survey of 10 states and 2 union territories in children in the age group 6 to 12 years and states that when the median urinary iodine excretion of ≥ 10 μg/dl was used as a criterion for assessing iodine deficiency a no state included in the study was deficient.

In another study Kapil et al (1998) collected casual urine sample from a sub-sample of 187 children of 6 to 11 year age in Pondecherry found the proportion of children with < 2 μg/dl, 2-4.9 μg/dl, 5-9.9 μg/dl and 10 and above μg/dl of urinary iodine excretion (UIEL) levels were 1.6, 3.2, 24.1 and 71.1 per cent respectively.

In Dharwad, Karnataka, Jayshree et al (2001) found the median urinary excretion of normal subjects was 25 μg/dl. The subjects clinically diagnosed for goitre were only suffering from mild iodine deficiency median UIEL being 5.0 – 0.9 μg/dl. Mittal et al (1998) in 770 children in the age group of 10 to 12 years in Pantnagar revealed that the result of urinary iodine excretion found 41.8 per cent children suffered from iodine deficiency.

In a study on assessment of iodine deficiency disorder in Hamirpur Himachal Pradesh in 8 to 10 years of children, Sohal et al (1998) found that 7.0 (n = 99), 8.8 per cent (n = 125) and 170 per cent (n=240) of the children of <2, 2-4 and 4-9.9 μg/dl, respectively. Nine hundred and forty nine children had UIEL of 10 μg/dl and above. The median urinary iodine excretion of the children studied was found to be 14.0 μg/dl.

In a comparative study in Baroda and Dang districts of Gujarat, Brahmbhatt, (2001) based on urinary iodine values recommended by found that in Baroda greater than 78 per cent of girls and 63 per cent of boys were iodine deficient (UI<100 μg/L) while 43 per cent of girls and 27 per cent of boys had moderate iodine deficiency (UI<50 μg/L). In Dang district 74 per cent of girls and 71 per cent of boys were iodine deficient and 38 per cent of girls and 40 per cent of boys had UI<50 μg/L (moderate iodine deficiency).
In a study conducted in Delhi, the median urinary iodine level was <2 \mu g/dl in 2.1 per cent cases, 2 to 4 \mu g/dl in 8.4 per cent cases and 5 to 9 \mu g/dl in 17.6 per cent cases. 71.9 per cent cases had normal iodine excretion of 10 \mu g/dl and above (Kapil et al, 1996).

2.10.12 Iodine Content of Water

It is desirable that water samples from all principal sources in each survey area should be collected and examined for iodine content.

Lei et al (2001) investigated whether a relationship exist between different iodine level areas and prevalence of goitre. They found that the mean value of iodine content in drinking water from selected districts were 2.00 \mu g /L, 8.95 \mu g /L and 242.15 \mu g /L respectively. They explored that those living in high iodine level area; the urinary excretion level of target population was significantly higher than others (P<0.005).

Brahmbhatt et al (2001) while assessing iodine deficiency disorder in Baroda and Dang cities of Gujarat state also revealed that drinking water in Dang was lacking in iodine content where as it was adequate in Baroda district. They claimed this difference was reflected in lower median urinary iodine levels in Dang district.

But contrary to this in a survey carried out in Mewat area of Haryana, Gaur et al (1989) found no definite correlation between iodine content of water and prevalence of goitre. They reported that in the block Tarou and Punehne the goitre prevalence was 8.3 and 6.2 per cent where as iodine content of water was found to be same as 14.3 \mu g/L. The difference being 1.9 per cent in prevalence of goitre in another area Nah, where the iodine content of water was 14.5 \mu g/L. The prevalence was greater in 13.1 per cent as compared to Hathin where the iodine content of water was lower 14.0 \mu g/L. the prevalence of goitre was only 6.9 per cent. These clearly demonstrate that there was no definite correlation between iodine content of water and prevalence of goitre. However Kochipillai et al (1982) reported the iodine content of water in the goitre endemic area varied from 9 to 14 micrograms per litter in rural areas and 12 to 14 microgram per liter in urban sample. They concluded that high prevalence rate of goitre i.e. 29.5 per
cent in Mewat may be associated with impurities like nitrites, nitrates, chlorides, and calcium present in water appears to exercise an indirect action on iodine deficiency by increasing the iodine requirement.

A task force study by ICMR (1989) also reported that there was clear evidence of high correlation of goitre prevalence with low iodine content in water in some areas. Low iodine content was found in 9.7 per cent in Vishakapatnam, 36.2 per cent in Sitamari, 24.2 per cent in Surat, and 28.1 per cent in Phule and 10.2 per cent in Nilgiri. In Shahdol (Madya Pradesh), iodine content of water was very low (2.1-4.2 µg/L) as compared to content from Rewa town being 19.4 µg/L where endemic goitre was not reported.

2.10.13 Iodine Content of Salt

The salt samples from the study population should be collected and examined for the iodine content of salt. The iodine content should be noted under three categories:

1. Salt with nil iodine.
2. Salt with < 15 ppm iodine
3. Salt with > 15 ppm iodine

For precise evaluation of salt iodometric titration method is recommended. No legal action can be taken on the basis of reports from Spot Testing Kit (STK) method. (GOI; UNICEF, 1995). Since facilities for iodometric titration are available only at very few specialized laboratories and it requires trained personnel, and in view of high sensitivity of 85 per cent and the specificity of 71 percent, the SKT may be widely recommended for quick estimation of iodine content of salt. (Kapil, 1996)

As per the survey conducted by Benoist (2001) estimated that 68 per cent of the population of 130 affected countries, about 30 countries have no programme. Salt quality control and monitoring of population iodine status is still weak in many countries, exposing the population to an excessive iodine intake and subsequently to the risk of iodine induced hypothyroidism.

Singh et al (2001) in Chiangmai, Thailand in a study on iodine deficiency disorders where the total goitre rate was 10.7 per cent found that most of the salt used (85.2%) was not iodized and the level of iodine content in the salt used by
the community was very low (<15 ppm). The large number of salt type being used in the community was crystalline, while very low percentage of families consumed powdered salt. At traders level, the majority of salt being sold was not iodized. In an evaluatory study where the prevalence of goitre was 22.4 per cent, 13.2 per cent, 4.3 per cent and 1.2 per cent in four countries of Africa, Kibambe (2001) found these values to be much lower than before the introduction of salt iodization. The access to iodized salt varied from 84 per cent to 98 per cent in the four countries, indicating excellent progress in the accessibility to iodized salt in these formerly severely iodine deficient countries. However they found the levels of salt iodization varied markedly from less than 15 ppm (in sufficient) to more than 100 ppm (excessive).

In an assessment survey on status of salt iodization and urinary iodine excretion level in 282 districts of India, Kapil et al. (1998) found that more than 90 per cent of the salt samples were iodized with the exception of Goa and Rasasthan. The salt samples that had nil iodine content in the state/UTS studied ranged from 0 to 6 per cent with the exception of Rajasthan (31.9 %) and Goa (48.9 %). The majority of the states had more than 80 per cent of the salt samples having an iodine content of 15 ppm and more. In yet similar study in the national capital territory of Delhi the some study group found 42 per cent consumed salt with iodine content of less than 15 ppm. These findings were similar to their earlier studies, which reported that 17 per cent urban, 43 per cent rural and 65 per cent of urban slum families were consuming salt with an iodine content of less than 15 ppm. Salt with nil iodine content was consumed by only 1.4 per cent of the subjects. They found that salt samples (90%) as compared to the powdered salt samples (43%) had an iodine content of less than 15 ppm.

In Baroda and Dang districts of Gujarat state iodine content of salt consumed by majority of the subjects was very low (7-10 ppm), except one family that use salt with iodine content of 2,000 ppm. 70.5 per cent in Baroda and 72.5 per cent subjects in Dang were iodine deficient.

Kapil et al (1998) on a study on school children where the prevalence of goitre was 2.6 per cent found that 78.6 per cent salt samples were powdered and 21.4 per cent were of crystalline variety. 69 per cent of salt samples had iodine content of less than 15 ppm, no sample had nil iodine, but 61.4 per cent of
powdered salt samples and 95.3 per cent of crystalline salt samples had less than 15 ppm of iodine. The difference in the iodine content of two salt samples was highly significant (P <0.01).

Sohal et al (1998) in Himachal Pradesh where the prevalence of goitre was 8.8 per cent observed that salt with a nil iodine content was consumed only by 2.5 per cent of the subjects. About 10.8 per cent of families consumed salt with an iodine content of less than 15 ppm.

In Pantnagar, Utter Pradesh, where the total prevalence of goitre in school children was 34.5 percent, Mittal et al (1998) found that 92 per cent of the families were consuming iodized salt. The data analyses show that on an average the iodine requirement in salt was so deficient that the deficient children in the area required therapeutic dose of iodine to improve their low iodine status.

An evaluation study conducted in six endemic districts of Himachal Pradesh revealed that 55 per cent of the salt samples collected from traders had iodine content of <15 ppm (Kapil et al, 1997).

Similarly, it was found in Haryana which is an endemic area for IDD, 20 per cent of the traders were selling salt with <15 ppm iodine. In another study, it was found that in the NCT of the Delhi, approximately 41 per cent of the families, surveyed, were consuming salt with <15 ppm iodine (Kapil et al, 1996).

In a study in Bikaner, Rajhastan, it was observed that nearly 32 per cent families consumed salt with nil iodine and 8 per cent with <15 ppm iodine (Bhardwaj et al, 1997).

Iodine content of salt samples was estimated in some western districts of U.P Iodine content of salt, estimated by STK method, was found <15 ppm in 52.0 per cent samples (Carg et al, 1997).