CHAPTER - I
INTRODUCTION
The prosperity of a nation is reflected in the nutrition of its people. No country can rise to its full stature with half of its people subsisting on less than a square meal a day. Approximately, every third person in the world spends his day hungry and malnourished. The problem is acute in the underdeveloped or developing countries where most of the hungry mouths and malnourished bodies are congregrated in millions (Reddy, 1978).

Malnutrition has today, emerged as the major health problem of the world (Gopalan, 1978). It adversely affects the growth potential of the nation and obstructs its development (Berg, 1971; Devadas, Easwaran, & Ponnamal, 1977).

The Asian continent is the most crowded, technically backward and unable to afford a decent level of nutrition for its vast population. It has been estimated that 0.5 to 7 percent of children below 5 years of age in these countries are undernourished and about three million of them die every year directly or indirectly due to malnutrition (Miladi, 1971).

Malnutrition problem is of great concern in the developing countries because of its mass prevalence, its tragic human implications and its adverse impact on economic development process (Aggarwal, 1986). This problem in India has been well recognized, although its exact estimate, solutions and implications were obscure until recently (WHO, 1979).
In developing countries like India enormous increase in population is going to expose several hundred thousand children to the effects of malnutrition during the formative years of life. Those children who would survive the exposure may remain handicapped in terms of physical and mental development. In the present situation of India, out of total population of 600 million, the child population is about 225 million out of which 100 million children belong to the category of the deprived and 65 million children are malnourished. While considering the nutritional status of school going children in India 22 percent show one or more signs of nutritional deficiency and anaemia (Sen, 1985).

Nutrition is the product of many parameters affecting the life of an individual of family or an ethnic group (Lamb, & Harden, 1973). According to Devadas (1993) human nutrition is not simply availability and intake of food. Good nutrition and malnutrition are the end results of many interacting factors, operating simultaneously and concurrently on the individual on the physical and cultural environment of the community.

Malnutrition continues to be a major health problem in India today. More than half of the child population is growing up undernourished. Subsisting on adequate diets and growth is an indicator of nutritional status (Vijayaraghavan, 1989).

Nutrition appears to be one of the greatest environmental influences on the developing organisation. An appropriate supply of essential nutrients is a necessity
for the maintenance of growth in all organs and for the normal development of physiological functions (Peter, Robert, Joseph & John, 1993).

Malnutrition literally means bad nutrition, and refers to the imbalance between the body’s supply and demand for nutrients. The condition resulting in the body could originate from an inadequate or an excessive supply, for example, overweight or obesity (Robinson, 1978). It refers to qualitative aspects of diet and denotes clinical deficiency arising from lack of one or more nutrients. Usually a person who is undernourished is also malnourished (Sukhatme, 1982).

Malnutrition is shocking on both scale and severity; stealthy accomplice of poverty, it stunts the mental and physical growth of one in three children in the developing world (UNICEF, 1994). Undernutrition and malnutrition are major health problems among young children in developing countries of the world. Malnutrition during the critical phases of the early growth can lead not only to the stunting physical growth but also to sub-optimal intellectual development and poor neuro-integrative competence in children. The consequences of undernutrition are poor bodily and mental health, which in turn causes physical suffering and mental anguish (Kakkar, Hooda, Jain, et.al., 1987).

Malnutrition develops because of insufficient dietary intake, often connected with an unprivileged environment. In most cases, the deficiency is not solely nutritional, but is social, educational and economic or poverty as well. Poverty is accompanied by a number of social factors-, low parental educational level, insanitary housing, family tensions, ignorance and children’s need and some
aspects of care they require, and unsatisfactory mother-child relationship. It is extremely difficult however to separate undernutrition from environment linked factors, since they are closely intertwined within the social context of actual situations (I.C.C., 1988).

Children are the most vital human resources a country possesses. They hold the potential and set the limits of future development (Puri & Mehta, 1994). Therefore, utmost care must be extended to promote their health and to protect them from diseases (Devadas & Easwaran, 1967). Because the foundation for health are laid in early childhood (Swaminathan, 1970).

School children constitute the important segments of the population (Reddy, 1975). Census of India revealed that the population has reached 844 million, 38% of whom are children under 15 years. Nearly 300 million of children constitute pediatric population under the age of 15 years and 12 million under 5 years. School age is a dynamic period of growth and development as children undergo physical, mental, emotional and social changes. Malnutrition is a common problem during school age period (Pai & Naik, 1989).

A child who is in a good state of nutrition can be happy, active, alert, and bright. In contrast a child in a poor state of nutrition will be listless and unhappy (Krause, 1964). Therefore, Devadas (1970) said that good nutrition in childhood and throughout the life span is of paramount importance in fostering the physical, mental and emotional and social growth of the population. A healthy mind in a healthy body is an obvious fact in children. The quality and adequacy of the diet
the children receive will be reflected in the state of their physical and mental development.

Poor nutritional status of children reflects poor developmental potential and prospect. Nutrition plays an important role in national development. People with malnutrition contribute a little to the national progress and become a big burden. Malnourished child who grows into adulthood have poor stamina, poor mental and psycho-motor competence. Chronic malnutrition in the early years of life causes not only stunt growth of children but leaves permanent and physical scar which hinders the process of brain development to its optimum, affects their intelligence and makes them unable to attain their full potential (Teply, 1979).

Children having malnutrition showed poor development in all the areas of behaviour i.e. motor, adaptive, language, personal and social (Upadhyay, Saran, Agarwal, Singh & Agarwal, 1992). During the past two decades evidence has accumulated to show that severe early malnutrition can affect brain structure and its function (Agarwal & Upadhyay, 1987). The physical growth and ultimate size of an individual is under the influence of both genetic as well as of environment. Among the environmental factors, effect of nutrition, education, economic condition on child’s growth are well established globally (Qamra, Mehta, & Deodhar, 1990).

The effects of malnutrition on the performance of the individual are generally a result of interference in the normal process of brain development during its peak period of growth, which results in permanent reduction of brain
size and defective intellectual development (Coursin, 1965). If mother fails to provide the needed nutrients, the results are disastrous for the baby because it is likely to change the composition of brain (Roeder & Chow, 1972).

While heredity is the key to the ultimate size of a youngster, nutrition largely determines how closely he will get to his genetic potential (BoVahlquist, 1971). Stoch and Smythe (1963) said that undernutrition during infancy may result in failure of the brain to achieve its full potential size and it is not unreasonable to suppose that this may also predispose to inhibition of optimum intellectual and personality development.

Cell division in the brain occurs during the gestation period and to complete at about 12 to 15 months of age (Winick & Brasel, 1973). Myelination and development of synaptic connections usually occur after birth of the child and this development completes normally by the third year of age. Consequently, nutritional deprivation during this time could adversely affect the development of these specialized structures of the nervous tissue (Review, 1975). Protein-energy malnutrition (PEM) reduces the cell number and affects adversely on myelination, so brain is reduced (Ghose et.al., 1979). Maternal rejection of an infant through failure to breastfeed leads to further impairment of brain growth and intellectual poverty (Devadas, 1980).

In prolonged PEM the rate of DNA synthesis is reduced with reduction in cell size (Udani, 1991). The effect of PEM in developing brain in infancy and in early childhood as well as experimental animals depend upon various factors.
Younger the age, longer the duration of insult of PEM, type of PEM namely marasmus, kwashiorkor or marasmaric-kwashiorkor lead to greater effect on brain growth and development (Udani & Dastur, 1988). The studies on experimental animals done by Udani (1992) in the west and children in developing countries have revealed the adverse effects of PEM on the biochemistry of developing brain which leads to tissue damage, growth arrest, developmental differentiation myelination, and reduction of synapses. Many of these adverse effects have been described in children in clinical data and reduction of brain size.

It should be emphasized that malnutrition does not start after birth but it is a continuation of intrauterine malnutrition and when prolonged, it leads to growth retardation. Twenty to forty percent of babies born in India have low birth weight because the mothers from underprivileged population are malnourished and often have severe anaemia and chronic diseases (Ghose et al., 1971; NIN, 1979; Udani, 1983). With a bad start before life, with poor beginning at birth, child has continuing malnutrition in postnatal period which leads to severe damage to all the systems but much more important is the brain (Dobbing 1968). By the age of two years, the human brain has approached its adult size, weight and cell number (Wilson, Fisher & Gracia, 1979). By the age of four years the brain has reached to 80 to 90 percent of its adult size. If malnutrition is usually severe during pregnancy and during first few months of life, as in the marasmic infant, the number of brain cells are greatly reduced. Once the critical period of cell division has passed, an adequate diet given subsequently can not bring about an increase in cell numbers. It is difficult to separate the influence of malnutrition and of environmental deprivation on the ultimate outcome with respect to mental
development (Robinson, Lawler, Chenoweth, & Garwick, 1986). Moderate undernourished and a deficient social environment together impair a child’s later intellectual performance. The U.S. National Academy Services had declared that studies relating moderate malnutrition - on later intellectual performance have frequently found that malnutrition does play a role apart from factors related to social status (Lewin, 1975; WHO, 1974). Sukla (1982) said that out of all possible factors that may contribute to growth retardation, malnutrition tops the list.

The most severe effects of stunting are concentrated before a child’s first birth day. Even if nutrition improves thereafter the child is likely to suffer from below normal growth affecting physical and mental development which comprises the future of children and their nation (UNICEF, 1993). Severe, prolonged and early malnutrition causes stunting of growth, changing in body composition, and affects neuromotor development (Paul, & Mathur, 1991).

Gupta (1981) reported that malnutrition under five years of age is frequently accompanied by varying degrees of mental retardation as well. Mental development in childhood moves constantly towards functions such as perceptual organisation, learning achievement, thinking, reasoning, and cognitive content (Brown, 1976).

According to Devadas (1972), the nutritional deficiencies most observed were those of calories, proteins and vitamin-A and B-complex. Stoch and Smythe (1976), have reported that the effects of a diet poor in calories, protein, and vitamins included the decreased ability to do physical and mental work and an
altered learning ability. Zaidi (1982) said that deficiency of nutrients are responsible for diseases: lesion of skin, stunted growth of children, and retarded formation of adult body and bad growth of bones and teeth.

Over the past two decades a number of investigators have tried to explore the question whether childhood malnutrition affects intelligence and behaviour development. This is further supported by studies demonstrating that babies born of undernourished mothers physiologically have poor brain development as demonstrated clinically and electro-physiologically (Bhatia, Katiyar, & Agarwal, 1979; Bhatia et.al., 1980). Further, besides nutrition, it is likely that environmental factors (i.e., socio-economic status, learning environment, stimulation at home, family size, recurrent infection, etc.) may also be playing important roles in mental development. The later confounding variables always make it difficult to visualize the role of mild to moderate degree of malnutrition on mental functions (Agarwal et.al., 1992).

The debate over the exact role of early undernutrition and social deprivation in impairing learning abilities is largely academic. The two negative forces virtually always co-exist, reinforcing each other. Moreover, apart from possible harm to the brain and nervous system, undernutrition can impair intellectual potential through its indirect impact on personality development. Undernutrition accentuates and even creates the other environmental deprivations of stimulation and experience that hinder personal development (Eckholm, & Record, 1976).
Nearly 150 million of children under 5 years in the world and 70-80 million in India suffer from PEM, nearly 20 million in the world and 4 million in India suffer from severe forms of PEM, viz, marasmus, kwashiorkor and marasmic kwashiorkor (Udani, 1992). It is a deficiency disease caused by inadequate intakes of protein and calorie in diet (Chopdar, & Samal, 1979). Children who have had severe PEM in early childhood usually retain a marked deficit in mental development several years later (Hertzig, Birch, Richardson, & Tizard, 1972; Hoorweg, & Stanfield, 1976; Pollitt, 1979; Stoch, & Smythe, 1976). Children with severe PEM usually continue to have low intelligence levels, behaviour problems and poor school achievements for several years (McDonald, Grantham-McGregor, & Chang, 1989).

Many investors have compared the cognitive development of children who have suffered from severe PEM in early childhood, with siblings or peers matched for social characteristics. The previously malnourished children showed marked deficits with few expectations (Grantham-McGregor, 1989). Studies with the Carribean children found that these children continue to have low IQs and school achievement levels (Galler, Ramsey, Forde, Salt, & Archer, 1987; Galler, Ramsey, Morley, Archer, & Salt, 1990).

Iron deficiency is the most common deficiency disorder all over the world, particularly, in the developing countries and is the pre-dominant cause of nutritional anaemia. The estimated prevalence of anaemia in the world is 46 percent among children of 1-12 years (Jindal, & Khanna, 1993), the magnitude may be even greater in developing countries (Kalra, 1994).
The lack of iron not only causes an energy crisis, but also directly affects behaviour, mood, attention span, and learning ability. Iron is involved in the functioning of many molecules in the brain and nervous system (Hamilton, Whitney, & Sizer, 1982). Iron deficient anaemic (IDA) infants attain lower mental and motor scores on Bayley scale of infant development (Fairchild, & Hass, 1989; Walter, 1991). Studies have suggested that iron deficient children have lower IQ scores, decreased attentiveness, restricted perception, impaired performance in measures of latency and associative reaction (Howell, 1971; Sulzer, Wesley, & Leonig, 1973).

Vitamin A malnutrition still is of a grave dimension in most parts of the world (Chandrasekhar, & George, 1990).

Iodine deficiency is now recognised as a major international public health problem (Stanbury, 1986). Experiment done by Sankar and his coworkers (1994) on children who were deficient in iodine, and the results showed impairment in intellectual and other neuropsychological functions in a high percentage of the children. Stanbury, (1992) also said that when there is insufficient supply of iodine to the body, severe impairment of intellectual and neuromotor control appear in the person.

It has been suggested that supplementation of diets with thiamine (vt.B_{1}), riboflavin (vt. B_{2}) and niacin may contribute to an improved performance in subjects engaged in stressful mental activity (FAO/ WHO Report, 1965).
Cravioto, & Robles, (1965) have reported deficiencies in adaptive behaviour, interpersonal social abilities, language acquisition and motor skills. It is apparent then that children with a history of protein-calorie malnutrition exhibits deficits in a variety of developmental tasks, when compared to adequately nourished children.

Cognition refers to mental growth and activity. It defines most of the processes of thinking and knowing that children employ daily - planning what to do in the morning, learning the rules of games, or making up an excuse for not going to bed early (Endres, & Rockwell, 1985). Human thinking is considered as the most outstanding development of psychological evolution. For this reason it is not surprising that a number of psychologists' viewed, thinking and associated processes collectively referred to as cognitive processes, as playing vital role in man's capacity for complex learning (Munn, Ferland Jr., & Ferland, 1978). According to Craig (1979) "Cognition is a process by which we come to perceive, know, understand something". Learning a new word, solving an equation and memorizing the conjunction of a verb are all examples of cognitive activity. Vedanayagam, (1989) said "Cognitive development indicates the gradual development of cognitive abilities such as the ability to perceive, attend, discover, recognise, imagine, assess, remember, conceptualize, reason, learn, etc. Cognitive development is influenced by nutritional, environmental, emotional, psychological, and social factors. Obviously brain development relates to cognitive development (Fischer, 1987). Developmental scientists generally make that assumption when
they consider relations between brain and behaviour. Myelination occurs progressively through out infancy, childhood and even adolescence (Gibson, 1977; Yakovlev, & LeCours, 1967).

Reading is the verbal processes interrelated with thinking and the other communication abilities like listening, speaking, writing (Hittleman, 1978). Reading is an activity of reconstructing a reasonable spoken message from a printed text, and making meaningful responses to the constructed message that would to be the spoken message (Carroll, 1979). Learning to read requires ability to transform temporally distributed auditory patterns into spatially distributed visual ones (Cravioto, 1971). Cravioto and DeLicardie (1979) said that malnutrition in early life may contribute to suboptimal functioning and learning disabilities in later life.

An episode of severe protein-calorie malnutrition during early years of life increases the chances of becoming a poor reader; this may be the starting point of a developmental path characterised by neurointegrative defective functioning, school failure, and subsequent subnormal adaptive functioning (Cravioto, & DeLicardie, 1971).

Learning to read, and reading itself, call upon visual perception, capacity for representation, attention, memorization and reasoning with respect to the language itself and its system of written representation. The comprehension of spoken language results from a mental effort essentially based on auditory perception. Similarly access to the meaning of written signs involves the
integration of visual perception (I.C.C., 1989). Studies have shown that there is a positive co-relation between the nutrition level of the children and intelligence or education on of the mother, as also have a correlation between the nutritional states of children and their intelligence (Moncheberg, 1969).

Evidences supported the view that early severe malnutrition is associated with intellectual impairment (Burton, 1976). Lowe (1969) expressed before a U.S. Senate Committee on nutrition that "when malnutrition is coupled with the constellation of adverse environmental factors that are characteristic of life in poverty, it is clear that intellectual growth will be jeopardized".

In the following section an attempt is made to review the findings of related studies with greater emphasis on human studies reporting the effects of malnutrition on cognitive and reading abilities as well as on the physical growth of children.