CHAPTER – 2

REVIEW OF LITERATURE
2. Review of literature has been divided into the following topics

2.1 Growth and development of children

2.2 Food Behaviour

2.3 Nutrition Education

2.4 Impact of nutrition education intervention on health of children

“Children are the world’s most valuable resource and our best hope for the future. Children are imbued with an extraordinary amount of courage and that over time, as they walk the Earth and become mired in the details of living, what we help them develop and become is a valuable resource to help generations to come. What is done to the children is done to society” ~ Gautham Buddha, 583-483 BC.

It is most fulfilling to watch children grow in good health into productive adulthood. Understanding their growth demands is essential to help them achieve their optimal growth and development, this knowledge has integrated itself into our socio-cultural system with significant hand me down knowledge from one generation to another.

The period that begins after infancy and lasts until puberty is frequently mentioned as the latent or quiescent period of growth – a contrast to the dramatic changes that occur during infancy and adolescence. Although the physical growth may be less during the first year, preschool and middle school years are a time of significant development in the social, cognitive and emotional areas. Growth is generally steady and slow during the preschool and school-age years, but it can be erratic in individual children, with periods of no growth followed by growth spurts. These patterns usually parallel similar changes in appetite and food intake. For parents, periods of slow growth and poor appetite can cause anxiety, leading to feeding challenges during meal time (Mahan and Escott-Stump, 2012).

Measurement of growth is an index of the overall health and nutrition of a population or subpopulation of children (Ragol et al., 2000). Children are continuously growing and changing, periodic assessment of their linear growth helps detect and treat any health problems (Mahan and Escott-Stump, 2012). The longitudinal growth of an individual child is a dynamic statement of general health.
Nutritional status and substantial exercise training are only two of the major stimuli on the linear growth of the children (Ragol et al., 2000).

Diet also impacts cognition and behaviour of children and adolescents. Nutrients and diet patterns can exert instant or long-term effects, helpful or harmful (Bellisle, 2004). There is increasing interest in the role of nutrition in the development of the functions of the brain, with levels of analyses varying widely across studies (Wainwright and Colombo, 2006). The impact of nutrition on brain and cognitive performance may depend on the timing of the nutritional impact during the child's lifespan. The accurate assessment of cognitive performance in children is critical for detecting the effects of micronutrient deficiency or supplementation on the developing brain and its functions. Relatively little attention has been paid to the selection of culturally appropriate measures that are sensitive enough to detect the subtle cognitive changes that could be expected following nutritional intervention (Hughes and Bryan, 2003). Nutrition, as part of the child's biological environment, can have broad effects on the development of the brain's macrostructure (e.g., the development of the frontal lobes), microstructure (e.g., the myelination of neurons), and the level and operation of neurotransmitters (e.g., dopamine levels or receptor numbers) (Wachs, 2000). The nature and severity of the effect will depend on the timing of nutritional influences on the brain and the cognitive abilities emerging at those times (Pollitt, 1996).

Nutrition education as part of the school curriculum has been part of structured nutrition research for as early as 1995 (Roseman et al., 2011). Schools continue to be the single most important location to have nutrition education programs.

A report drafted at the Brainstorming Meeting on the development of a framework on the Nutrition-Friendly Schools Initiative (WHO, 2006) listed the following inputs:

a. WHO emphasises that cultivating improved nutritional status of school-age children and adolescents is an effective investment for the future generation and also helps combat nutrition related chronic diseases, obesity etc. in their adult lives. Schools are a platform to promote healthy food habits and physical activity patterns for children and also act as a venue to engage parents and care
givers to disseminate knowledge to help prevent their own and their children’s malnutrition in all its forms viz. under nutrition, nutrient deficiencies, obesity and other nutrition related chronic diseases. Both WHO and FAO emphasise the universality of the school being the access point to teach children, parents and care-givers make it highly applicable to global efforts in dealing with public health problems of the double burden of under- and over-nutrition.

b. The WHO, as part of its Global School Initiative (i.e. Health Promoting Schools), uniting with United Nations (UN) agencies joint Focusing Resources on Effective School Health (FRESH) initiative, UNICEF's Child Friendly Schools Initiative, joint UNICEF and World Food Program (WFP) Essential Package as well as other relevant school-based programmes being implemented by concerned partner agencies; built the Nutrition Friendly Schools Initiative (NFSI). The programmes are aimed to achieve good health, hygiene and nutrition at school age and are, therefore, essential to the promotion of basic education for all children.

c. FAO promotes strategies to provide information, education and skills needed to empower children and their families to select healthy meals and practise healthy eating habits. Nutrition education in schools has a superior impact and is more sustainable as a part of a programme involving the entire school, parents and the community. Since eating habits are learnt early, schools can play an important role in promoting sustainable and healthy dietary habits; hence playing a role in the children.
According to the WHO reports updated in March 2011, the incidence of worldwide obesity has more than doubled since 1980. Approximately 43 million children under the age of five were overweight in 2010. In the 2005 WHO report, 22 million children under the age of five were overweight; this alarming 51% increase within a brief span of five years warrants serious attention on preventing and
controlling the factors which contribute to obesity. Past studies have shown that obesity in children increases the threat of ensuing morbidity, whether or not obesity perseveres into adulthood (Must et al., 1992). Consequences related to childhood obesity encompasses hypertension, type 2 diabetes mellitus, dyslipidaemia, left ventricular hypertrophy, non-alcoholic steatohepatitis, obstructive sleep apnoea, and orthopaedic and psychosocial problems (Barlow and Dietz, 1998; Nanda, 2004 and Li et al., 2004). In national surveys conducted in the USA from the 1960s to the 1990s, the occurrence of overweight in children augmented from 5% to 11% (Ogden et al., 1997).

Studies on urban Indian schoolchildren from selected geographical areas report a high prevalence of obese and overweight (Chhatwal et al., 2004; Ramachandran et al., 2002; Marwaha et al., 2006; Khadilkar and Khadilkar, 2004; Kapil et al., 2002). Further, studies on Indian schoolchildren have also established that the occurrence of hypertension in overweight children is significantly higher than that among normal children (Verma et al., 1994; Mohan et al., 2004; Anand and Tandon, 1996; Gupta and Ahamad, 1990). According to the WHO updated data in March 2011; untreated overweight leads to obesity and its consequences contribute to the fifth leading risk for global deaths. At least 2.8 million adults die each year as a result of being overweight or obese. In addition, 44% of the diabetes burden, 23% of the ischaemic heart disease burden and between 7% and 41% of certain cancer burdens are attributable to overweight and obesity. At one time obesity was considered a high-income country problem, currently overweight and obesity is now rapidly increasing in low- and middle-income countries, particularly in urban settings. Almost 35 million overweight children are living in developing countries and 8 million in developed countries. Overweight and obesity are associated with more deaths worldwide than underweight; 65% of the world's population live in countries where overweight and obesity kills more people than underweight (this includes all high-income and most middle-income countries).

It is evident that controlling overweight and helping establish growth in normal weight ranges is imperative for children the world over. The essential causes for obesity and overweight is an energy imbalance between calories consumed and calories expended. There has been a global trend of increased consumption of energy-
dense foods that are high in fat, salt and sugars but low in vitamins, minerals and other micronutrients; and a decrease in physical activity due to the progressively sedentary nature of several systems of work, easier modes of transportation, and growing urbanization. Deviations in dietary and physical activity patterns from what is healthy are due to environmental and societal changes associated with development and lack of supportive policies in key sectors viz. health, agriculture, transport, urban planning, environment, food processing, distribution, marketing and education (WHO, 2011).

Optimal growth in children encompasses both physical and cognitive growth to ensure a healthy adulthood. Satisfactory brain function is a prerequisite for proficient cognition and the performance of organized behaviour. Needless to say, the uninterrupted activity of the brain is essential for the survival since it ensures the continuous performance of many essential voluntary and involuntary functions which support life. Food choices affect cognitive ability and behaviour in children and adolescents (Bellisle, 2004). Health promotion policies and physical activity programs ought to be set to improve cardiorespiratory fitness, muscular fitness and speed/agility of children as part of their school curriculum to ensure healthy endurance and health (Ortega et al., 2008).

It does seem rather simple, that eating better is a good solution to help people make better food choices and health. The media today is furnishing an abundance of information; however its impact on food behaviour does not seem effective in reducing the resultant impact of poor food habits. Families need help to make the right dietary choices due to an increasing complex food environment today. A few decades ago people lived on several hundred foods made with locally grown ingredients. However, today, an average super market offers a myriad of globally produced foods with multiple choices catering to the customer’s convenience. The entire selection of food is predicated, simply by the science and logic of “food behaviour”. 
2.1 Growth and development of children

2.1.1 Physical Growth in children
2.1.2 Physical endurance in children
2.1.3 Cognitive Performance
2.1.4 Role of nutrition in growth

Growth and development of children is no longer simply a concept of wanting them to achieve appropriate anthropometry standards over their childhood; it is a comprehensive development of cognitive growth, physical growth and ability to be fit. Urban India is undergoing a rapid transition in the kinds of food available and changes in the economic ability to purchase these foods. Anthropometric measurements of height, weight, skin fold thickness; mid-upper arm circumference and BMI form the gamut of nutritional anthropometry standards to assess the growth of a population. The information thus elicited is categorised into percentiles and standards set by the WHO. Percentiles are a calculation standards derived from the percentage of observations from a distribution of a population which falls below the value of a set variable. This is an easy to read quick reference indicating the profile of a nutritional status. The Z-Score is a calculation standard derived from the number of standard deviation (SD) from a distribution of population which falls away from the mean of the data. Although this is not an index as easy to read as percentiles, it offers the unique ability to help assess precise changes in anthropometric studies (Wang and Chen, 2012).

Table 1. The WHO growth reference (1995) provides the following index to analyse anthropometric data

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Anthropometric measures</th>
<th>Indication of growth problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stunting</td>
<td>Low height for age</td>
<td>Chronic malnutrition</td>
</tr>
<tr>
<td>Wasting / Thinness</td>
<td>Low weight for age</td>
<td>Acute or current malnutrition</td>
</tr>
<tr>
<td>Thinness</td>
<td>Below 5th percentile or minus 1 SD Z Score BMI for age</td>
<td>Under weight</td>
</tr>
<tr>
<td>At risk for overweight</td>
<td>Above 85th percentile or 2SD Z Score BMI for age</td>
<td>Overweight</td>
</tr>
<tr>
<td>Obese</td>
<td>Above 95th percentile of 3 SD Z Score BMI for age</td>
<td>Obese</td>
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</tbody>
</table>
BMI forms a critical and an instant index to assess growth. The prevalence of overweight in young children is seen in most developed countries; USA (35%), Germany (14.8%), Greece (31.9%), Denmark (10.4%) (Kimbro et al., 2007; Keupper-Nybelen et al., 2005; Manios et al., 2007; Aarup et al., 2008). Study conducted in Chinese children 2-6 yr of age has reported 10.7% overweight and 4.2% obesity (Jiang et al., 2006). Similar to other countries one of the serious concerns in urban Indian school children is that of overweight and obesity. A myriad of studies have established the presence and progressive increase of this condition (Midha et al., 2012).

2.1.1 Growth studies in urban Indian Children

• In a cross-sectional study conducted on urban Indian pre-school children in Mangalore, the prevalence of overweight and obesity was 4.5% and 1.4%, respectively. The researchers collected data from 425 children in the age groups 2 to 5 years form three nursery schools. The sample consisted of (66.12%) boys and (33.88%) girls. The ‘weight for age’ criteria data indicated that 11 children (2.59%) were overweight (i.e., had weight >85th percentile for the age and sex) and 6 children (1.41%) were obese (i.e., had weight more than 95th percentile for the age and sex). BMI data indicated that 19 children (4.47%) were overweight (i.e., had BMI >85th percentile for the age and sex) and 6 (1.41%) children were obese (i.e., had BMI >95th percentile for the age and sex) (Kumar et al., 2008).

• The prevalence of overweight is greater when compared to obese in higher age groups seen in other Indian studies. In a study conducted by Ramachandran et al., (2002) the prevalence of overweight and its risk factors in adolescent children in urban India was assessed. School students in the age group of 13–18 years (n=4700, M:F 2382:2318) formed the study sample. Data collected encompassed Body mass index (BMI), information on physical activity, food habits, occupation of parents and their economic status obtained by questionnaire. Age-adjusted prevalence of overweight was found to be 17.8% for boys and 15.8% for girls. Overweight incidence was found to increase with age and was higher in lower tertiles of physical activity and in higher socio-economic group. The study established the high prevalence of overweight in
adolescent children in urban India and that life style factors are positively associated with BMI in adolescent age.

- In a cross sectional study done evaluating anthropometric parameters in Delhi school children (5-18 years) from different geographical zones; high prevalence of overweight and obesity was seen in children from high socio-economic groups (Marwaha et al., 2006). The study compared children between government and private schools; the private school sample (N 12645 (6197 boys, 6448 girls) formed the high socio-economic group bracket. The overall presence of overweight and obesity was in the children from the private schools and found to be 16.75% and 5.59 % respectively (p<0.05). Children as young as 5 years of age had started showing an increase in BMI, with 9% being overweight and 8% obese in this age group. Across the various age groups, 11-13 years old boys (19.5%) and 9-11 year old girls (20-23%) showed higher prevalence of overweight compared to other age groups.

- The study by Subramanyam et al., (2003) evaluating the prevalence of overweight and obesity in affluent girls aged 10-15 years in Chennai established a prevalence of 9.6% overweight and 6.2% obese.

- A study from Pune (Khadilkar and Khadilkar, 2004) established that the overweight and obesity prevalence in boys aged 10-15 years was 19.9% and 5.75.

- Establishing concrete concern in the increasing trend of high BMI from across urban India is from a recent study by Khadilkar and Khadilkar, (2012a). The study had a total sample of 20243 children between the age of 2-17 years (1823 from central zone, 2092 from east zone, 5526 from north zone, 3357 from south zone and 7445 from west zone. The study collected data of height, weight and calculated BMI. A comprehensive analysis of Z-Scores from the WHO cut offs and the standards from the International Obesity Task Force (IOTF) was used to classify the data. The results indicated that there was an overall presence of overweight and obesity by the IOTF classification (18.2%) and (23.9%) by the WHO standards. There was a greater prevalence of overweight and obesity was higher in boys than girls. Also the comparison of mean values of anthropometry in 2011 was significantly greater than the data reported in 1989 for children between 5-17 in all ages and both sexes.
Weight and Height are the two most popular growth exercises children enjoy. It forms the exciting data of their growth and annual school health check-ups. Before the nutrition transition from malnutrition to obesity; weight for age was a critical predictor of morbidity in children (Waterlow, 1976). High weight for age is a strong predictor for high BMI and obesity (WHO, 1995). Children however, have a good ability to lose excessive weight more effectively than adults, if given the right motivation and impetus. Studies have shown that family based treatments are more effective in dealing with children having anthropometric challenges (Epstien et al., 1995). Studies spanning a decade have observed that behavioural family-based treatments have maintained effects over 10 years and the results were systematically replicated in new cohorts of samples (Epstein et al., 1994). Nuutinen and Knip, (1992) showed maintenance of weight control treatment from a behaviour modification study over 5 years follow up.

It is a common layperson’s thought that eating disorders in childhood are the sole predictors for obesity. However, research proves otherwise. In a recent study by Braet, (2006) on a weight loss program of children for 2 years, established baseline degree of overweight, age, and initial weight loss were significant positive predictors of weight loss even 2 years after treatment. However, eating disorder characteristics were a negative predictor.

Intervention studies to help reduce the incidence of obesity and control overweight in children have shown positive results. Interventions were based on nutrition education, fitness training programs and reducing television viewing (Doak et al., 2006).

In a study done by Huang et al., (2007), the impact of an intervention in a classroom-based weight-control intervention on cardiovascular disease in elementary-school obese children was explored. The subjects were 120 obese fifth graders (65 boys and 55 girls, aged 10-13 years (mean 10.6 yrs); with a body mass index (BMI) at the 95th percentile or more) and were randomly assigned to an intervention group (n=60) and control group (n=60). The intervention group received a twelve-week heart education program on diet, lifestyle and heart health and also had a physical activity program; while the control group did not. The parameters studied both at pre-test and post-test level were height, weight, BMI, body fat, blood pressure (BP),
physical fitness (800-meter running test), heart health knowledge, and serum biochemistry. Differences for baseline and post-test data were compared between both groups. The changes in the intervention group versus control group were significant for weight (p<0.024), BMI (p<0.047), percentage body fat (p<0.008), physical fitness (800-meter running test) (p<0.025), health, nutrition and lifestyle knowledge (p<0.006), total cholesterol (p<0.027), triglycerides (p<0.018), high-density lipoprotein cholesterol (HDL-C) (p<0.009), low-density lipoprotein cholesterol (LDL-C) (p<0.041), sugar (p<0.035), insulin (p<0.007), and insulin resistance (HOMA-IR) (p<0.028). At post-test, weight, BMI, body fat, total cholesterol, triglycerides, LDL-C, sugar, insulin and HOMA-IR had decreased, but HDL-C had increased in the intervention group. The study established the positive impact of effective simple interventions at a classroom level.

2.1.2 Physical Endurance in children

Physical endurance is one of the most essential indicators of a child’s health and biological development. Any form of ill health present during childhood and later, like chronic diseases can adversely affect endurance levels (Haladaj et al., 2009). Children are encouraged to run and play, often with the reinforcement that physical activity will help them become stronger and develop better muscle mass. Recent interest in child physical endurance has been largely due to interest in training for sports.

The present environment for young children includes insufficient opportunities for physical activity and an excess of unhealthy foods. Sedentary lifestyles and poor nutrition are counterproductive for children who are predisposed to metabolic disorders (Sothern, 2004), children who do not have optimum nutrition status and relatively less frequent exercise have poor muscle mass and ipso facto, poor physical endurance. Reviews indicate that aerobic power relative to body mass remains stable from ages 6 to 16 for boys, but for girls it declines about 2% per year. In general, boys are about 25% more fit than girls. Over the course of childhood, consistent decline in physical activity is seen, with boys reducing physical activities about 2.7% per year and girls reducing physical activities about 7.4% per year. These data indicates that there is a risk for older children to develop lifestyle related obesity (Sallis, 1993). It is important to assess physical endurance of children along with nutritional status; to get a comprehensive picture of their health status.
In this study, physical endurance of children was studied in both base-line and post-test levels.

The tests used to assess physical endurance were

- Hand Dynamometry
- Vertical Jump Test

**Hand Dynamometry:** Is a measure of isometric muscle strength of the arm and digits. Hand grip strength is measured on the dominant side and non-dominant side, i.e. both right and left hands (van den Beld et al., 2006). Hand dynamometry often reflects maximum strength, a reflection of neuromuscular strength and also provides an index on finger and thumb strength. Among all muscle function tests, measurement of hand grip strength has gained attention as a simple, non-invasive marker of muscle strength of upper extremities (Norman et al., 2011, Hager-Ross and Rosblad, 2002, Rauch et al., 2002, ven den Beld et al., 2006). Muscle strength has an association with chronological age (Molenaar et al., 2010). However, Rauch et al., (2002), established that it is not just chronological age that accounts for muscle strength due to physical development, but it is also body size, which is an important determinant of strength. Many predictive models for grip strength indicate that normal anthropometric growth has a bearing on its result (ven den Beld et al., 2006; Eek et al., 2006; Niempoong et al., 2007). Height is found to have a positive correlation with grip strength (Hogrel et al., 2012, Niempoog et al., 2007; Hogrel et al., 2007; Jurimae et al., 2009). In children, grip strength is an especially relevant measure of strength associated with anthropometric growth, more so since their torque measurement and lever arm length increases during growth (Eek et al., 2006). There has been found to be no impact due to gender on hand grip between girls and boys under 160 cm of height (Newman et al., 1984) and also when the data is normalised for fat free mass in children between the ages of 5 to 15 (Sartorio et al., 2002). In a study by Visnapuu and Jürimäe, (2007); hand dynamometry also had a positive correlation with body height, as a rule, in combination with BMI, was the strongest predictor of handgrip strength, especially in older children (about 40-60 % of the total variance, R2 x 100).

The test has its applications spread across a myriad of physiological changes, and has the advantage of being able to read subtle changes over a brief period of time.
In a study by Raghuraj et al., (1998); impact of pranayama (yoga practise of breathing) was studied on grip strength of children and its lateralisation. The study (n 130) encompassed school children from 11 to 18 years, who were right hand dominant. In randomly assigned groups, they were given various yoga practises for 10 days. Grip strength was measured at baseline and post-test levels. Results found that right, left- and alternate- nostril breathing groups had a significant increase in grip strength of both hands, ranging from 4.1% to 6.5%, at the post-test level. The other groups showed no change. The study established that yoga breathing increases hand grip strength of both hands without lateralization.

Hand Dynamometry has not been found to get directly impacted by micro-nutrients. A study exploring the functional consequences of subclinical riboflavin deficiency and the effect of riboflavin supplementation on hand dynamometry was investigated in children belonging to low-income group (Padmaja et al., 1990). The authors found a biochemical improvement in the children, however there was no positive correlation of the supplementation with hand dynamometry scores at the post-test level. The test has been explored in earlier studies exploring protein calorie malnutrition; results have been established that the test is a strong indicator of nutritional anthropometry and not muscle mass more than an indicator of a direct impact of nutrients. Studies which have explored low nutrition status in childhood having an effect into adult life have indicated poor hand dynamometer readings in adulthood (Woo et al., 2010). Hand dynamometry readings get indirectly influenced by nutrients, since the nutrients directly impact muscle mass of children.

**Vertical Jump Test**

Vertical jumping is one of the fundamental movements of the human body (Gallahue and Ozmun, 2002). It is a well-practiced and enjoyable movement for children between 5 and 12 years. To gain a good jump height, there has to be countermovement with a co-ordinated arm swing (Harman et al., 1990). The recognised pattern of vertical jumping is stable and is observed to be stable by the age of 3 years in children. Vertical jump is a measure of explosive muscle strength of the lower limb (Sayers et al., 1999). The Lewis power nomogram and formula is commonly used to calculate power output from vertical jump-and- reach distance and body weight. Harman et al., (1999) validated the calculation of power using the Lewis
power formula and established its credibility. The researchers found that the standard deviation in their validation study to be low and thus indicating low variations between individual readings.

Most physical activities improve with practise. In a study by Coledam et al., (2012); effects of an exercise training program on flexibility and vertical jump performance on school age children was explored. The study had boys (n 30) and girls (n 30) participate in a 12 week exercise program; the test was divided into experiment and control groups. At the post-test level, the experiment group showed significant improvement in vertical jump test scores (p<0.005). The test indicates a good measure to assess children’s fitness and to screen children who practise fitness related activities versus those who are largely sedentary.

Vertical jump is impacted by specific nutrients and isolates during sports training in adults (Ostojic, 2004); however in children there are no similar studies. Nevertheless, the vertical jump is associated with the nutritional anthropometry status of children. The scores are dependent on muscle mass and also fat mass. Children suffering from overweight or obesity have poorer vertical jump scores compared to those who have lesser fat mass and a greater muscle mass (Diane et al., 2006). The impact of nutrients on anthropometry has a direct bearing on vertical jump test scores.

2.1.3 Cognitive performance in children

Cognitive development is associated with the interaction between the brain and its environment (Isaacs and Oates, 2008). Nutrition plays a dynamic role as one of the most important environmental factors influencing cognitive performance, by providing the building blocks for neural formation and brain development (Benton, 2008). Hence insufficient nutrient intakes through the developmental stages during childhood may adversely affect cognition (Benton, 2008; Grantham-McGregor and Baker-Henningham, 2005). Situations of physiological stress during early life, viz. intrauterine growth and infancy, may influence cognitive development in many ways such as through interference with the normal physiological process that could prevent the brain from achieving its full potential (Gordon, 1997). Children from socio-economically disadvantaged backgrounds are more at risk of having poorer cognitive development due to the poor cognitive stimulation at home (Burger, 2010). Welsch
and Zimmer, (2010) had found that the basic determinants of cognitive development were the unobserved child- and family-specific factors viz. educational environment, nutrition, lifestyle and general parenting ability of the parents. These factors are also correlated with socio-economic status such as poverty, family size, employment and educational status (Nasir et al., 2012). Contrast to physical endurance, cognitive performance is directly impacted by nutrient intake.

Cognitive functioning is likely to be more susceptible to short-term variations of nutrition in children due to their high metabolic rates and increased energy demands on a daily basis the largest nutritional variation occurs during overnight fasting, which may last more than 9–10 h in children because of their extended sleep time (Thiedke, 2001). Nutrients provided by breakfast is therefore particularly important for meeting the physiological and cognitive demands children face in the morning. Immediate cognitive benefits of eating breakfast that have been reported in children include improved memory, attention, and visual discrimination (Michaud et al., 1991; Pivik and Dykman, 2007).

Relationships between nutrition and brain function has been part of cognitive research focus for years. Studies have established the impact of dietary basics on normal brain functions. Neurotransmitters have been studied in conjunction with nutrition. The brain cannot by viewed as an autonomous organ; it produces many neurotransmitters and is affected by glucose, choline and amino acids. Our food consumption directly affects all that fuels the brain. Poor nutrition has a negative impact on school performance. Iron is an integral component of nutrition affecting cognitive performance (Halterman et al., 2001). The other micronutrients which affect cognition are iron, zinc and selenium.

In this study, cognitive performance of children was studied in both base-line and post-test levels.

**Cognitive performance was measured using the following tests**

- Digit Span Test
- Raven’s Progressive Colour Matrices
- Manual Dexterity Test
Digit Span Test: The Digit Span (DS) is subtest of a few standardised batteries of cognitive tests (Wechsler, 2003, Prasad and Verma, 1990). The test comprised of digits forward (DF) and digits backward (DB) components that yield separate raw scores. A few batteries recommend that these scores be combined to yield a single scaled score. However, it has been established that the practice of combining DF and DB results in a loss of important information (Banken, 1985; Ramsey and Reynolds, 1995; Reynolds, 1997). Factor-analytic studies have found that the memory processes involved in forward recall of both digits and letters are distinctly different from those involved in backward recall (Reynolds, 1997). It has been suggested that DF is a task of short-term auditory memory, sequencing, and simple verbal expression (Hale, 2002), while DB is more sensitive to deficits in working memory (Rosenthal et al., 2006). Working memory refers to an individual's capability to hold relevant information in mind for the purpose of completing a task; it is that functional system that provides for temporary storage and manipulation of information (Baddeley, 2003).

Raven’s Progressive Colour Matrices

Raven’s CPM measures clear-thinking ability and is designed for young children ages 5:0-11:0 years and older adults. The test consists of 36 items in 3 sets (A, Ab, B), with 12 items per set. Before the ability to reason by analogy has developed, the CPM can be used to assess the degree to which children can think clearly. The test has a three sets compilation of 12 items each and are arranged to assess the chief cognitive processes of which children are usually capable (Raven et al., 1998). Raven's Progressive Matrices and Vocabulary tests were originally developed for use in research into the genetic and environmental origins of “cognitive ability”. It helps gauge if a subject can think clearly and think of solving complexities. Due to its independence of language and writing skills, it is a popular and effective mode of testing cognitive ability of children.

Manual Dexterity

The O’Connor Tweezer Dexterity Test was used to measure the eye hand coordination of the subjects. The test measures the speed with which the subject can pick up pins with tweezers one at a time and place them into the holes. The test
requires finer hand-eye coordination than the simple finger dexterity test. Tweezer dexterity gives a more precise result than the finger dexterity test (Brandy, 1995).

**The impact of nutrition on cognition is part of nutrition research for decades**

It has long been suspected that the specific nutrients can affect emotions and cognitive processes. Recently established influences of dietary factors on neuronal function and synaptic plasticity have revealed some essential mechanisms that are responsible for the action of diet on cognitive performance and brain health. Numerous gut hormones that can enter the brain or that are produced in the brain itself, influence cognitive ability. In addition, well-established regulators of synaptic plasticity, such as brain-derived neurotrophic factor, can function as metabolic modulators, responding to the peripheral signal of food intake (Gómez-Pinilla, 2008).

Erickson, (2006) established that the key components for optimum cognitive performance are food based. Proteins that are found in meat, fish, milk, and cheese are important for cognitive performance. Proteins are used to make neurotransmitters in our body. Protein deficiency triggers malnutrition related poor cognition in children. Carbohydrates induce the calming effects of tryptophan and serotonin. Fats rich in omega 3 fatty acids are also essential for optimum cognitive performance. The essential micronutrients for optimum cognitive performance are vitamins A, C, E, and B complex vitamins. Manganese and magnesium are two minerals essential for brain functioning; sodium, potassium and calcium play a role in message transmission and the thinking process.

There is long standing research that nutrition affects learning and behaviour and diet does influence cognition and behaviour. The lack of certain nutrients can be quite detrimental. A study done by Lahey and Rosen, (2002), indicated that children with inadequate intake of fruits and vegetables had poor cognitive performance.

Although the role of fat in cognitive performance is largely based on omega3 research; studies have also proven that high intake of polyunsaturated fatty acids (PUFAs) also had an impact on cognition. Poor PUFA content in diet resulted in low reading performance; but high consumption results in behavioural problems. It is essential to note that neither increasing nor decreasing dietary fat is associated with cognitive functioning (Zhang et al., 2005).
The curiosity to get the right kind of nutrients for the best cognitive performance is always a quest towards helping humanity at large. Children are the most susceptible to suffer from loss of cognitive performance due to poor diet. Established nutrients like carbohydrates, proteins, iron, zinc, iodine and selenium have been associated with cognitive performance. However, it is not just one or two odd nutrients consumed which will help develop optimum cognitive performance in children, a balanced diet is most essential for this.

2.1.4 Nutrition for growth

Nutrient requirements for populations are framed by expert committees of FAO, WHO and UNU. In 1944, the Indian Council of Medical Research (ICMR) framed the Recommended Dietary Allowance for Indians (RDA). This data has been modified periodically and the most recent modification by ICMR was published in 2010. The expert committee has used the anthropometric data of well to do, urban Indian children to form the RDA for children. It is interesting to note that the anthropometry data of urban Indian children now compares similar to western children’s data, indicating the nutrition transition of urban India.

The RDA per day for children are specified by age till the age the 9 years for both genders and after the age of 10 years, the RDA is specified by both age and gender. This is to cater to the unique growth requirement of boys and girls.

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (Years)</th>
<th>Body Weight (kg)</th>
<th>Energy (Kcal)</th>
<th>Protein (g/d)</th>
<th>Visible Fat (g/d)</th>
<th>Calcium (mg/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td>4-6</td>
<td>18</td>
<td>1350</td>
<td>20.1</td>
<td>25</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td>7-9</td>
<td>25.1</td>
<td>1690</td>
<td>29.5</td>
<td>30</td>
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</tr>
<tr>
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<td>34.3</td>
<td>2190</td>
<td>39.9</td>
<td>35</td>
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</tr>
<tr>
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</tr>
<tr>
<td>Boys</td>
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<tr>
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<td>61.5</td>
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</tr>
<tr>
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<td>800</td>
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Table 3. Mineral requirement for boys and girls of the study sample as recommended by the ICMR in 2010

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (Years)</th>
<th>Calcium (mg/d)</th>
<th>Iron (mg/d)</th>
<th>Zinc (mg/d)</th>
<th>Magnesium (mg/d)</th>
</tr>
</thead>
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<td>13</td>
<td>7</td>
<td>70</td>
</tr>
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<td>7-9</td>
<td>600</td>
<td>16</td>
<td>8</td>
<td>100</td>
</tr>
<tr>
<td>Boys</td>
<td>10-12</td>
<td>800</td>
<td>21</td>
<td>9</td>
<td>120</td>
</tr>
<tr>
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<td>165</td>
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<tr>
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<tr>
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<td>800</td>
<td>28</td>
<td>12</td>
<td>195</td>
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<tr>
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<td>800</td>
<td>26</td>
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<td>235</td>
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</table>

Table 4. Vitamin requirement for boys and girls of the study sample as recommended by the ICMR in 2010

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (Years)</th>
<th>Retinol µg/d</th>
<th>β-Carotene µg/d</th>
<th>Thiamine mg/d</th>
<th>Riboflavin mg/d</th>
<th>Niacin Equivalent mg/d</th>
<th>Vitamin B 6 mg/d</th>
<th>Ascorbic Acid mg/d</th>
<th>Folate µg/d</th>
<th>Vitamin B12 µg/d</th>
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</thead>
<tbody>
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<td>3200</td>
<td>0.7</td>
<td>0.8</td>
<td>11</td>
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</tr>
<tr>
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<td>13</td>
<td>1.6</td>
<td>40</td>
<td>120</td>
<td>1</td>
</tr>
<tr>
<td>Boys</td>
<td>10-12</td>
<td>600</td>
<td>4800</td>
<td>1.1</td>
<td>1.3</td>
<td>15</td>
<td>1.6</td>
<td>40</td>
<td>140</td>
<td>0.2</td>
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<tr>
<td>Girls</td>
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<td>600</td>
<td>4800</td>
<td>1</td>
<td>1.2</td>
<td>13</td>
<td>1.6</td>
<td>40</td>
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<td>1</td>
</tr>
<tr>
<td>Boys</td>
<td>13-15</td>
<td>600</td>
<td>4800</td>
<td>1.4</td>
<td>1.6</td>
<td>16</td>
<td>2</td>
<td>40</td>
<td>150</td>
<td>0.2</td>
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<tr>
<td>Girls</td>
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<td>4800</td>
<td>1.2</td>
<td>1.4</td>
<td>14</td>
<td>2</td>
<td>40</td>
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<td>Boys</td>
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<td>1.5</td>
<td>1.8</td>
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<tr>
<td>Girls</td>
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<td>1</td>
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<td>4</td>
<td>2</td>
<td>40</td>
<td>200</td>
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</tbody>
</table>

The food behaviour of urban Indian children has changed rapidly over the past decade. Studies indicate a cause for alarm and immediate action to help counter the consequences of indiscretion in food habits, lifestyle and the need for empowerment with nutrition knowledge to sustain the change:

- In a cross-sectional study in children (6-16 years) visiting St.John’s Medical College Hospital, Bangalore; a study was conducted on anthropometry, diet and lifestyle of the children. The results of the study demonstrated a positive correlation between children who consumed fried foods and were overweight. Children who chose to buy a regular snack from outside were associated with greater total calorie intakes, poorer diet quality and excessive weight gain. The
percentage distribution of TV viewing in its tertiles was 33%, 45% and 23%. The highest tertile was associated with fried food consumption (Kuriyen et al., 2007).

- In a cross-sectional, epidemiologic descriptive study of urban children and young adults in India (n 1236, 607 males and 629 females) aged 13-25 years. The absolute daily intake of total fat was 84 ± 29 g/d in males and 72 ± 21 g/d in females, this being approximately 4 times the recommended dietary allowance for Asian Indians (20–22 g/d) is the trigger for obesity and its consequent diseases. Of the fat intake, high SFA intake and a low intake of MUFAs and ω-3 PUFAs showed a further imbalanced nutrition. Among food groups, a high intake of milk, milk products, roots, and tubers was observed (Gupta et al., 2010).

- In a cross-sectional study of urban school children in Bangalore city, between August 2008 to January 2010; food habits and lifestyle data was collected from 8444 children; 4707 children aged 3–10 years and 3737 children aged 10–16 years. Data were collected on the food frequency, physical activity patterns, sedentary habits at home, sleep duration and food behaviours, eating in front of television and frequency of eating out. Simple linear regression analysis of waist circumference on various food items, physical activity, behaviour and parental BMI was done, thus developing a path model to identify potential causal pathways to increase in waist circumference. Increased consumption of foods from bakeries, non-vegetarian foods, increased television viewing, decreased sleep duration, eating while watching television, snacking between meals, family meals, skipping breakfast (in older children), and parental BMI were found to be positively associated to waist circumference. Older children perhaps underreported their intake of “unhealthy” foods, but not their lifestyle (Kuriyen et al., 2012).

The overview of the urban Indian school children’s nutrition status is a clear indication that a systematic national level intervention is needed to help children grow up healthier. Growth and development should be a comprehensive balance of physical growth, physical endurance, cognitive performance and optimum nutrition status. The food behaviour and knowledge which empowers food behaviour choices spell the difference between ill health and optimal growth for children.
2.2 Food Behaviour

Food is an integral part of our culture, our conversations and our lives. Food is not simply a necessity but also one of life’s pleasures. Almost 186 years ago, Brillat-Savarin in his book, physiology of taste wrote that “the pleasure of eating….occurs necessarily at least once a day, and may be repeated without inconvenience two or three times in this space of time;….it can be combined with all other pleasures, and even console us for their absence” (Brillat-Savarin, 1825).

Food Behaviour

Food behaviour in children, both an instinctive as well as a learned behaviour, is one of the building blocks for a healthy life. It is an adaptive trait which helps a child adjust and function well within a changing social and emotional environment. Instinctively, any living organism, from the time of birth to death seeks food while hungry. Learning what to eat and when to eat is part of a multitude of conditioning processes all organisms grow to learn from, right from the time of birth.

Maladaptive food behaviour

Maladaptive food behaviour can be changed by education and counselling techniques. Approaches using Social Cognitive Theory (SCT) have been useful to change behaviour of a group of people. Behaviour modification techniques never fail. Rather, they are either applied inefficiently or inconsistently, which leads to less than desired change (Mather and Goldstein, 2001).

Children go through periods of "Food Jags" where they prefer certain foods compulsively and thereafter lose interest in that food for months. Other common childhood maladaptive food behaviours that can cause anxiety in many parents include fear of new foods and refusal to eat what is served (Heird, 2007). However, if maladaptive food behaviour is of serious nature, it would result in diluting nutrient intake resulting in malnutrition.

Behaviour therapy has been part of psychological research documented by the famous experiment of Pavlov and the salivation of the dog in 1891. Ever since a myriad of behaviour research has been researched upon to focuses on changing maladaptive behaviours and replacing them with healthier types of behaviour. In
social sciences, a theory is defined as a set of inter-related constructs which gives a schematic presentation of a phenomenon (example, eating more fruit and vegetables) by specifying an association to predict the impact (Kerlinger and Lee, 1999). Behavioural change in food behaviour science is a carefully interpreted systematic summary of empirical evidence (Brug et al., 2005).

A conditioned response is a construct essential to establish the bedrock of behavioural therapy; all conditioned responses are based on the initial stimulus applied to a subject. Conditioning is done by pairing two stimuli which elicits a response. The various conditioned responses which impact food behaviour are:

- **Classical Conditioning**: is a form of learning where in the conditioned stimulus (CS), signals the occurrence of a second stimulus, the unconditioned stimulus (US). The US is typically a biologically significant stimulus viz. food or pain that elicits a response from the start; this response is an unconditioned response (UR). Initially the CS usually produces no particular response, however but after conditioning it elicits the conditioned response (CR) (Bouton, 2007). This is an interesting area of food behaviour; if a child is given unhealthy food options by a parent, every time the child perceives hunger between meals, the child will get conditioned to eating the snack offered. Classical conditioning is based on reflexes which form the CR.

- **Operant Conditioning**: also known as instrumental conditioning; is a type of learning in which voluntary behaviour can be modified by its consequences. The behaviour is expected to change in its form, frequency, or strength. This form of conditioning was coined by Skinner in 1937 (Domjan and Michael, 2003). Operant conditioning is ideal for nutrition education studies, since it gives a clear picture on the consequences of selected food behaviour.

**Methods to counter maladaptive food behaviour**

Guidance and counselling can modify food behaviour; however it is not effective enough to sustain a long term effect. Positive reinforcement rather than punitive action is the best method of behaviour modification in children. Serious maladaptive food behaviour can be changed by systematic de-sensitization, where the worst behaviour is modified at the end. Aversive modification, token economy and
observational learning are effective tools based on psychological science in helping reinforce better food behaviour in children. Use of multimedia presentations and realistic children's food films produce a situation of comprehension at the children's grasping level creating room for autosuggestion. Autosuggestion is a powerful tool in behaviour modification that results in sustainable and healthy food behaviour.

- **Systemic Desensitization**: is a type of behavioural therapy used in the field of psychology to help effectively overcome phobias and anxiety disorders. It works on a simple principal of relaxation techniques and working on the challenging set of obstacles in a descending order of potency (Mc Glynn et al., 2004). Systemic desensitisation has evolved into **cognitive behaviour therapy**, which especially helps counter maladaptive food behaviours. Cognitive behaviour therapy is based on a number of goal-oriented, explicit systematic procedures, where the easiest tasks are dealt with first leaving the toughest for the end (Lambert et al, 2004). This behavioural modification approach has worked well in reducing obesity in children (Tanofsky et al., 2011).

- **Aversive Modification**: Is a technique where immediately after a maladaptive behaviour is exhibited, there is an aversive stimulus applied to the subject (Lerman and Vorndran, 2002). A verbal stimuli reprimanding a child from eating unhealthy food, immediately after the food choice is made amounts to aversive modification. This is often done by parents or primary caregivers.

- **Token Economy**: is an effective system of behaviour modification based on the systematic positive reinforcement of the aimed behaviour pattern. The reinforcing material; are symbols or tokens that can be exchanged for other reinforcers. Token economy is based on the principles of operant conditioning and can be applied with children (Filcek and McNiel, 2004). This process entails giving small collectables, stars or stickers as a reward for positive behaviour and withdrawing accumulated rewards on maladaptive choices.

- **Observational Learning**: is the learning that occurs through observing the behaviour of other people. Observational learning can affect food behaviour in many ways, with both positive and negative significances. It can teach entirely
new behaviours or increase or decrease the frequency of behaviours that have
previously been taught (Cole et al., 2010).

Preference is a vital predictor of children’s food selection (Bere and Klepp,
2005). Since food behaviour established in childhood extends into adulthood, children
are a suitable group to target in order to positively influence their food behaviour
(Nicklaus et al., 2005). Parents are responsible for food and beverage accessibility at
home and influence healthy food consumption (Birch and Davidson, 2001). They play
a significant role in teaching and reinforcing healthy eating patterns in children and
distinguishing between healthy and unhealthy food selection (Benton, 2004). The
domestic mealtime atmosphere has the potential to affect the food intake and obesity
rates of children (Dietz and Gortmaker, 2001). Studies have shown significant
positive associations between family eating their meals together and children’s
nutritional and food group intake and inverse associations with consumption of soft
drinks and high-fat foods and obesity (Gable et al., 2007).

Nutrition knowledge plays an essential role in food behaviour. The public
domain interest in Healthy Foods has increased with dedicated shows on cooking,
nutrition and food on television, newspapers, internet and books. With the food
industry catching on selling “low fat”, “low salt”, “light” food forming nutrition as a
buzz word to attract customers, there is a paradigm shift in how people perceive food
as a tool for better health. Current reviews of published research indicate that whole
grain intake reduces the risk of various chronic diseases such as coronary heart
disease (Flight and Clifton, 2006; Jacobs and Gallaher, 2004) and type 2 diabetes
(Kaline et al., 2007). Most newspapers have a segment on food. Cooking shows are an
integral part of television programs. News about nutrition and health is often a key
element of television discussions. Annual surveys of supermarket shoppers showed
that nutrition is increasingly important determinant of food purchases (Food
Marketing Institute, 2004). Food companies have recognized and adapted to this
change in consumer requirement and are manufacturing and marketing foods with
supporting buzz words viz. “low fat”, “no added sugar”, “zero transfat” etc.
Determinants of food behaviour

The obesity trends coupled with possible further illnesses offer conclusive evidence that people need information on food composition, food label reading skills, to cook healthy and select a balanced diet always. However, just knowing about nutrition and food doesn’t always translate to consistently eating healthy. There are various factors which influence food behaviour and comprehending these helps nutrition professional to deliver more effective and long lasting nutrition education programs.

We make food choices many times over a day; when, what and with whom and how much to eat. Notwithstanding if the selection is for a meal or a snack, the choices are complex and predicated on multiple influences (Shephard, 1999).

The determinants of food behaviour patterns in populations motivated by

2.2.1 Biological and Experience related determinants
2.2.2 Person related determinants
2.2.3 Social and Environmental determinants
2.2.4 Economic determinants
2.2.5 Information determinants

Understanding these determinants helps to coalesce apt nutrition education strategies

2.2.1 Biological and Experience related determinants

(a) Basic tastes and food behaviour: Humans have evolved to be born with an unlearned biological taste predisposition towards accepting sweet taste and rejecting sour and bitter tastes (Mennella and Beauchamp, 1996). The fondness for sweet taste is lifelong and transcends the universality of cultures (Pepino and Mennella, 2005). The liking for salty taste develops during infancy, a few months after birth (Bernstein, 1990). These taste predispositions are an adaptive trait, signalling to the brain, that the food is safe if it is sweet and not so safe if it is bitter. The liking for fat appears early in infancy, since fat contributes to favourable mouth feel and texture (Mattes, 2009).
(b) **Genetic determinants of food behaviour:** Multiple biological and genetic programs control hunger and satiety, ensuing we eat till we achieve our energy needs (de Castro, 1999). The recorded history of human evolution establishes a primary challenge of getting enough food. The human body advanced to adapt physiologically to an environment where food was scarce and physical activity was intense. This resulted in the development of physiological mechanisms which encourage fat deposition in the body and defend against easy expansion on energy (Lowe, 2003; Chakravarthy and Booth, 2004). In today’s urban circumstances, high energy food is available at an affordable price and daily work demands significantly less physical activity. Nutrition scientists have proposed that the “modern environment has taken body weight control from an instinctual (unconscious) process to one that requires substantial cognitive effort. In the current environment, people who are not devoting substantial conscious effort to managing body weight are probably gaining weight” (Peters et al., 2002).

(c) **Satiety and food experiences:** Humans have a built-in biologically determined sensory specific satiety mechanism whereby they get weary of one taste and move to another over a brief duration of time, such as eating a meal (Rolls, 2000). Over evolution this mechanism would have had value to help humans eat a variety of foods. Studies however suggest that people adapting to eating a variety, is today a learned behaviour; this is a physiological learning and can have a reinforcement, can be either positive or negative depending on their complex taste, satiety and feeling “happy” after a particular food choice (Mennella et al., 2001).

(d) **Physiological experiences** are an integral component affecting food behaviour. How we feel after a meal, if negative for example resulting in nausea, a negative conditioning occurs whereupon the person avoids that food. Conditioned aversions are powerful, sometimes lasting decades. Learning to like a particular food is a slow process needing repeated exposures to develop familiarity and experience a good consequence such as satiety. Conditioning is a strong predicator for food behaviour in children and adults. It determines a complex matrix of food choices and volumes of foods consumed. Familiarity is very essential since humans are programmed by evolution to think new foods to be potentially poisonous. Infants seldom refuse the nourishment provided by their parents. However, during early childhood (2-5 years)
they tend to exhibit neophobia (Birch, 1999) and can be reduced by frequent exposures and repeated opportunities to sample new foods, sometimes needing 12-15 exposures (Birch and Marlin, 1982; Birch and Fischer, 1998; Birch1999), perhaps via a “learned safety mechanism”. The fundamental premise being, that if by eating a food, there is no negative consequence, there will be an increase in the acceptance of the food. When food preferences are set, they tend to persist (Skinner et al., 2002). This behaviour pattern remains till adulthood. If children are repeatedly exposed to unhealthy food at home, at school, at other settings, these will become more familiar and part of their food behaviour vis-à-vis whole grains, legumes, fruits, vegetables and dairy. Once the taste patterns for healthy food is set, over repeated exposures, it will gradually be accepted over that of the unhealthy foods. Studies have shown that in both children and adults, the feeling of satiety is influenced by associative conditioning. Research studies have proved that high-fat and high-sugar foods induce overeating and obesity in animals (Scalfani and Ackroff, 2004) and this trait is adaptive for people in today’s urban environment.

(e) Social Conditioning: Is an integral component on food experiences. A social-affective environment has a powerful impact on food behaviour. It also has an integral bearing on emotional responses to the social context of food behaviour, especially in that of children. This also encompasses parental influences on food behaviour.

i. Social Modelling: Children adopt food behaviour from their peers and the adults in their lives who are familiar. Adults cannot influence a positive food behaviour if they themselves do not choose healthy foods in the observational scope of the child. Also familiar adults can positively influence food behaviour if they are friendly in their approach to interacting with the children about their food behaviour (Birch, 1999; Addessi et al., 2005).

ii. Parenting Practices: Parental efforts in food behaviour if positively set along healthful eating and apt portion sizes is a good influence on the children, especially if parents themselves follow the same practises. Children who are taught to accept internal cues of satiety are able to eat appropriate amounts of food better than those who are taught to eat with external cues like the time of the day and amount of food remaining on the plate (Birch, 1999). The age of the children while applying these food behaviour habits have to be kept under consideration; for example at the age of 3 a child would eat only as much as the
child can notwithstanding the portion size offered; however by the age of 5 the child can eat more food, when they are offered a larger portion that what they need to feel satiety (Rolls et al., 2000).

**iii. Rewards and Bribes:** Rewards and bribes to eat foods have complex consequences (Birch, 1999; Savage et al., 2007; Ventura and Birch, 2008). Offering a reward for eating a healthy food, example “if you eat your spinach, you can watch your favourite television show” has a negative food selection as the child grows up. Also bribing with high fat, high sugar foods for acceptable behaviour patterns, example “if you pick up you toys, you can have candy” has a influence on selecting these foods as the child grows up. If rewards and bribes are used indiscriminately, parents can actually program the children to develop maladaptive food behaviour (Contento et al., 2006).

**iv. Parental efforts in offering foods:** Pressure to eat results in children becoming picky eaters (Venutra and Birch, 2008). Excessive restriction makes the restricted foods more attractive (Birch et al., 2003; Faith et al., 2004b). This can possibly lead to overeating of unhealthy food options if the children are given free access to these foods (Birch et al., 2003). If parents select and eat healthy foods and practise good food behaviour, the children are ipso facto tuned into eating similarly and this helps nutrition educators provide a more effective strategy to help form good food behaviour patterns in children (Robinson et al., 2001, Contento et al., 2005, Lin and Lang, 2005, Fischer et al., 2002, Birch and Fischer, 1998, Pliner et al., 1993).

**2.2.2 Person-related determinants**

(a) **Intrapersonal Determinants:** Our food behaviour is predicated by what we perceive as a benefit from the food choices we make. We want to select foods which are delicious, convenient, inexpensive, satisfying, familiar and comforting. Our food behaviour is based on the personal meanings we give to the choices we make. Foods which we choose when we are unwell, when we feel like indulging, what we feel will promote our wellness and looks are determined by our attitudes towards them. Identity of age comes into consideration in the development of food behaviour in children, for example teenagers tend to select more high fat foods than primary school children. Family culture also plays a significant role in food behaviour (Contento et
al., 2010). For instance, in USA, the major values of selecting foods are taste, convenience, and cost (Glanz et al., 1998) and in Europe, the major values are quality, price, nutritional value and family preferences (Lennernas et al., 1997).

(b) Interpersonal Determinants: The complex communications we share in society influences our food behaviour. Often to begin with, within the family and thereafter our peers have an impact on our food behaviour. Within the family, food behaviour patterns and choices impact family budgets for food (Connors et al., 2001; Contento et al., 2006) and with our peers daily food choices are impacted while outside of home (Devine et al., 2003). Health choices and special diets also play an integral role in family food behaviour.

2.2.3 Social and environmental determinants

(a) Physical environments, viz. grocery stores, restaurants and availability of foods in day to day places like schools, workplaces and along the way to work have an impact on health and physical activity of people (Sallis and Glanz, 2009). Globalisation has revolutionised India, since the late 1990’s there is an increase in the supermarkets and food retailers at the disposal of the middle class and even the rural citizens; ever since India gradually progressed to having 5-20% of its national food retail via supermarkets (Gulhati, 2008).

(b) Social relations and culture: Eating with familiar people influences food behaviour, family and peers play an essential role in developing and constantly changing food behaviour. Parents’ food behaviour has a positive impact on that of their children (Fischer et al., 2002; Contento et al., 2005), studies have proved that children and adolescents eating with their family have a healthier food behaviour (Gillman et al., 2000). Culture encompasses family food habits passed down generation to generation keeping in mind tradition, learned benefits, beliefs and values. Food culture unilaterally is based on the premise that healthy food behaviour results in positive health and wellness.
2.2.4 **Economic Determinants:** The price of food, income, time to purchase foods and understanding ability about the foods are essential determinants of food behaviour.

(a) **Price:** The cost of food is an integral factor in food behaviour of families the world over. Increase in food prices have caused food security to become an essential food behaviour determinant for any nation (Swinnen and Squicciarini, 2012). The cost of fruits and vegetables are seasonal in India and most families subscribe to traditional cereal rich meals daily. However, the presence of global fast food chains, offering meals as low as Rupees 50/1 US $ has increased the trend of families eating out. This is similar to the cost of fast food in western nations which have the obesity epidemic, the cost of processed foods is cheaper due to its bulk business model. In developed nations with a cold chain, the cost of adding fats and sugars contribute to a price reduction of 5% to 40% for a freely chosen fresh meal. However the cost of adding fruits and vegetables increases the cost by 20-30% (Drewnowski and Barrett-Fornell, 2004). India being a nation without a cold chain facility connecting farms to consumers, the cost of food is quite elastic and hence poses a challenge for families to make a conscious consistent healthy food choice.

(b) **Income:** Indian families spend 38.5% of their annual income on food (USDA Economic Research Service, 2011). There are no research studies available in India with reference to the percent of income spent in eating bought out food. The statistics of USA indicates only 10% of the annual income is spent on food. In most low income countries up to 53% of the annual income is spent on food (Seale et al., 2003). Compared with other economic variables, income has the strongest bearing on food behaviour; those with better incomes eat better quality diets.

2.2.5 **Information**

Most nutritional information has been known for over a decade, new information is constantly appearing as a result of continuing research. Nutrition information now is becoming part of “nutrition communication” to affect choices of consumers. Understanding the impact of nutrition and health information by the consumer will help form better models to alter food behaviour (Shiratori, 2011). The food behaviour of people are based on the assumption that their choices are based on
knowledge and desire for the product; both of which are impacted by the information they have been exposed to. It is nearly impossible for researchers to establish a comprehensive metric represent the total flow of information to consumers; hence it is necessary to make several simplifying assumptions when selecting nutrition information for dissemination (Chang and Just, 2007). Most consumers prefer getting their information on nutrition from media, than nutrition professionals (Food Marketing Institute, 2008). In a study by Shiratori, (2011); it was established that nutrition information dissemination thought popular media increased the purchase of omega 3 fortified eggs in the USA from 1998 to 2007. Children as young as 2-5 years are exposed to up to 32 hours of television per week. Media in all its forms, television, radio, newspapers, magazines and hoarding play an integral role in food behaviour of families and children. Advertisements in developing countries spend up to 15 billion USD aimed at children’s products. In year 2003, USA spent 580 million USD to advertise soft drinks, 150 million USD for candy bars and over 1.5 million USD for fast foods (Centre for Science in the Public Interest, 2003). Impact of marketing influence in food behaviour choices have been studied (Taras et al., 2000; Borzekowski and Robinson, 2001; Story and French, 2004; Institutes of Medicine, 2006). An interesting comparison of money spent to advertise fruits and vegetable intake in USA in 2003 by the national cancer institute’s budget was 4 million USD. The competitive advantage of money always renders unhealthy foods the winner through sales via advertisements.

Understanding the determinants of food behaviour, it is essential to use the knowledge of how lifestyle practises and food behaviour changes across the world have impacted lives and health. It gives a sound indication, for the need of comprehensive nutrition education research to help set a model which will work effectively across the nation.
2.3 Nutrition Education

2.3.1 Behaviour modification theory

2.3.2 Influence of nutrition knowledge of parents on the food behaviour of children

2.3.3 Importance of nutrition education intervention programs for parents

Nutrition education is defined as a system with a combination of education strategies, with environmental supports, developed to help the voluntary selection of a healthy diet, which will help achieve better health and wellness. Nutrition education ranks high in the public agenda in developed countries and gradually there is an increase in food and nutrition information due to media delivery systems.

People by and large are interested in knowing about nutrition, however eating healthy for the sake of health and wellness is not a top priority. Studies indicate that the adoption and maintenance of positive behaviour is in two phases; a decision making phase and an implementation phase (Abraham and Sheeran, 2001). This is a clear indication that nutrition education programs must have both a pre-action motivational phase and post-action reinforcement or conditioning. It is essential for the nutrition education program plan to understand the food culture of a given population in focus. Food culture spans the core communication within a family, both verbal and non-verbal on foods selected, foods avoided, who shops for food, who cooks and the opinions which count at home for food choices (Kittler and Sucher, 2001). Children get their inputs on food culture directly from family and indirectly from external sources. Mainstream cultures are also integral, the impact of media on food choices creates shifts; families perceive food culture deviating from the traditional concepts and children emulate them (Ventura and Birch, 2008).

The degree of acculturation of multi-ethnic population groups is interesting for food behaviour studies. In a study of Chinese Americans, predictive behaviour of health and food choices were positive among those who were acculturated (Liou and Contento, 2001). Behavioural intention had a positive association with food behaviour with a positive association on gender and acculturation in a study on Latino adolescents (Diaz et al., 2009).
Planning a nutrition education program needs a comprehensive view on psycho-social background of the population being addressed. One of the most critical factors is addressing “motivation” in a study group. There is always a disparity between intention and motivation in people. It is important to accept that people may know some value of positive food behaviour but not be committed to take action. Some people have weak intentions to follow good food behaviour and some fail to sustain positive action after a while due to inadequate reinforcement on using their knowledge to make better choices.

2.3.1 Behaviour modification theory

Keeping these challenges in mind; a few theories of nutrition education have been explored to assess their impact on a population.

1. The health belief model: This model was developed in 1950s by social psychologists working in the Lewin tradition and explored using social science to solve public health challenges (Becker, 1974; Rosenstock, 1974). They explored using common sense based constructs for a long-term impact of interventions. The construct of the model is based on (a) Perceived severity (b) Perceived susceptibility (c) Perceived risk (d) Perceived benefit (e) Perceived barriers (f) Self-efficacy (g) Cues to action. The challenge in this model is the presence of an optimistic bias, people just think they are eating right or ignore the real risks and insist they are eating healthy (Shim et al., 2000; McClure, 2002). The limitation in this model is that it is only the perceived risk which makes a population want to change their food behaviour. However, it is a good model to help create motivation.

2. Theory of planned behaviour: This model was developed to understand social behaviours, like attendance in churches and colleges (Ajzen and Godey, 1990); and was found very effective in altering food behaviour. This theory assumes that people make decisions in a reasonable manner. The core concept is that people make a decision without having to think too much about their actions. Fundamentally, the educationist has to just “motivate” the right food behaviours. This theory alters behavioural intentions and expected actions versus desires. Intentions are largely associated with health outcomes (Armitage and Conner, 2001). Expected outcomes are based on health benefits and that of the person
feeling self-appraisal for having selected a better diet (Kristal et al., 2000). Early studies on nutrition education based on theory of planned behaviour indicate that taste is an integral component in food selection. An early study on consumers preferring low salt breads confirmed this finding (Tuoroila-Ollikainen et al., 1986). Research on nutrition education with theory of planned behaviour over the decades gave a very clear picture that the most integral component to affect change is “observation”. Descriptive norms i.e. observing other people’s attitudes create a concrete injunctive in motivating food behaviour (Sheeran et al., 1999).

3. **Perceived Behaviour Control**: This theory is based on how one perceives their choices and the impact of their choices. The focus in this theory is how one can control ones choices and overcome barriers to follow a specified behaviour. It controls both intention and behaviour, and establishes that perception of control is likely to increase our effort to carry out an intention. Perception is a reflection of actual control in this theory. It is similar to the self-efficacy construct of social cognitive theory (Armitage and Conner, 1999, 2001). Perceived behaviour control provides a construct of confidence to carry out a particular behaviour notwithstanding the barriers (Bandura, 2000; Fishbein, 2000; Lien et al., 2002; Kassem et al., 2003). Personal responsibility and moral obligations are found to bridge the intention-behaviour gap (Godin et al., 2005; Bissonnette and Contento, 2001); this is a factor which motivates parents to feed their children an appropriate diet.

Various studies based on behavioural theories have established findings indicating that the theory of planned behaviour is a good tool to influence food behaviour:

- In a study of “eating a healthful diet” on adolescents, results showed that the constructs of the theory of planned behaviour predicted 42% of intention and 17% of behaviour (Backman et al., 2002). In the consumption of soft drinks, the predictions from the theory of planned behaviour were high; 64% intention and 34% for behaviour (Kassem et al., 2003). Soft drink consumption is also based on the theory of perceived control; viz. the construct that it will quench thirst, provide instant energy etc. However, the consumption is based on the subjective norm of availability of the product at home or having money to buy
a soft drink. Theory of planned behaviour is impacted by behavioural intention about outcomes and perceived social influences. This was seen in adolescents purchasing fruit and vegetables; they were found to have an increased sense of self-worth (Bissonette and Contento, 2001).

- In a study on older adults focusing on eating more whole grain was based on the health belief model. The program was delivered in congregate meal sites and addressed all the constructs of the model with communication on benefits, education on tastes, demonstrations and giving take home material as reinforcement. The program was positive in impact, although even to begin with the consumption of whole grains was high in the subject group, the program succeeded in reinforcing long term adherence to the education model (Ellis et al., 2005).

- An eight session program, based on the health belief model to university employees addressed the challenges of cardiovascular disease and cancer. The program supported consuming more fruit and vegetable and reduced fat. The sessions were successful but results were not statistically significant (Abood et al., 2003).

4. Social Cognitive Theory: was proposed and developed by Bandura, (2000). The basic construct implies that behaviour is the culmination of personal, behavioural and environmental factors that are interdependent in a dynamic and reciprocal fashion. This theory is very popular in nutrition education programs, since it accepts environmental pressures that affect a behaviour pattern; however it establishes that individuals have their own capacity to override environmental stimuli. The present study had an intervention of nutrition education based on social cognitive theory. The education model was based on observational learning with operant conditioning to teach participants the pros and cons of a chosen behaviour. The session was concluded with a positive reinforcement to motivate participants to adopt a better food behaviour and lifestyle.

2.3.2 Influence of nutrition knowledge of parents on the food behaviour of children

Parents have a direct impact on the food behaviour of their children. Most parents deal with feeding challenges and the consequences of an unhealthy diet. The
office for national statistics, 2011, has estimated 289,266 of children born in England and Wales in 2010 have a feeding problem in toddlerhood itself. Similar issues are seen in 1,600,122 children in the USA in the same year (Hamilton et al., 2011). The United Nations, 2011 estimated 3,160,320 children across the European Union to have comparable challenges. The feeding issue is the bedrock for poor health in adulthood (Craigie et al., 2011) and the predicament of metabolic diseases that follow. The cost of poor diet in childhood is rather heavy on national spending. The British healthcare system spent £5.8 billion to treat nutrition related illnesses in 2006-2007 (Scarborough et al., 2011).

Parental impact on food behaviour of children is positive. Children get to eat the variety and volumes which are provided by their parents. There is a positive impact of the parent’s food choices child the nutrition status of the child (Mitchell et al., 2013). Introducing new foods to the children require as up to 15 exposures of the new food to the child before the food is ‘trusted’ and subsequently tasted (Wardle et al., 2005) and more than 15 exposures for the child to develop a liking for the food (Wardle et al., 2003). Neophobia is a part of normal child development around the age of 2 years; reluctance to eat new foods is evolutionary-based response for safety (Rozin and Vollmecke, 1998). Parents need to learn how to positively keep offering rejected foods to achieve a wider food acceptance by their children. This affects pre-school food behaviour and subsequent childhood food behaviour. If parents give up in introducing a rejected food beyond five attempts, the diet of the child can become needlessly limited (Aldridge et al., 2009). Parents themselves having a restricted diet is detrimental is providing children with the variety needed (Haycraft and Blisset, 2008). Foods forming threats and bribes are also counterproductive (Fisher et al., 2002 and Wardle et al., 2005). Parental pressure to eat has been associated with increased food consumption; in a study by Orrell-Valente et al., (2007) exploring parental feeding strategies of 142 families; 83% of the children were found to eat their food in direct response to parental pressure.

Estimates of amount eaten due to parental pressure were made using a 4-point scale, from none (0), a little (1), a moderate amount (2), to a substantial amount (3). According to this rating, results indicated that that 38% of children ate moderately to substantially more than they would have had there been no parental promoting. A
study by Lumeng et al., (2012); explored the role of mothers (n 1218) prompting their infants with assertive prompting to eat, resulted in higher incidence of child overweight just at 3 years of age. This study was similar to other studies which have found that the frequency of maternal prompts was positively associated to the number of calories consumed by 3.5 year olds (Drucker et al., 1999) and to higher child weight in pre-school children (Klesges et al., 1986 and Klesges et al., 1983). The “clean your plate” concept that compromised children learning to acknowledge feeling of hunger, fullness and trigger food intake regulation challenges in later life (Carper et al., 2000). Also changes in distraction and attention can trigger over-eating in children (Brunstrom et al., 2005). Hence the delicate situation of parents feeding practises resulting in either poor food behaviour (Farrow and Blissett, 2006) or over-eating (Farrow and Blissett, 2006).

Other child feeding practices by parents are known to set the foundation for children’s maladaptive food behaviour (Benton, 2004). When foods are restricted by parents, children tend to consume the restricted foods in excess if freely available (Ventura and Birch, 2008) and this triggers rapid weight gain, over a short time (Clark et al., 2007). Well-structured restriction with the apt verbal stimuli has no counterproductive effects (Ogden et al., 2006). Parents with children who have high BMI are more restrictive in feeding (Brown and Lee, 2011) than those with underweight children (Farrow and Blissett, 2008).

The impact of overt parental food restriction can be seen as early as pre-school ages (Farrow, 2011; Campbell et al., 2010). Rewarding children with food is also seriously counterproductive for regulation of food intake and BMI in later childhood and adulthood (Puhl and Schwartz, 2003). If a food is used as reward, it tends to increase in its affective value (Birch et al., 1980) and instigates excessive consumption when available without control on portions (Baughcum et al., 1998). Food given as comfort increases BMI (Stiftler et al., 2011) and triggers eating when not hungry (Blissett et al., 2010); a food behaviour habit which directly leads to increased BMI (Fisher and Birch, 2002). Retrospective studies indicate that preference for restricted foods and emotion-induced over-eating continues into adulthood (Brunstrom et al., 2005; Puhl and Schwartz, 2003). In the context of feeding, the authoritative approach of providing rules in context to a positive food
behaviour (Ventura and Birch, 2008), helps improve healthy food selection like that of fruit and vegetables (Blisett et al., 2006). Parents promoting an indulgent food behaviour triggers the onset of high BMI, even in children as young as 3-5 years (Olvera and Power, 2010; Hughes et al, 2005). Fathers’ permissive parenting style with association to food behaviour has found increase in child BMI in a study by Wake et al., (2007). However other studies have proved that either parents’ permissive parenting style has an impact on child BMI (Haycraft and Blisette, 2008). The right parenting strategy to help children form optimal food behaviour is essential.

2.3.3 Importance of nutrition education intervention programs for parents

Intervention programs in school are normally well-received by parents. Most parents have issues pertaining to food behaviour of their children and seek to augment their own nutrition knowledge. Mothers are largely involved in offering meals to children (Blissett et al., 2006; Robinson, 2000; Savage et al., 2007). Self-regulation of food intake is one of the major concerns families have for their children (Tan and Holub, 2011); adding to this are concerns of overweight (Gregory et al., 2010) and underweight (Galloway et al., 2006).

Parents experiencing food behaviour issues with their children normally turn to doctors for advise and also to other professionals (Gildea et al., 2009). Other sources of information parents depend on are from friends and family members (Heinig et al., 2009) and media, viz. internet and books (Olson et al., 2010). The plethora of information available from multiple sources tend to render parents confused (Walker, 2005) with a food plan which is difficult to follow (Olson et al., 2010) and often inaccurate information is imbibed as true (Carruth et al., 2001). Credibility of the professional advice and their suitability to individual needs are also essential to parents (Horodynski et al., 2007; Heinig et al., 2009). A study in UK indicated that many mothers prefer to self-manage their child’s feeding difficulties due to lack of a credible resource to learn about nutrition for children (Mitchell et al., 2012). Although international guidelines give advice on breast feeding and weaning of children; there is no source of information which teaches parents how to introduce foods to children and deal with maladaptive food behaviours. Ergo, interventions and essential to first validate its impact and thereafter form a larger national education model in countries and across nations.
• It is essential to note that parent’s food behaviour has an impact on that of their children. This is established clearly in a comprehensive study by Guidetti and Cavazza, (2008); exploring the structure of the relationship between parents’ and children's food preferences and avoidances. The study explored a descriptive model assessing the connection between parents’ and children's food repertories. The study specifically explored the structure of the relationship between parents’ and children's preferences and avoidances of foods, and studied its association with the children's age. The sample comprised of 282 parent-child dyads (children ages 10-20 years); providing a self-administered questionnaire on food behaviour. The results showed that parent’s choices had an anchoring function in the formation of their children’s food preferences and not only in terms of imitation, but also in terms of influencing the direction of differentiation and innovation in food choices. The results also indicated that only two out of eight areas of food avoidances by parents limited the children’s choice. The avoidance pattern had a positive impact on the child’s age.

Various intervention studies have been done to explore the impact of parent’s nutrition knowledge on the food behaviour and nutrition status of their children

• In a study by Vereecken and Maes, (2010); an association was explored with mother’s nutrition knowledge and the dietary habits of pre-school children. A sample of 862 parents of children (51% girls and 49% boys, mean age 3.5±0.4) from 56 schools, were administered a questionnaire to study their socio-demographic profile of the families, food frequency questionnaire to assess children’s dietary intakes and a nutrition knowledge and attitude questionnaire for the mothers. The results indicated that 92% of the children lived in a traditional family and all mothers and fathers were educated with minimum of a basic degree. Of the working mothers, 20% of the mothers were classified into the high-occupation category, 58% were in the medium category, 11% belonged to the low-level occupation group, and 11% were not working women. The knowledge score of the mothers varied from −9 to 20, with an average of 6.6 (±4.9). In general, the attitudes were positive, averaging 0.76 (SD = 0.48) on a scale from −2 to +2. Regression analysis showed a lower dietary adequacy in children of mothers with low and medium level of
education, medium-ranked occupation, and lower levels of both nutritional knowledge and food-related health attitude. The study indicated that mothers educational background, occupation and nutrition knowledge had a positive bearing on the children’s dietary habits.

- A study exploring the fruit and vegetable consumption in association with the nutritional knowledge and beliefs in mothers and children indicated a direct association between maternal nutrition knowledge and fruit consumption in UK (Gibson et al., 1998). The study focussed on ways of increasing fruit and vegetable consumption in children (9-11 years). Parental and other psychosocial influences on children's fruit and vegetable consumption are poorly understood; hence the study collected data from ninety two mothers and children (48 girls and 44 boys). Questionnaires and semi-structured interviews assessed nutrition knowledge of mothers and the food behaviour of children. Fruit and vegetable intake was compared with that of the children’s confectionary intake. Micronutrient intake was typical for the U.K., which amounted from fruit, fruit juice and vegetable intake amounted to about 2.5 servings per day. Univariate correlations and subsequent multiple regression analyses revealed quite different influences on the three food types. Independent predictors of children's fruit intake included mothers nutritional knowledge (beta=0.37), mothers frequency of fruit consumption (beta=0.30) and mothers attitudinal conviction that increasing fruit and vegetable consumption by their children could reduce their risk of developing cancer (beta=0.27/ multiple r2=0.37, p<0.0001). Children's vegetable consumption was independently explained by the child's liking for commonly eaten vegetables (beta=0.36) and the mother's belief in the importance of disease prevention when choosing her child's food (beta=-0.27 r2=0.20,p<0.001). Children's confectionery consumption was predicted by the mother's liking for confectionery (beta=0.32) and the children's concern for health in choosing what to eat (beta=-0.26 r2=0.16, p<0.005). Children's consumption of fruit and vegetables are related to other psychosocial and environmental factors. The results indicated the importance of nutrition education to parents to positively influence the fruit and vegetable consumption of their children.
• A study by Savage et al., (2007), established that parents are the main providers of children’s food. Parent’s nutrition knowledge also has a bearing on their own food behaviour and BMI and the BMI of their children. Parents nutrition knowledge has a positive impact on their children’s diet. The study recommended age appropriate feeding strategies and nutrition education programs for parents.

• A cross sectional study by Hudson et al., (2005), explored diet-related attitudes and knowledge of parents, family money spent on fast food, fruit and vegetable intake of pre-children, and their relation to their children’s body mass index-for-age status. The results indicated that 95.5% of the children do not get their recommended intake of daily fruits and vegetables and there was a disparity in food consumption between ethnicities. Parents knowledge was not associated the food behaviour and BMI of children. The study indicated that motivation is as essential as knowledge on nutrition for parents, to help their children follow a balanced diet. A negative correlation was found between family money spent to buy fast food and children’s vegetable intake and positive correlation to children’s fruit intake.

• A study by Variyam et al., (1999), on 458 preschool children aged two to five years, found higher maternal nutrition knowledge was directly associated with lower child intakes of total fat, saturated fat, cholesterol and sodium, and higher child intakes of fibre.

• A study by Gibson et al., (1998) found that nutrition knowledge of parents of pre-schoolers described in qualitative study with focus group of 25 parents in the US; found that many parents were not confident that their children could self-regulate their intakes, and most gave examples of over feeding their children. Poor nutrition knowledge was compelling factor to find the right balance between quality and quality of foods given to children.

• A study exploring the impact of parents nutrition knowledge on packed snacks of pre-schoolers lunches; showed a positive association between nutrition knowledge scores and nutrition quality of the snacks. The participants included 27 parents of preschool children (3-5 years), who completed a nutrition knowledge questionnaire and a 3-day food log reporting the items packed in their pre-schooler lunches. Nutrition knowledge score over 70% was
the cut off between low and high knowledge, profiling parents into two groups. Descriptive statistics were used to determine outcomes for nutrition questionnaire, demographics, and snack consumption. Independent t tests were calculated to study the differences between lunches packed by parents with high and low nutrition knowledge. Baseline analysis found fruits, vegetables, low-fat dairy, and whole-grain foods, as well as calories, fat, saturated fat, and fibre provided in the packed lunches. Results found that nutrition knowledge had a significant effect only on the amount of grains and meat or beans present in packed lunches (p<0.048 and p<0.040, respectively). Overall, lunches were found to be below the standards of the United State of Agriculture's My Pyramid for pre-schoolers. The demographics demonstrated that mothers were responsible for grocery shopping and snack box packing. The authors recommended that an effective nutrition education system is needed in schools to motivate parents to pack healthy snack boxes and just knowledge does not translate into action (Buchanan, 2011).

Studies on quantifiable changes in parental nutrition knowledge scores after an intervention of nutrition education programs are rare. Studies however have proved the importance of nutrition education with adequate motivation to get parents to compliment a better food behaviour for children.

Nutrition education for children is an essential component of their childhood education system. This concept has evolved over decades and studies have established that an apt communication of messages can influence children’s food behaviour. The basics of operant condition to influence behaviour have been studied using both positive grain-framed messages with benefits and positive loss-framed messages with consequences of risks associated with behaviour. Schools form a sound platform for nutrition education. In 2003; the American Dietetic Association (ADA), the Society for Nutrition Education (SNE), and the American School Food Service Association (ASFSA) cohesively established that a comprehensive nutritional program should be offered in all schools to students in pre-school through the twelfth grade.

However, the genuine impact of the nutrition education needs to be studied and effective model of delivery has to be put in place. Many nutrition education
programs cause a positive change in nutrition knowledge scores, but few demonstrate a behavioural change (Caballero et al., 2003; Luepker et al., 1994).

- A study by Bannon and Schwartz, (2006); explored a pilot study using a video about snack choices, choosing apples as a snack, to a group of school children. Three classrooms were randomly allocated to watch one of the following 60 s videos: (a) a gain-framed nutrition message; with the positive benefits of eating apples (n14); (b) a loss-framed message; with the negative consequences of not eating apples (n18); or (c) a control scene of children playing a game (n18). Following this video program, the children were offered a choice between animal crackers and an apple for their snack. From the children who saw one of the nutrition message videos, 56% chose apples rather than animal crackers and in the control condition only 33% chose apples. The difference was statistically significant ($\chi^2=7.56, p<0.01$). The study established that videos containing nutritional messages may have a positive influence on children's short-term food choices.

- Turri et al., (2009); studied the impact of the “Smart Bodies” school wellness program and focussed on increasing children’s nutrition knowledge and improve psychosocial variable associated with eating fruit and vegetables with helping children develop a preference for these foods. The intervention was based on social cognitive theory. A randomized controlled intervention trial, in seven pairs, was conducted in 14 low-income, urban, public elementary schools. Data was collected from 278 fourth and 282 fifth graders (234 boys, 326 girls; 82% Black, 10% White, 1% Hispanic, 5% Asian, 2% Other) and was examined using multi-level modelling. The program involved a 12-week intervention and included participation in an interactive wellness exhibit and a classroom curriculum which promoted the consumption of fruit and vegetables. Post-test data indicated that children who in the experiment group had greater nutrition knowledge scores and expressed more self-assurance that they could eat fruit instead of a dessert and consume the recommended number of fruits and vegetables servings each day. However, the preference for fruit and vegetables did not change in the post-test level for either group. The findings indicated the intervention had a positive impact on the nutrition
knowledge scores of children and the psychosocial variables impacting fruit and vegetable consumption.

• In a study at a comprehensive school Butera, Sicily; a survey was conducted on children (n 445, 4-16 years) to test the reliability of a nutrition questionnaire and to assess potential associations between nutrition knowledge, food consumption and lifestyle behaviours, controlling for socio demographic factors. Students with higher nutrition knowledge scores were less likely to snack in excess or engage in sedentary activities. The study concluded that improved nutrition knowledge is essential to induce better food behaviour (Grosso et al., 2012).

• In a study by Matvienko, (2007); the impact of nutrition education curriculum on snack choices on children between 6 and 7 years was studied. The intervention of nutrition education was done in school settings after the school hours. The study design was a quasi-experimental model and had students at 2 intervention schools participate in a 4-week after-school program. The program was called NutriActive Healthy Experience and included nutrition lessons, healthy snacks, and parent education. Students at 2 control schools did not receive any intervention but participated in the assessment of snack choices. Experiment and control group students were offered the choice of 3 out of 10 snack items at baseline, at the end of the 4-week program, and 4 months later. Soon after the program, the experiment group showed a 25.7% improvement in choosing more healthful snacks, and the control group showed an 18.2% decline. After the 4 months follow up, the experiment group’s score was 33.3% higher than baseline and the control group’s score remained 18.2% lower than baseline (time by treatment interaction, p<0.023). The study established the positive impact of nutrition intervention on the food behaviour of the subjects in the experiment group.

• In a study by Prelip et al., (2012); the impact of a multi component nutrition education program on student knowledge, attitudes, and behaviour’s related to consumption of fruits and vegetables (FVs) was assessed. The study design was a quasi-experimental pre-test/post-test research design; 3 study conditions (Intervention+, Intervention, Comparison). The subjects were from six schools
in Los Angeles Unified School District (n 399) from the low socio-economic status. The children were from grades 3 to 6. The Intervention+ condition comprised of 4 components: traditional Network–LAUSD program, new standardized nutrition curriculum, teacher training workshops, and parent nutrition education workshops. The Intervention condition comprised of 2 components: traditional Network–LAUSD program and teacher training workshops. The Intervention+ resulted in a positive change in knowledge (p<0.005), attitudes and beliefs toward vegetables (p<0.001), and teacher influence on students’ FV attitudes (p<0.005). The authors established that the school should change its food environment and food options for the students for effective sustenance of the intervention impact.

2.4 Impact of nutrition education on the health and growth of children

2.4.1 Skipping Breakfast

2.4.2 Obesity and food behaviour factors in children

2.4.3 Iron deficiency Anaemia and Nutrition education interventions

Intervention studies have formed a significant part of efforts to help establish protocols to improve health and growth of children. Nutrition education especially has played an integral role in the lives of school children the world over.

Changes are sometime positive for a long period of time, sometimes quite simply impermanent. The impact is dependent on the quality of the intervention model; this can either be a supplement or a behaviour change. The models to elicit behaviour change although difficult have a lasting effect if applied properly.

Similar to interventions which have established the positive impact of nutrition education on food behaviour in children; studies (Table 5) have also established that a comprehensive education intervention can also impact physical fitness as well.
Table 5. Various school based education programs addressing lifestyle changes along with food behaviour in children (1988-2006)

<table>
<thead>
<tr>
<th>Aim of the program</th>
<th>Target age group (years)</th>
<th>Sample size</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>To prevent excess weight gain, heart risk by promoting physical activity.</td>
<td>11-12</td>
<td>954</td>
<td>4 years</td>
</tr>
<tr>
<td>Simon et al., 2006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testing of Kaledo board game, to improve nutrition knowledge, dietary behaviour and</td>
<td>11-14</td>
<td>307</td>
<td>23 weeks</td>
</tr>
<tr>
<td>anthropometry. Amaro et al., 2006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program on “Wellness, Academics and You” to impact BMI, Fruit and Vegetable</td>
<td>9-11</td>
<td>1013</td>
<td>4 months</td>
</tr>
<tr>
<td>consumption, Physical Activity. Spiegel and Foulk, 2006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program addressing dietary and exercise habits. Seo et al., 2005</td>
<td>6-7</td>
<td>57</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Behavioural intervention addressing dietary habits and physical activity. Gortmaker</td>
<td>9-10</td>
<td>479</td>
<td>2 years</td>
</tr>
<tr>
<td>et al., 1999</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program to improve parent and children’s nutrition knowledge and physical endurance</td>
<td>6-10</td>
<td>962</td>
<td>3 years</td>
</tr>
<tr>
<td>of children. Manios et al., 1998</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiovascular risk prevention “know your body” program. Bush et al., 1989</td>
<td>9-11</td>
<td>1234</td>
<td>5 years</td>
</tr>
<tr>
<td>Program on exercise and choosing heart healthy snacks. Killen et al., 1988</td>
<td>15</td>
<td>1147</td>
<td>2 months</td>
</tr>
</tbody>
</table>

2.4.1 Skipping Breakfast

An established body of research supports significant associations between skipping breakfast and damaging health outcomes such as dental caries (Bruno-Ambrosius et al., 2005), dysmenorrhoea (Fujiwara, 2003) and reduced weight control (Berkey et al., 2003), as well as reduced cognitive performance (Pollitt et al., 1995; Rampersaud et al., 2005). School children tend to skip breakfast, may tend to skip breakfast daily. In a survey of year 6 children (aged 10–11) from United Kingdom, 5% of children reported having skipped breakfast that day, 3% had only consumed a beverage and 10% reported eating crisps or chocolate for breakfast (Balding, 2001).
A study amongst school children in Wales indicated that breakfast was the most commonly missed meal and indications that obese children skip breakfast on average twice a week, double the frequency of normal weight children (Elgar et al., 2005). Data from USA show that breakfast skipping may increase in prevalence as children get older, with their estimates increasing to 19% for 15-year-old school children (Nicklas et al., 1998). Understanding and intervening to consolidate habitual breakfast eating at a young age may play a role in reducing this age related decline. Interventions to help resolve the challenge include school-based breakfast provision, which aim to promote habitual breakfast consumption at an early age (Crepinsek et al., 2006, Moore et al., 2007; Shemilt et al., 2003).

Studies based on understanding and improving breakfast intake in children have had varying results

- In a study by Hallström et al., (2011); factors influencing breakfast consumption and food choices at breakfast in adolescents were explored. The study defined breakfast habits and their influencing factors within the framework of the EU-funded HELENA study from ten European cities (n 3528). Furthermore, socio-demographic differences in breakfast habits and in influencing factors were also investigated. Results found that half of the adolescents (lesser girls than boys) indicated being regular breakfast consumers. Girls whose mothers had a high level of education, boys from ‘traditional’ families and boys who felt they are from poorer families were positively associated with breakfast consumption. Boys whose parents encouraged eating breakfast and girls whose peers ate more healthy were more likely to be regular breakfast consumers. ‘Hunger’, ‘taste’, ‘health concerns’ and ‘parents or guardian’ were the essential influences on the adolescents’ food choices at breakfast. Adolescents from southern Europe and girls described more impact of personal and socio-environmental factors.

- In a school-based intervention to promote eating daily and healthy breakfast, the impact of 'Fits me' program to promote eating daily and healthy breakfast among elementary school children was assessed. The researchers sampled separate clusters of children from seven regions around Israel. The study was based on a case-control structure. Data was collected via questionnaires and coded according to quality of breakfast as follows, “the answer to the
question: ‘what do you eat for breakfast?’ considered as a healthy breakfast if it included one of the following food items: A sandwich (not including chocolate, jam or butter), cereals, vegetable, fruit, egg and dairy product”. After an intervention, the results indicated that more children ate breakfast daily over the two years of the study (51-65%, p<0.001). Healthy breakfast choices improved after the intervention. However, only 75% of the children in the experiment group could self-evaluate that they are eating a healthy breakfast. The authors concluded that the intervention was successful to improve breakfast eating, but the definition of a healthy breakfast needs to be further crystallised (Eilat-Adar, 2011).

- A study testing the efficacy of a brief theory-based intervention to promote regular consumption of breakfast, based the theory of planned behaviour (TPB) to influence breakfast consumption was done by Kothe and Mullen, (2011). The study had a four-armed randomised controlled trial. Participants \( n = 349 \) were allocated to receive either a (1) positively framed attitude intervention, (2) negatively framed attitude intervention, (3) Perceived Behavioural Control (PBC) intervention, or (4) control task. Parameters of relevance were attitude, subjective norm, PBC and behaviour and were measured at baseline and 4-week follow-up. Results showed that all three interventions employed persuasive communication and an implementation intention task. The intervention did not result in expected increases in breakfast consumption, or in changes in attitude, subjective norm or PBC. However, the study found that baseline intention predicted 33% of breakfast consumption. Despite a lack of intervention effects, the TPB model of nutrition education provided a good model of breakfast consumption over the four-week follow-up period.

2.4.2 Obesity and food behaviour factors in children

The burgeoning problem of obesity in children the world over has triggered the need to have an effective intervention to control and reduce the challenge. Interventions comprising of nutrition education and behavioural change motivators are essential to achieve a positive result. Intervention studies have had promising effects:
Donnelly et al., (1996) explored a study to reduce the incidence of obesity and improve physical and metabolic fitness in elementary school children. The study comprised of cohorts from grades 3 to 5 in two school districts in rural Nebraska (Intervention/Control) who participated in a 2-year study of physical activity and modified school lunch program. Data was assessed for aerobic capacity, body composition, blood chemistry, nutrition knowledge, energy intake, and physical activity was at the beginning and end of each year. The intervention group received enhanced physical activity, grade specific nutrition education, and a lower fat and sodium school lunch program. The control group continued to have a regular school lunch and team sports activity program. Post test result found physical activity in the classroom was 6% greater for the intervention group compared to the control group (p <0.05) but physical activity outside of school was −16 % less in the intervention group compared to the control group (p <0.05). There was no difference in body weight and body fat in groups between schools for normal weight or obese children. No differences were found for cholesterol, insulin, and glucose; however, HDL cholesterol was significantly greater and cholesterol/HDL was significantly less in the intervention group when compared to the control group (p<0.05). The authors established that compensation in both energy intake and physical activity outside of school may be responsible for the lack of differences between intervention and control groups.

A study by Abood et al., (2008) evaluated a minimal school based nutrition intervention for adolescents to reduce obesity. The participants comprised of seven schools and were randomly assigned as experimental, and 7 as delayed-treatment. The minimal intervention was Present and Prevent, a commercially available PowerPoint program presented in two 30-minute time slots over 1 week. Results found significant improvement in nutrition knowledge (p<0.001) and intention to maintain a healthy body due to peer pressure (p<0.001) and better nutrition and lifestyle practices (p<0.001) in the experimental group. Authors established that behavioural intentions are present in adolescent groups.
• To assess the effects of a low cost behavioural prevention program in a preschool setting was explored by Bayer et al., (2009). The study comprised of 64 kindergartens in 4 Bavarian regions who were randomly assigned as intervention or controls in a 2:1 ratio. The intervention program led to an increased proportion of children with high fruit and vegetable consumption already after 6 months, which was sustainable with adjusted odds ratios of 1.59 (1.26: 2.01) and 1.48 (1.08: 2.03) after 18 months. Subgroup analyses by gender, overweight and parental education, performed to evaluate the consistency of effects, showed similar results.

2.4.3 Iron deficiency Anaemia and Nutrition education interventions

The WHO (2001) has established that anaemia is a public health problem in many developing countries, including Africa and Asia. Studies have encompassed children below the age of 5 years are most vulnerable (Saxton et al., 2009); attention is also warranted by older school children too (Oliveira et al., 2007). Anaemia is controlled by multiple factors. A study in Korea by Choi et al., (2011) established the positive association of material education status to reduced incidence of anaemia in children (p<0.032). Although it is logical and established by research studies that iron supplements will help alleviate the situation, it is also important to explore the impact of food behaviour change to ensure a long term iron rich diet.

• In a community-based, randomized trial, in urban slum children of Delhi, a study explored the comparative effects of nutrition education and/or iron supplementation (weekly) on iron status. Post intervention studies showed that change in the nutrition education group was seen only at 16 weeks (p<0.050) and had improved serum ferritin levels when compared to their status at the baseline (p<0.001). The group with supplementation improved more swiftly. The nutrition knowledge of the intervention group with nutrition education was greater than control groups (p<0.001). The study indicates that nutrition education is a possible mode of improving iron status in urban Indian children (Kapur et al., 2003).

• A study by Alaofe et al., (2009) explored nutrition education to improve iron intakes for treatment of mild iron-deficiency anaemia in adolescent
girls in southern Benin. The program comprised of 34 intervention and 34 control boarding-school girls aged 12 to 17 years from Benin. The experimental design entailed 4 weeks of nutrition education combined with an increase in the content and bioavailability of dietary iron for 22 weeks at the intervention school, but not in the control school. Data were obtained from both groups from a nutrition knowledge questionnaire, 24-hour dietary recalls, anthropometric measurements, measurement of iron status indices, and screening was done for malarial and intestinal parasitic infections. Results indicated an improvement in nutrition knowledge scores and mean intakes of nutrients, including dietary iron, absorbable iron, and vitamin C, were significantly higher in the intervention group (p<0.050) than in the control group after 26 weeks. Mean haemoglobin (p<0.002) and serum ferritin values (p<0.040) were also significantly higher in the intervention group than in the control group. No significant differences between the groups were observed in intestinal parasitic infections or malaria status post intervention. The study established the positive impact of nutrition education on improving anaemia in adolescent girls.

- A recent study by Kaur et al., (2011) established the positive impact of nutrition education to reduce the level of anaemia in adolescent Indian girls. The study assessed serum iron status of fifty girl students with an intervention of nutrition education. The results indicated that 62% of girl students had mild anaemia (Hb>12gm/dl), and 14% of them had anaemia of moderate degree (Hb>12gm/dl) at baseline showing significant improvement due to nutrition education intervention after a follow up study of 12 months. The study established the credibility of nutrition education as a good strategy to reduce anaemia in children.

The review thus indicates that interventions with nutrition education based on a reliable behaviour change model can help elicit a positive change in food behaviour and the associated factors resulting in better growth, development and health of children.