DEVELOPING A HEALTHY EATING INDEX AND FOOD BEHAVIOUR CHECKLIST FOR ADOLESCENTS IN THE INDIAN CONTEXT AND ASSESSING THE IMPACT OF A NUTRITION COMMUNICATION PROGRAMME TO IMPROVE THEIR DIETARY PRACTICES

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By

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CERTIFICATE

This is to certify that the research work embodied in the thesis has been carried out independently by Ms Vijayata Sengar in pursuit of doctoral degree in Foods and Nutrition and represents her original work.

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"*Adolescence is a gateway to the promotion of health. Adolescence provides opportunities to prevent the onset of health-damaging behavior and potential repercussions. Fortunately, adolescents are receptive to new ideas; they are keen to make the most of their growing capacity for making decisions. Their curiosity and interest are a tremendous opening to foster personal responsibility for health*".

(WHO/UNFPA/UNICEF, 1999)

ABSTRACT

Adolescence refers to the long transitional, developmental period between childhood and adulthood, and to a maturational process involving major physical, psychological, cognitive and social transformation. During adolescence, nutritional problems from childhood can potentially be corrected in addition to addressing new ones. Therefore, it is a period to shape and consolidate healthy eating and lifestyle behaviours, thus preventing or postponing nutrition related disorders and diseases later in life.

Thus the present study was planned with the broad objective of developing a Healthy Eating Index and Food Behavior Checklist for adolescents in Indian context and to implement a Nutrition Communication Programme to improve their dietary practices from three schools of urban Vadodara.

The study was conducted in three purposively selected schools of urban Vadodara. All the children from Std. V to std. XI were enrolled for the study. Anthropometric data was obtained on 1041 subjects. Data on socio economic status, food frequency, Dietary and physical activity practices was collected on 631 subjects. Knowledge, attitudes and practices (KAP); dietary intakes using 3- day recall, morbidity profile and cognitive development was obtained from 478 subjects from two schools. Hemoglobin estimation was done on a subsample of 61 subjects.

Two schools were allotted to the Experimental (EG) and Control group (CG) for the Nutrition Communication Programme (NCP), known as Creating Healthy and Active Learning Kids (CHALK) Programme. EG consisted of 212 subjects and CG had 266 subjects. Due to dropouts impact data was collectedon 191 subjects in EG and 245 subjects in CG who completed the study.

Mean age of the study subjects was 12.45± 0.07 years. Peak height velocity was observed in boys at 12 years and in girls at 11 years of age with a mean increment of 7 cm and 5.9 cm in boys and girls respectively. Peak weight velocity was observed in boys at 15 years and in girls at 11 years of age with a mean increment of 8 kg and 5 kg in boys and girls respectively.

One–fourth of the subjects were found to be underweight, with moderate (WAZ<-2SD) and severe (WAZ<-3 SD) forms being 4.8% and 0.9% respectively. Stunting was prevalent in 14% of the subjects, moderate (HAZ<-2SD) and severe (HAZ<-3 SD) stunting was observed in 2% and 0.3% of the subjects.Prevalence of thinness was 33%, with moderate (BAZ<-2SD) and

severe (BAZ<-3SD) thinness being 8% and 2% respectively. Overweight and obesity were found in 13% and 4% of the subjects respectively.

Mean intakes for all the food groups except edible oil was below 75% of the recommended dietary allowances.Consumption of all the nutrients except protein and fat was below 84% of the RDA. Mean nutrient intakes of boys were significantly higher than girls. Age and sex significantly affected mean nutrient intakes except fat (ANOVA $p<0.01$).Amongst unhealthy foods the most frequent consumption was observed for baked foods (42.5%) followed by accessories (42.3%) with meals on a daily basis.

Mean hemoglobin level of the subjects was 11.9 g/dl. Prevalence of anemia was 42.6% with mild and moderate forms being 66% and 31% respectively. More than half of the anemic subjects showed normocytic red blood cells. Two- thirds of the subjects reported to have experienced some or the other form of morbidity (ies) in the past fortnight. Most common morbidities were cold, headache, stomachache and cough. Two-third of the subjects slept for <8.5 hours in a day. As age increased study time increased while duration of physical activity, playtime, sleep time and leisure time decreased.

Mean cognitive scores were positively correlated with age. Undernourished subjects had lowest overall scores in the cognitive tests. KAP revealed lack of knowledge amongst subjects regarding, growth and development, healthy foods, functions of foods, food groups, healthy eating practices etc. Incorrect self perception was observed amongst 64% of the subjects.Lack of awareness regarding adolescence, health, foods to be given under various conditions etc. was observed amongst the teachers.

Healthy Eating Index for Adolescents (HEIA) was developed in the present study to assess the dietary quality of the subjects. HEIA consisted of 10 dietary components namely, Total Grains; Total Pulses/ Meat/ Fish and Poultry; Total Vegetables; Total green, yellow and orange vegetables; Total Fruits; Total Milk; Total Oil; Total Sugar; Variety and SOFAAS. Mean overall HEIA score was 63.3 ± 5.2 and was higher in boys as compared to girls. Almost all the subjects needed improvement in their diets according to their HEIA scores. Individual HEIA components scores revealed low intake of fruits and green, yellow, orange vegetables. Parents' education, family size and family type affected the individual component scores for certain foods.

A short Food Behaviour and Activity Checklist for Adolescents (FBACA) was developed to assess the quality of 20 dietary and physical activity practices. Mean total FBACA score was 70.20$\pm$ 8.35 and was higher in girls as compared to boys. Most of the subjects needed improvements in the quality of dietary and physical activity practices being followed. More females than males had ‘good’ dietary and physical activity practices (13% v/s 8%). The highest mean FBACA score was observed for vegetables (4.9), which indicates almost all the subjects consumed vegetables regularly. The lowest scores were for evening snack item (0.97) indicating higher intakes of unhealthy foods as evening snacks. Content, Construct and criterion validity were established for both HEIA and FBACA. Analysis revealed that both the tools were reliable to be used time and again.

Based on the assessment of knowledge, attitudes and practices of the subjects, key messages were selected and a nutrition communication strategy was developed. Intervention was carried on for a period of 3-4 months followed by reinforcement sessions. Various communication methods like PowerPoint presentations, posters, puzzles and video clips were used.

Impact evaluation showed that NCP was successful in significantly increasing the knowledge levels, of the EG subjects as compared to CG, with respect to most of the messages covered in the CHALK programme. Significant improvement in the dietary practices, like regular breakfast and mid morning food consumption and vegetable consumption was observed in EG post intervention.EG showed a significant improvement in self-perception after the intervention. A significant increase in the mean food group intakes of grains, vegetables and edible oil was seen in EG after intervention.Mean nutrient intakes were significantly higher for all the nutrients in EG after the intervention. Mean increments in the nutrient intakes were significantly higher in the experimental group as compared to the control group post intervention.

The present study revealed dual burden of malnutrition, among school children of urban Vadodara. HEIA and FBACA were developed in the present study and were found to be valid and reliable tools in measuring the diet quality and the quality of dietary and physical activity practices. The need of the hour in India is for a targeted approach to assess, evaluate and improve the dietary behaviours. The approach should focus on the improvement in dietary behaviours of both undernourished and over nourished children together, as these problems coexist in the society. Thus, dietary tools like HEIA and FBACA should be used along with simple behavioural change communication messages to bring positive changes amongst populations.

INTRODUCTION

In the Millennium Declaration, adopted in 2000, world leaders made a promise to children to help them fulfill their human potential. The children born in that milestone year are now adolescents. It is time to review whether the promise is being kept for these 'Millennium children' and for all adolescents (UNICEF, 2012).

Adolescence is the period when a growing child experiences a linear growth 'spurt' to attain his or her fullest potential of adult height, shape, body composition, physical and sexual function. Although there is no internationally accepted definition of adolescence, the United Nations defines adolescents as individuals aged 10-19 years (WHO, 2002).

The proportion of adolescents in the global population peaked around 1980 and is now on the decline almost everywhere, a trend expected to continue through 2050. The absolute number of adolescents, however, is expected to rise during the same period (Figure 1.1.1) (UNICEF, 2012).

In 2009, there were 1.2 billion adolescents aged 10–19 in the world, forming 18 per cent of world population. Adolescent numbers have more than doubled since 1950. More than half of the world's adolescents live in either the South Asia or the East Asia and Pacific region, each of which contains roughly330 million adolescents. India has the largest national population of adolescents, nearly 243 million (UNPD, 2010) (Figure 1.1.2).

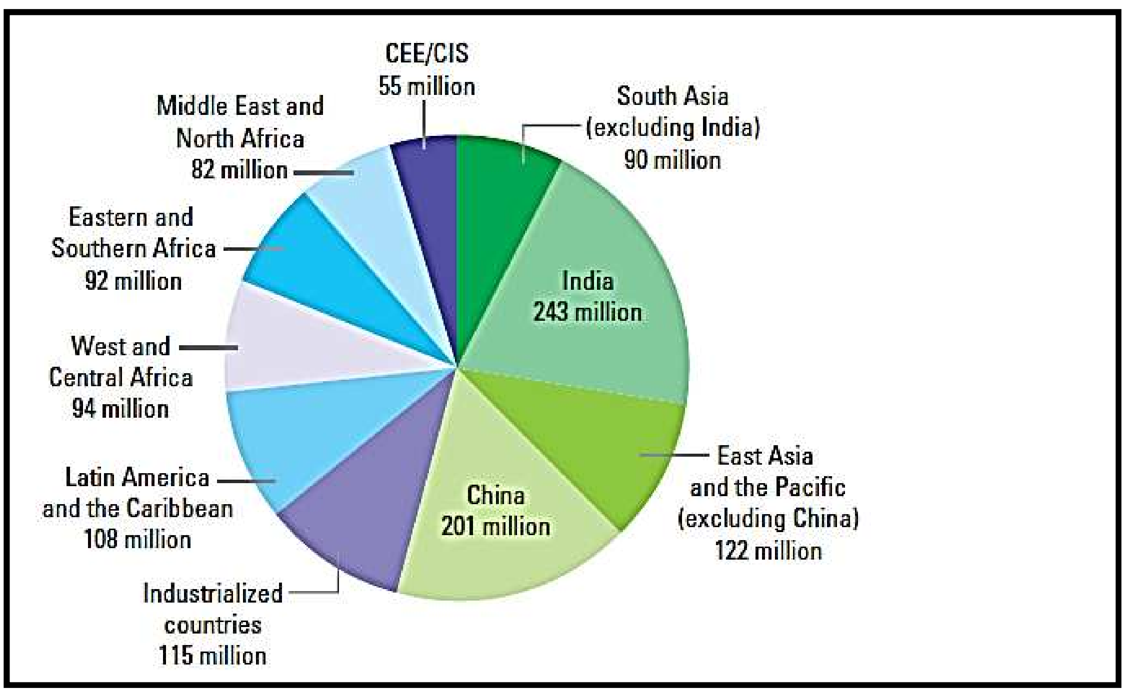
Adolescents – A Neglected Group

Adolescence though is a time of enormous physiological, cognitive and psychological change, WHO, acknowledges that adolescents remain "a neglected, difficult-to-measure and hard-to-reach population" (WHO, 2006).

In the Millennium Development Goal, adolescents are not specifically mentioned, although they are the future adults. Health information on adolescents is not widely available in many developing countries, apart from indicators on sexual and reproductive health collected by major international health surveys.

Figure 1.1.1: Adolescents' share of a growing world Population (Source: UNICEF, 2012)

Figure 1.1.2: Population of Adolescents 10-19 years old by region, 2010 (Source: UNPD, 2010)



During adolescence, the growth velocity increases, individuals can gain 15% of their ultimate adult height and 50% of their adult weight. Approximately 45% of skeletal mass is also added during adolescence (SCN, 2006).

Thus, appropriate dietary intakes and healthy food choices are very critical during this period and inadequate dietary intakes (mainly energy, protein and micro nutrients) and inappropriate food choices may lead to undernutrition among the adolescents or prevent them from attaining their full potential for growth and development.

State of Adolescent Health

According to National Nutrition Monitoring Bureau, (2002), in India, the prevalence of undernutrition tends to increase from about 63% among 6-9 year age group to 78% in 10-13 years and then decrease to 66% in 14-17 year age group of children. Though no significant sex difference in the prevalence of undernutrition were observed in 6-9 and 10-13 year age groups, however, a relatively higher proportion of boys (73%) in 14-17 year age group were found to be undernourished as compared to their female counterparts (60.4%).

Thinness reported as ‘Undernutrition’ by ICRW, was prevalent only in 3 countries out of the 11 studied. India reported the highest prevalence with 53% of the subjects having low BMI for age (Kurz, 1996).

There is also a large inter - state variation in the patterns and trends in underweight. In six states, at least one in two children are underweight, namely Maharashtra, Orissa, Bihar, Madhya Pradesh, Uttar Pradesh and Rajasthan. Gujarat has a prevalence of 50% underweight which is higher than the national prevalence. Undernutrition is more prevalent in rural than urban areas. Even in urban areas 40% of children are stunted and 33% are underweight (NFHS III, 2007). Undernutrition (BMI <18.5 kg/m^2) among adolescent girls between 15- 19 years of age was found to be 47% (UNICEF, 2012).

Shah, 2005 reported the prevalence of under nutrition in Vadodara as 34% according to Must et al standards (1991) and 19% according to Agarwal standards (1992). According to both the standards, undernutrition was higher in boys (41.2% and 19.9%) than girls (24.7% and 17.6%) in the age group of 10-18 years.

Kanade et al (1998) reported a delay of 18 months in the peak height and weight velocities for children who were stunted at 10 years of age.

Agarwal et al (1992) carried out a multi-centric study in eight states of India on affluent school children and found that Indians were shorter and lighter as compared to NCHS standards.

A study by Gandhi (2004) in 10 schools of urban Vadodara covering 4808 children of 8th to 12 h standards from middle to high socio economic status indicated the high prevalence of both undernutrition and overnutrition. Overall prevalence of underweight varied from 34% to 36% while that of overweight ranged from 4.6% to 24.9% and obesity ranged from 0.6% to 5.3%.

Stunting was prevalent amongst both the sexes in 9 out of 11 studies conducted by International Center for Research on Women (ICRW) ranging from 27 to 65%, in India it was reported around 32%. (Kurz, 1996)

Srihari et al (2006) reviewed twelve studies carried out between 1995 and 2006 on nutritional status of Indian school children 6- 18 years from middle and high socio economic status. Out of the 12 identified studies, eight reported on the prevalence of overweight and obesity. The range of prevalence of overweight (8.5- 29%) and obesity (4.5 – 7.4%) was large.

Srihari et al (2006) reported that anemia prevalence with haemoglobin concentration <12 g/ dl ranged from 19% - 88%among middle to high socio economic status adolescents across five different cities in India.

Anemia and stunting in this age group is of public health importance because adolescence can be the second opportunity to catch up growth if environmental conditions are favourable (NFI, 1989).

Inappropriate Dietary Intakes during Adolescence

For many adolescents, inadequate quality and quantity of food and lack of nutrition knowledge are the main determinants of nutritional problems. In high socio economic status as well, due to faulty dietary food habits, in conjunction with over nutrition, under nutrition is also prevalent (Kaya, 2006).

Pre-adolescence is a period when nutritional requirements increase on account of rapid growth. There is widespread prevalence of dietary and nutrient inadequacy among adolescents as evident from research by several investigators (Kapil et al, 1993; Seshadri et al, 1999; Vijayapushpam et al, 2003).

Inadequate intake of micronutrients can adversely influence growth and development, cognitive performance and increase susceptibility to infections (Halterman et al, 2001; Benton, 2001; Caulfield et al, 2004).

Healthy eating patterns in childhood and adolescence promote optimal health, growth, and intellectual development, prevent immediate health problems, such as iron deficiency anaemia, obesity, eating disorders, and dental caries and may prevent long-term health problems such as coronary heart disease, cancer and stroke (SCN, 2006).

In view of the present unsatisfactory nutritional status of the school going children, particularly adolescents as highlighted above, there is a strong need to evaluate the dietary quality and behaviours of these subjects. Also there is a need to assess their current dietary and physical activity practices and to educate these children, so that their dietary and physical activity practices (behaviours) improve.

Dietary Assessment

Various qualitative and quantitative methods have been developed for dietary assessment. The most commonly used methods are Food frequency questionnaire and 24 hour recall method. However, these methods have their own limitations, which affect the validity of these tools for dietary assessment.

Administering a 24 hour recall in a group setting is cumbersome. Underreporting or overreporting the dietary intakes and an inability to recall accurately the types and amounts of food eaten are two main weaknesses of 24 hour recall methods. Single 24 hour is not representative of habitual intake but may be useful for group means. Multiple averaged 24-hour recalls are needed to estimate the usual food or nutrient intake of individuals. Moreover, detailed quality control for achieving accuracy involves a protocol for administering the recall and for the training and periodic retraining of the interviewers and data coders. Data coding, data entry, and data analysis are usually more expensive than those entailed with the food frequency method (Thompson and Byers, 1994).

An alternative to the 24 – hour recall, food frequency questionnaire (FFQ) is also difficult and time consuming to administer in a group (Kristal et al, 1998). Since FFQs are designed to assess the ranking of intakes within a population, they cannot be relied on to produce reliable estimates of absolute intake. Over- estimation is common, particularly for foods eaten lees often or for foods perceived as 'healthy' such as fruit and vegetables (Day et al, 2001)

Neither the dietary recall nor the FFQ assess the behaviours and practices related to diet and physical activity.

Current dietary concerns, among populations as a whole, include overconsumption of calories, added sugars and saturated fats; underconsumption of whole grains, fruits and vegetables (USDA ERS, 2013)

New Tools for Assessing Dietary Quality

Healthy Eating Index (HEI) was developed by United States Department of Agriculture (USDA) in 1989, which was released in 1995 (Kennedy et al, 1995).

HEI measures the dietary quality of subjects age 2 and older. It assesses the level to which the Americans conform to the Dietary Guidelines. HEI has been revised over time in 2005 and in 2010 to adhere to the revised dietary guidelines (Guenther et al 2007 and 2013).

HEI -89 consisted of 10 dietary components. Five components assessed the nutrient adequacy of the diet by using the five major food groups of the original Food Guide Pyramid: Fruit, Vegetable, Grains, Milk and Meat (USDA CNPP, 1996). Four components assessed aspects of the diet that should be limited or consumed in moderation: Total Fat, expressed as a percentage of total calories; Saturated Fat, expressed as a percentage of total calories; Cholesterol; and Sodium. The tenth component was a measure of Variety in food choices regardless of food group.

The release of the 2005 Dietary Guidelines for Americans, necessitated a revision of the HEI because of the increased emphasis on important aspects of diet quality, such as whole grains, various types of vegetables, specific types of fat, and the introduction of "discretionary calories."

The HEI 2005 (Guenther et al, 2007) has twelve components. Total Fruit; Whole fruit; Total vegetable; Dark Green and Orange vegetables and Legumes; Total Grains; Whole Grains; Milk; Meat and Beans; Oils; saturated Fat; Sodium; and Calories from Solid Fats, Alcoholic beverages and Added Sugars (SoFAAS).

The components of HEI 2005 were of two types. The food group and oils components were the "adequacy components" because the recommendations on which they are based were established to ensure adequacy of nutrient intake. The "moderation components" were saturated Fat, Sodium, and Calories from Solid Fats alcohol and added sugar (SoFAAS).

USDA's Center for Nutrition Policy and Promotion (CNPP) assesses the dietary quality of Americans using HEI from the dietary data available through National Health and Nutrition Examination Survey (NHANES) and the Continuing Survey of Food Intakes by Individuals (CSFII).

Aust- HEI was developed in Australia to provide a measure of the total dietary quality based on food choices and whether recommended foods are being chosen. Aust – HEI used a Short Dietary Questionnaire (SDQ) and a Food Frequency Questionnaire (FFQ). It included 7 components namely, Measures of variety, Measures of 'Healthy Choices', Fruit consumption, Vegetable consumption, Low fat milk chosen, Trim fat off meat and Consumption of high saturated fat and low nutrient density foods (AIHW,2007)

Another important tool that was developed by Blackburn et al (2006) is a Food Behaviour Checklist (FBC) to evaluate the fruit and vegetable intake among ethnically diverse women in the Food Stamp Nutrition Education Program (FSNEP) and the Expanded Food and Nutrition Education Program (EFNEP).

Nutrition Communication

To combat the double burden of malnutrition, various school based programmes and interventions have been initiated by governments, national and international organizations. Programmes like Health promoting Schools or Global School Health Initiative (WHO), School Food and Nutrition Education Program (FAO) etc.

WHO Information Series on School Health (1998) also justifies the decision to support school based interventions among adolescents. Improving the nutritional status of school age children and adolescents is an effective investment for the future generation, as well as for combating the development of obesity and other nutrition related chronic diseases later. Nevertheless schools can be an important setting to address the problems of under nutrition and anaemia also.

Evidence supports the effectiveness of school- based health promotion strategies with a focus on healthy eating (Rodrigo and Aranceta, 2001).

School settings are appropriate for carrying out studies on school aged children in India as, according to NFHS III, 90.1% of the 6-10 years and 74.2% of the 11-14 years old children attended primary school in 2005-2006 in India (NFHS III, 2007).

Nutrition health education is an effective strategy for behavioral change to improve home diets. Nutrition health education is a process of formulating and disseminating messages that make individuals and communities aware about health and other related issues, strategies and behavior that enable them to make informed choices (Nandi and Bhattacharjee, 2005).

A cost effectiveness study conducted on the Nutrition Communication and Behavior Change Component (NCBC) of the first World Bank loan to Indonesia for community nutrition showed that the successful nutrition communication component, significantly improved the nutritional status of 40% of the children. It cost about 0.15% of the national budget. This would be one-tenth the cost of an institutional feeding program and one twentieth of the cost of consumer food subsidies (Ho and Teresa, 1983; Berg, 1987). Thus, Nutrition Communication Programme is a cost effective strategy aimed at behaviour change.

In India, as in most developing countries, the bulk of nutritional problem lies in mild and moderate malnutrition. Half or more of young children in many countries are affected by these forms of malnutrition (Pelletier, 1994). In most families, mild and moderate malnutrition can be eliminated or controlled through simple changes in dietary and food hygiene practices that are amenable to change through well planned and executed behaviour change strategies.

Integration of qualitative and quantitative methods is a very important in designing and assessing a Nutrition Communication Program (NCP). Qualitative methods produce factual reliable data that are usually generalizable to larger population while qualitative methods generate rich, detailed valid process data that usually leaves the study participants' perspective intact (Steckler et al, 1992).

For a nutrition communication program, quantitative methods help to obtain nutrition related data such as magnitude of the problem and etiological factors and help in understand the nutritional problems of the subjects. The qualitative methods in the formative research give insight into perceptions and reasons underlying dietary and health related behaviour in the target groups which helps in the development and implementation of a nutrition communication program.

Rationale for the Present Study

Although dietary inadequacies have been highlighted by many investigators, so far no attempt has been made to evolve a Healthy Eating Index scoring system or to develop a Food behaviour checklist to assess the dietary inadequacies/practices of school children in India, unlike western countries where HEI has been developed and validated to assess the quality of diet. This under researched area needs to be focused on and explored and attempt should be made to validate the tool developed and to test its reliability in the Indian context.

The challenge for India is clearly to counteract the seeming inevitability of the degenerative phase of the nutrition transition. This must be done while continuing the efforts to address the additional burden of undernutrition. Considerable headway needs to be made in nutritional knowledge and practice among health professionals and public (Vaz et al, 2005).

In India not many researches have been focused on nutrition communication for school children based on the quantitative and the qualitative aspects of dietary and physical activity practices.

In view of the above, the present study was undertaken with the **Major Objective** to develop a Healthy Eating Index and Food Behavior Checklist for adolescents in Indian context and to implement a Nutrition Communication Programme to improve their dietary practices in selected schools of urban Vadodara.

The study was divided into **four phases** with the following specific objectives:

Phase I: Assessment of the Nutritional status of the subjects

- To assess the nutritional status of the children aged 7-18 years in selected schools of urban Vadodara by anthropometric measurements and perform biochemical estimations on a subsample.
- To assess the cognitive development among children aged 7-18y in selected schools of urban Vadodara.
- To assess the daily dietary intake by 24 hour Dietary Recall method and Food frequency method among children aged 7-18y in selected schools of urban Vadodara.
- To evaluate the knowledge, attitude and practices (KAP) of the students regarding health, diet, healthy eating practices, physical activity etc. among children aged 7-18y in selected schools of urban Vadodara.

Phase II: Healthy Eating Index and Food Behaviour Checklist – Development, Assessment and Validation

- To develop a Healthy Eating Index and Food Behaviour Check List for adolescents in the Indian context.
- To review the dietary quality of the study subjects with the help of the developed Healthy Eating Index.
- To evaluate the behaviour pattern of the subjects regarding dietary and physical activity practices.

- To assess the validity of Healthy Eating Index and Food Behaviour Check List as a tool for assessing dietary quality and the quality of dietary and physical activity practices respectively.

Phase III: Development of Nutrition Communication Programme (NCP) and its implementation

- To plan and develop a Nutrition Communication Programme based on the assessed knowledge attitudes and practices, focused on bringing about improvements in their knowledge, dietary practices and physical activity pattern

- To implement the Nutrition Communication Programme developed for the study subjects in one selected school of urban Vadodara.

Phase IV: Assessing the impact of Nutrition Communication on the Subjects

- To assess the impact of the Nutrition Communication Programme (NCP) on the knowledge and practices of the study subjects after a period of six months in the selected schools of urban Vadodara.

REVIEW OF LITERATURE

Adolescence has been described, by Anthony Lake (Executive Director UNICEF), not only as a time of vulnerability but also as an age of opportunity (UNICEF, 2011). Adolescents form 18% of the world's population. The vast majority of adolescents (88%) live in developing countries. More than half of world's adolescents live in South Asia or the East Asia and Pacific region. India has the largest national population of adolescents (243 million) (UNPD, 2010).

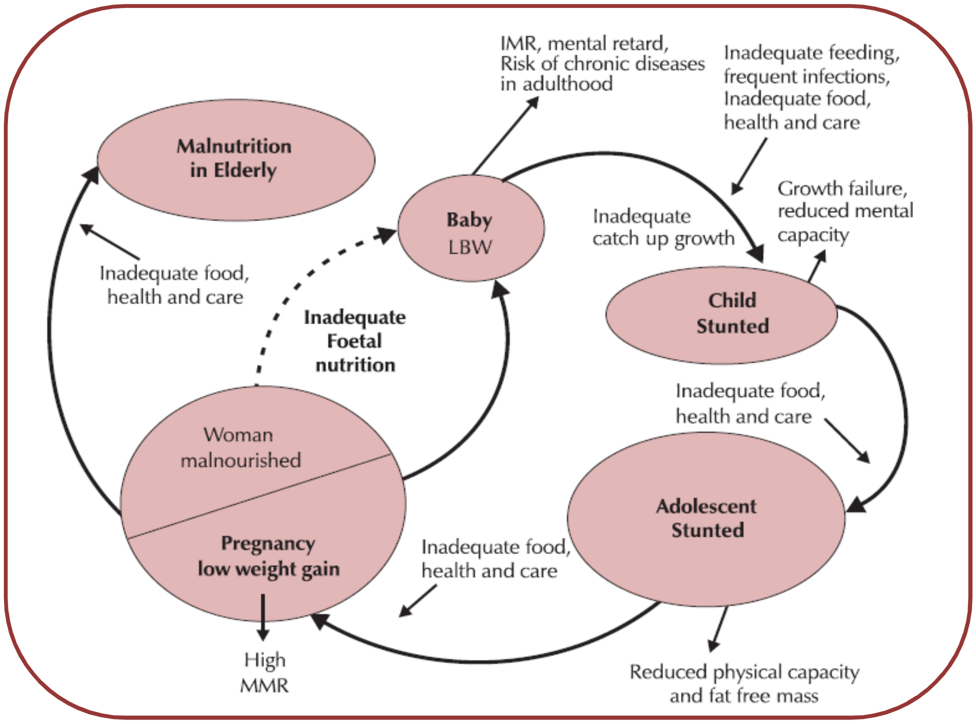
Adolescence is a time of rapid growth, second only to infancy. It is the only period in an individual's life when growth velocity increases. This rapid growth is accompanied by an increase in nutrient demand (Heald and Gong, 1999; Rees et al, 1999). During this period, body proportion, including height and weight measurements change substantially. Adolescent boys generally build more muscle mass, gain weight at a faster rate, have larger skeleton, and deposit less fat than girls. Boys also tend to grow for a longer period of time. For adolescent girls the greatest gain in height and weight normally occurs in the years preceding menarche (Heald and Gong, 1999; Allen and Gillespie, 2001) and the growth spurt continues for two years after menarche (Travis, 2003).

Adolescents and their Nutritional Needs

Adolescents are the future generation of any country and their nutritional needs are critical for the well being of society.

Addressing the nutrition needs of adolescents could be an important step towards breaking the vicious cycle of intergenerational malnutrition and chronic diseases (Figure 2.1.1). Epidemiological evidence from both the developed and developing countries indicates that there is a link between foetal under-nutrition and increased risk of various chronic diseases during adulthood (ACC/SCN, 2000).

Figure 2.1.1: Vicious Cycle of Intergenerational Malnutrition (ACC/SCN, 2000)



Studies conducted in different countries in the region, reveal that nutritional deprivation affects almost all growth parameters and final adult body size resulting in thinness and stunting. However, nutritional status of both boys and girls improves with age, showing that the effect of malnutrition is more pronounced at the time of peak growth (WHO 2006).

Malnutrition during Pre adolescence and Adolescence

Malnutrition in all its forms refers to both underweight and overweight. Underweight is defined by a low weight for age; Stunting refers to low height for age independent of their weight for age; Overweight refers to excess weight for length/ height, measured by BMI for age (SCN, 2006).

Along with the growth spurt of adolescents, nutrition transition due to increased economic development and market globalisation, leading to rapid changes in life style and dietary practices, makes them more vulnerable to dual burden of malnutrition.

In SEAR, a large number of children suffer from chronic malnutrition and anaemia, which adversely impacts their health and development (WHO, 2006). India ranks first with 39% of underweight children globally and a prevalence of 47% of underweight among children (UNICEF, 2006).

Almost one-third of all the children in developing countries are stunted, thereby increasing the risk of illness and death, reduced cognitive ability and school attendance in childhood and lower productivity and lifetime earnings as adults (FAO, 2004).

Vidal et al. (2008) reported that the prevalence of thinness (BMI $\leq$ 18.5) increased with age amongst European (Portugal) adolescents. In girls (10-18 yrs) it increased from 1.5% to 7.6% and in boys the corresponding trends were from 0% to 7.3% for thinness.

In Nigeria, a study among the adolescent girls (Brabin et.al., 1997) showed that under nutrition was more widespread both in urban and rural areas: 10% of rural and 8% of urban adolescent girls were stunted (<2nd percentile, British reference values of 1990) and 16% in rural vs. 12% in urban could be considered thin (<9th percentile BMI).

A study conducted in Iran (Janghorbani et. al.1998) reported that 54.6% and 1.6% of affluent adolescent (13-14 yrs) school children were underweight (BMI 15-19.9) and very underweight (BMI < 15) respectively.

Two surveys conducted, namely National Health Survey of Pakistan (1990-1994) and the Karachi survey(2004-2005), to determine trends in nutritional status of school aged (5 – 14 yrs) children in urban Pakistan, reported that 29.7% v/s 27.3% and 16.7% v/s 14.3% children were underweight (weight-for-age less than- 2 SD) and stunted (height-for-age less than -2 SD) and overweight and obesity was3.0 v/s 5.7 ($p<0.001$) in the two surveys, respectively (Jafar et al. 2008).

In 2004, a study was conducted to assess the nutritional status of 8-12 years old school children from middle to high socio economic status in an urban area of Sri Lanka. The result of the study showed the prevalence of thinness in 24.7% in boys and 23.1% in girls. About 5% and 7% of both boys and girls were stunted and underweight respectively (Wickramasinghe et al, 2004).

Kapil and Shethi (2004), reported that undernutrition amongst school going children 6-9 years of age in National Capital Territory (NCT) of Delhi, 52.5%, 45.1% and 11.1% children were underweight, stunted and wasted respectively. It was observed that 9.7, 15.3, and 2.8% of the children were severely (<-3SD) underweight, stunted and wasted respectively.

However, a study conducted in Kerala on 3886urban adolescents (10-15 years), reported a very low prevalence of underweight among boys - 8%, while none of the girls were found to be underweight.

Coming to the trends in the Eastern Region (West Bengal) of the country as reviewed by Das and Bisai (2009), the prevalence of underweight among middle to high income school going adolescent children (10 – 13 years) was 28.6 % and undernutrition was significantly higher among boys (37.59%) than girls (19.43%).

Another study (De Onis et al. 2001) in the eastern region (Calcutta), assessed the prevalence of undernutrition among affluent adolescent boys (10-16 yrs). The study reported the prevalence of thinness and stunting to be51% (BMI $<5^{th}$ percentile i.e. thinness) and 11% (height for age $<5^{th}$ percentile i.e. Stunting) respectively.

Studies carried out over the years by Munshi (2008), Iyer, Venugopal, and Gandhi (2006) reported the prevalence of under nutrition in young children and adolescents (6-18 years) ranging from 7.3 to 33.8%. Table 2.1.1 shows prevalence of undernutrition in various parts of India.

Though limited data on malnutrition among school age children is available, it is enough to establish the need for strengthening the school health activities and creating awareness among parents about the nutritional requirements of their children.

The highest prevalence rates of childhood obesity have been observed in developed countries (Table 2.1.2), however, its prevalence is increasing in developing countries as well (James, 2004)

There is dearth of published data on growth pattern of Indian affluent adolescent children. In contrast to extensive data available for children from low socio-economic backgrounds, information on nutritional status of children among middle and high-income groups is limited (Toteja et al. 2004).

Table (2.1.3) shows the prevalence of overnutrition among adolescents in India. A study conducted by Kapil et al (2002) in India, showed the prevalence of obesity in affluent adolescent school children was 7.4%, and higher in males than females. The maximum prevalence of obesity was found during the pubertal period (between 10- 12 years).

A recent study on urban adolescents (10-19y) from 10 schools and colleges in Ahmedabad revealed that 20% of the subjects were overweight while none was obese (Prajapati et al, 2011). Parekh et al (2012) stated that there was a significantly higher risk of being overweight and obese in urban than rural areas, after adjusting for age and gender. A local study conducted by Mani et al (2008) on 2374 adolescents from four schools of urban Vadodara in the age group of 12-18 years reported 16% of overweight and obesity along with aberrations in lipid profile.

Anemia and Prevalence among Adolescents

Malnutrition in children often leads to micronutrient deficiency like iron deficiency anemia. Adolescence is a time of increased iron requirement because of the expansion of blood volume and increase in muscle mass. During adolescence, requirement for growing boys also jumps up significantly due to muscle mass development (Mittal, 2007). One-third of the world's population suffers from anemia.

The International Center for Research on Women (ICRW) studies documented high rates of anemia in Nepal (42%), Cameroon (32%) and Guatemala (48%). In India also more than 55% of the adolescents population has been reported to be suffering from Iron Deficiency Anemia (Adolescent Nutrition, 2003).

Table 2.1.1:Prevalence of Undernutrition in various parts of India

Author	Year	Place	Age	Prevalence
Das and Bisai	2008	West Bengal	13- 18	UN: 29%
Unnithan and Syamakumari	2008	Urban Thiruvanathapuram, Kerala	10-15	UW – Boys 8% Girls 0% Severe UW – 0%
Deshmukh et al	2006	Wardha	6-14	UW - 54%
Mukhopadhyay et al	2005	West Bengal	11-14	UN – 37%
Rao et al	2003	Madhya Pradesh	11-19	UN: 62% Stunting – 52% Wasting – 33%
Kapoor and Aneja	1992	Delhi	10-18	Stunting Girls – 36%

UN – Undernutrition   UW - Underweight

Table 2.1.2: Changes in Prevalence of Obesity in children of various countries

Country	Year	Age (years)	Prevalence
USA	Bogalusa 1973- 1994	5-24	Twofold increase in the prevalence of Obesity
	NHANES I 1971-1974	6-19	Relatively Stable
	NHANES II 1976-1980	6-19	Relatively stable
	NHANES III 1988-1994	6-19	Doubled to 11%
	NHANES IV 1999-2000	6-19	Increased by 4%
Japan	Kaotani et al 1974-1993	6-14	Doubled (5% to 10%)
UK	Labstein et al 1984-98	7-11	Changed from 8% to 20%
Spain	Moreno et al 1985/6-1995/6	6-7	Changed from 23% to 35%
France	Rolland-Cachera 1992-1996	5-12	Changed from 10% to 14%
Greece	Krassas 1984 – 2000	6-12	Increased by 7%

Table 2.1.3: Prevalence of Overnutrition in various parts of India

Author / Year	Place	Prevalence
Prajapati et al, 2011	Ahmedabad	OW 20%
Parekh et al, 2012	Surat	OW 26.3% OB 14.6%
Mani et al, 2008	Vadodara	OW 13.4% OB 2.6%
Misra et al, 2006	New Delhi	OW + OB 29%
Kapil et al, 2002	New Delhi	OB 7.4%
Iyer and Parikh, 2002	Vadodara	OW 7% OB 0.7%
De Onis et al, 2001	West Bengal	OW 4.2%
Jayshree S, 2001	Dharwad	Children(OW)16.3% Adolescents(OW)2.8%

OW –Overweight OB - Obesity

Table 2.1.4 shows prevalence of anemia among adolescents. High rates of anemia have been observed in other developing countries, like Indonesia, Brazil, Egypt and India within the range of 24% to 60% (WHO 2003, Anjali 2000, Verster et al 1998, Mashauri et al 1998, Sichieri et al 1996). Prevalence of iron deficiency anemia amongst Turkish adolescents between 11- 18 years, was found to be 4.2% (Mine et al, 2002).

Prevalence of anemia was reported to be around 13% among subjects living in high socio economic areas as compared to 18% amongst the subjects in low socio economic areas of Baghdad (Shatha et al, 2003).

Sen and Kanani, 2006, in their study stated very high prevalence (67%) of anemia in adolescent girls of Vadodara, in India. Though no case of severe anaemia was found; 32.6 % girls were mildly anemic (Hb = 11.0-11.9 g/dL) and 34.7 % girls were moderately anemic (Hb = 7.1-10.9 g/dl).

Consequences of Malnutrition and Anemia

Under or overnutrition during the school years can inhibit a child’s physical and mental development. Stunting is associated with long term consequences, such as impaired intellectual achievement and school performance (Frongilo, 1999; Martorell et al, 1992). Stunting also lead to reduction in adult body size and, subsequently, reduced work capacity and obstetric complications (Martorell et al, 1992).

Thinness in school aged children can result in delayed maturation, deficiencies in muscular strength and work capacity, and reduced bone density later in life. Underweight in young children is highly correlated with an increased risk of morbidity and mortality (WHO, 1995).

Table 2.1.4: Prevalence of Anemia in Adolescents

Author / Year	Year	Place	Prevalence (%)
Sudhagandhi et al	2011	Tamil Nadu	Boys 37.6 Girls 67.8
Kotecha et al	2009	Vadodara	Girls 75
Agarwal et al	2003	Delhi	45
Basu et al	2003	Chandigarh	25.4
Soekarjo et al	2001	Indonesia	Boys 12.1 Girls 25.8
Family Health Bureau	2000	Sri Lanka	Boys 31.6 Girls 40
Ahmed et al	2000	Bangladesh	Girls 27
Mehta et al	1998	Mumbai	64

Undernourished children 10-12 years of age demonstrated the following when compared to normal nourished children (Agarwal et al, 1995):

- A relative deficit of memory quotients assessed by Wechsler memory scale.
- Lower scores for abilities related to personal and current information, orientation, mental control, logical memory, digit span, visual reproduction and associative learning.
- Impaired set formation and flexibility in attention as assessed by the card sorting test.
- Impairment in conditional learning on maze and conditional associative learning tests.

The overweight or obese school child also faces increased risks of high blood pressure, metabolic syndrome, non- insulin dependent diabetes and psychological disorders as an adult (WHO, 2003).

Overweight and obesity during adolescence have some immediate consequence, particularly as they relate to body image and self-esteem, and become a risk factor for overweight and obesity as an adult. One-fourth to half of the individuals who are obese in adolescence remain obese in adulthood (Must 1999, Whitaker et al, 1997)

Overweight and obesity in childhood have significant impact on both physical and psychological health; for example, overweight and obesity are associated with Hyperlipidaemia, hypertension, abnormal glucose tolerance, and infertility. In addition, psychological disorders such as depression occur with increased frequency in obese children (Daniels et al, 2005). It has been reported that overweight children, who had been followed up for40 (Mossberg, 1989) and 55 years (Must et al, 1992), were more likely to have cardiovascular and digestive diseases, and die from any cause as compared with those who were lean.

Data from Bogalusa(USA) show that adolescents with a BMI >75th percentile were more than eight times as likely to have hypertension in adulthood as compared with leaner adolescents (Srinivasan et al., 1996).

Iron deficiency anemia can lead to reduced muscle function and work capacity (Haas and Brownlie,2001; Sharp,2005) and less explorative behaviour in school aged children (Zimmermann et al, 2000). Iron deficiency or iron deficiency anemia is also consistently associated with impaired cognitive function and lower school performance in school-aged children (Granthom and Ani, 2001; Sungthong et al, 2002; Halterman et al, 2001, Otero et al, 2008). Severe anemia negatively impacts work capacity, intellectual performance and cognitive development (De Benoist et al, 2008).

In developing countries, micronutrient deficiencies do not occur in isolation but in combination with malnutrition. This is because the main underlying cause of malnutrition is a poor-quality diet (Ramakrishnan and Huffman, 2008).

Nutritional Needs of Adolescents

Studies conducted in different countries in South East Asia, reveal that nutritional inadequacy affects almost all growth parameters and final adult body size resulting in thinness, underweight, and stunting. However, nutritional status of both boys and girls improved with age, showing that the effect of malnutrition is more pronounced at the time of peak growth (WHO 2006).

Both muscle and fat mass increases during adolescence, girls gain more fat and boys gain more muscle. Therefore, the energy and protein requirements increase considerably during this period. Energy and protein needs correlate more closely with the growth pattern than with the chronological age. The peak in energy and protein requirements coincides with the peak in growth of adolescents. If energy intake is limited, dietary protein may be used to meet energy needs and be unavailable for synthesis of new tissues or tissue repair. This may lead to a reduction of growth rate and muscle mass despite an apparent adequate protein intake (Spear, 2002).

Iron requirements peak during adolescence due to rapid growth with sharp increase in lean body mass, blood volume and red cell mass which increases iron needs for myoglobin in muscles and haemoglobin in blood (Beard,2000).After the growth spurt and sexual maturation, there is a rapid decrease in growth spurt and need for iron(Dallman,1989).Iron requirements in adolescence are greater in developing countries because of infectious diseases and parasitic infections that can cause iron loss, and because of low bio-availability of iron from diets (Brabin andBrabin,1992).

At the peak of the growth spurt, the daily deposition of calcium can be twice that of the average between 10 to 20 years. In fact, 45% of the skeletal mass is added during adolescence (Spear 2002, Sentipal et al, 1991)

Inadequate diets of adolescents

A longitudinal study in New Jersey (Videon and Manning, 2003) showed, that a large percentage of adolescents reported eating less than the recommended amount of vegetables (71%), fruits (55%), and dairy foods (47%). The results showed that almost one in five adolescents skipped breakfast regularly. In Australian adolescents, along with the skipping breakfast inadequate consumption of fruits, vegetables and dairy products was also observed (Nowak and Speare, 1996).

Diet related data was collected from adolescent girls for 3 consecutive days by means of 24 hr dietary recall method along with FFQ in a study among adolescents in Delhi, the findings revealed that the food intake was grossly inadequate with poor intake of vegetables, fruits and milk (Agarwal et al. 2000).Fast foods with soft drinks, burgers and pizzas are more popular among the adolescents, and this can contribute to high intake of calorie and saturated fat and less amount of micronutrients (Srihari et al. 2006; Misra et al. 2006).

Gupta et al (2006) conducted a study on food habits of adolescents and adults between 13- 25 years, in two public schools of New Delhi and found that intake of cereals, pulses, milk and green leafy vegetable was inadequate compared to visible fats, roots and tubers. SHAHN Survey (2002) among Delhi students revealed that 30% of boys and 40% girls skipped one meal everyday and consumed junk food in the last 24 hours preceding the survey and breakfast was the commonest casualty. These foods spoil the appetite for regular meals and are high on calories and low on nutrients.

Consequences of Inappropriate Dietary Intakes during Adolescence

Inappropriate dietary intakes during adolescence has several consequences. **Firstly**, it can potentially retard physical growth, reduce intellectual capacity and delay sexual maturtion, as rapidphysical growth creates an increased demand for energy and nutrients (Story, 1992).

Secondly, inappropriate dietary intakes affect young people's risk for a number of immediate health problems such as iron deficiency, undernutrition, stunting, bone health, eating disorders and obesity (CDC, 1996). It may also affect concentration, learning and school performance in school going adolescents.

Thirdly it also has long term implications, like low bone density and an increased risk of osteoporosis caused due to low calcium intakes during adolescence (CDC, 1996). **Fourthly**, high fat intakeduring adolescence and into adulthood is associated with an increased risk of heart disease (CDC, 1996).

Fifthly, the compromised nutritional status and poor growth in adolescent years affects the reproductive role. Stunting and underweight among girls during adolescence, if continued into adulthood may lead to increased obstetric risk for women in case of an early pregnancy (Gopalan, 1989).undernutrition, iron deficiency, obesity, poor bone health and eating disorders are some of the consequences of inappropriate dietary intakes. In addition, to these concentration, learning and school performance of the school children also gets affected due to inappropriate dietary intakes (CDC, 1996; WHO, 2005).

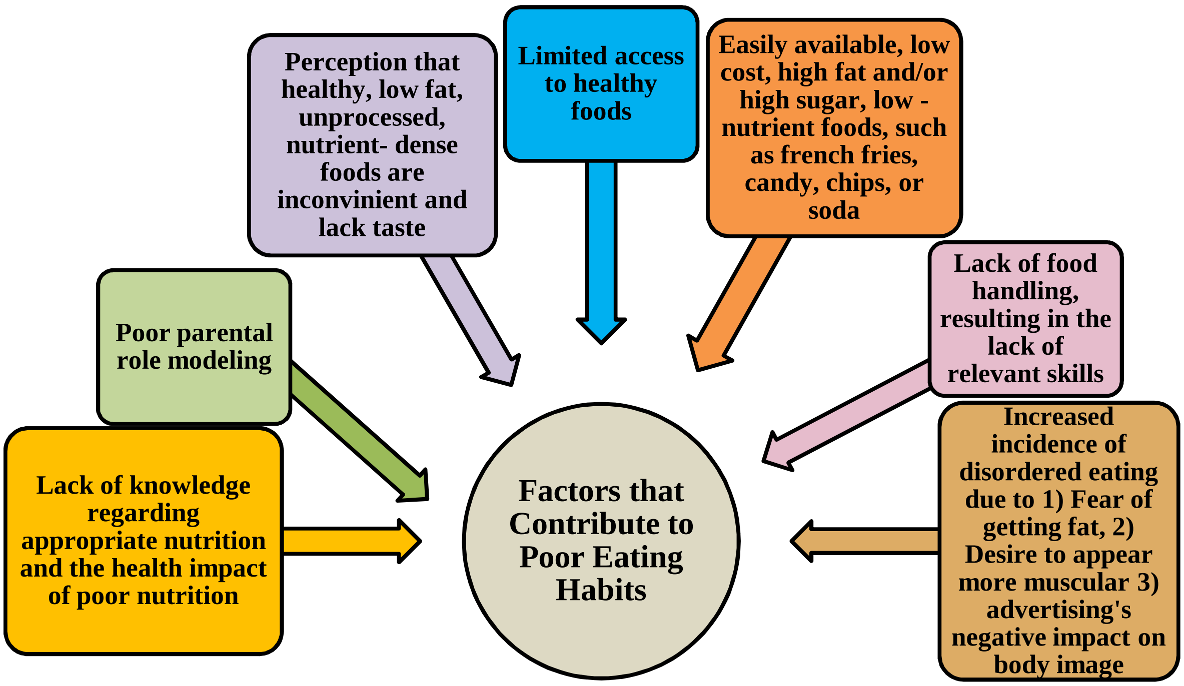
Causes of Poor Eating Habits of Adolescents

Adolescence is seen as a transitional stage for diet and eating patterns. The diets of young people often undergo substantial change as a result of body growth and development and as newly developed independence and diminished family influence gives young people more control over their eating habits. Young people are more likely to suffer from binge eating, restrained eating, fear of fatness and purging than adult population (NHMRC, 1995). California Department of Public Health has listed down factors contributing to poor eating habits among adolescents as shown in Figure 2.1.2.

The experience of childhood is increasingly urban. Over half of the world’s people, including more than a billion children, now live in cities and towns. An increasingly urban world is also contributing to the rising incidence of non-communicable diseases and obesity (WHO 2010).

In developing countries also, especially in cities, some of the following methods are common (Dennison et al., 1995, Spear, 2000) -

Figure 2.1.2: Factors contributing to Poor Eating Habits of Adolescents (CDPH, 2012)



- The meal pattern of adolescents becomes more disorganized, and they tend to miss their meals at home as they get older, often skipping breakfast.
- Some dietary patterns like snacking, usually on energy dense foods, wide use of fast foods that are low in iron, calcium, riboflavin, vitamin A, folic acid and fibres, low consumption of fruits and vegetables and faulty dieting are more common among the adolescents of industrialized countries.
- The search for identity, the struggle for independence and acceptance, and concern about appearance, tend to have a great impact on lifestyle, eating patterns and food intake among adolescents.

Adolescent eating is conceptualized as a function of individual and environmental influences. Four levels of influence are described: Individual or intrapersonal [psychosocial, biological]; social environmental or interpersonal [e.g., family and peer]; physical environmental or community settings [e.g., schools, fast food outlets] and macro system or societal [e.g., mass media, marketing and advertising, social and cultural norms] (Story,2002).

A study on Nepalese school children showed that fast foods (ready to eat snacks, chips etc) were preferred by more than two-third of adolescents. Advertising, probably TV and magazines, influenced preferences in 80% of these Nepalese adolescents (Sharma, 1998).

Although dietary habits of adolescents have changed over a period of time yet little has been documented. It has been recommended that research should be conducted to find new and innovative ways with which the nutritional problems of adolescents can be approached. Qualitative studies should be carried out on adolescent's diet and eating behaviours (WHO, 2006).

Estimation of Dietary Intake

Dietary intake data may be collected at the national, household or the individual level. Food supply data, which are normally collected at national level, are useful for purposes, such as tracking trends in the food supply. Food supply data are not useful for identifying individual or subgroups of the population at risk of inadequate nutrient intakes. Data at these levels allow disaggregated analysis to identify vulnerable groups, in line with human rights focused approach there is a wide array of methods of dietary assessment (Pao and Cypel, 1994).

Dietary intake estimation involves the collection of information of foods eaten by individuals and computation of the energy and nutrient contents of these foods by using values from food composition tables. The choice of method in each case should be guided by the purpose of the monitoring, the need for data accuracy and the availability of the resources. Dietary assessment methods should also be adapted to the target population and be culturally sensitive (Pao and Cypel, 1994).

Individual Surveys

Dietary surveys among individuals provide information that can be used to describe differences in intake of food and nutrients between subgroups. These methods depend on the ability of the subject to provide accurate information. Main methods for assessing present or recent diet include records, 24-hours (or 48-hours) recall, and food frequency questionnaires. In order to quantify the intake of foods, some estimate of the weight of consumed food is required. To convert food intake into nutrient intake, the availability of a food composition database/food table is essential. By combining the information of dietary intake and food composition databases/tables one can determine whether the diet is nutritionally adequate or not (Pao and Cypel, 1994).

Food records (Food Diary)

Food intake is measured at the time of eating. Food intake is quantified by weighing and using household measures (Kim et al, 1984). Household members themselves usually record their food intake, although a fieldworker might keep the record. Prospective methods are associated with the fewest number of errors and are generally thought to be the most accurate methods available. However, the data collection and processing are time consuming and expensive. These methods require a high degree of cooperation from the subjects, which can lead to poor response rates. Also, the need to weigh and record food, or the act of being observed, may alter the intake (Calkins et al, 1986). Table 2.1.5 shows the strengths and weaknesses of food record methods.

24-hour recall

This widely used method involves asking subjects to recall and describe all intakes of foods and drinks in the previous 24 hours. Large national dietary intake surveys, diet health studies as well smaller studies use this method to estimate dietary intakes by individuals. This method usually requires a trained fieldworker / dietician / nutritionist to interview subjects, to assess portion weights and make appropriate enquiries about types of food and drinks consumed and possible omissions of, for example, snacks (Pao and Cypel, 1994).

It is a much used dietary assessment method because it is simple, quick and inexpensive, but it is prone to reporting errors, including biased or inaccurate recalls of food intake and portion sizes. It requires a good methodological knowledge in order to transform the interview data of the dietary intake to nutrients. Applied once, it yields no information on day-to-day variation on food or nutrient intake. Table 2.1.6 shows the strengths and weaknesses of 24- hour recall.-

Food frequency questionnaires (FFQ)

As noted by Sampson (1985), usual dietary intake over an extended period is more pertinent in assessing the relationship of nutrition to chronic disease than is diet on a recent specific day or week.

These questionnaires provide information about how often certain foods or foods from given food groups, were eaten during a time interval in the past, usually day, by either the household or an individual. The questionnaire can be self-administered or be administered through a short personal interview. The food list may range from a few questions to capture intake of selected foods and nutrients, to a comprehensive list to assess the total diet. The frequency responses can be open-ended or multiple choice, ranging from several times per day to number of times per year, depending on the type of food (Axelson and Csernus, 1983).

FFQ can be qualitative with no information on portion size (Axelson and Csernus, 1983), semi-qualitative with standardized portion size estimates (as predetermined by the interview team), or

Table 2.1.5: Strengths and Weaknesses of food record methods (Pao and Cypel, 1994)

Strengths	Weaknesses
1. Respondent does not rely on memory`	1. Respondents must be literate
2. Time period is defined	2. Respondents must be highly cooperative
3. Portions can be measured to increase accuracy	3. Food consumed away from home may be less accurately reported
4. Omission of foods is minimal	4. Habitual eating pattern may be changed or influenced by the recording process
5. For elderly people, records may be more accurate than recalls	5. Requirement for literate respondents may introduce bias as a result of overrepresentation of more highly educated individuals
6. Food intakes are quantified so nutrient contents can be calculated	6. Record keeping increases respondent burden
7. Multiple days may yield a measure of usual intake of a group	7. Increased respondent burden may adversely affect response rates
8. Multiple days provide reliable information about less frequently eaten foods	8. Self- administered records require more callbacks and editing than interviewer administered records
9. Two or more days provide data on intra and inter-individual variation in dietary intakes	9. One day records provide an inadequate indication of usual intake for groups or individuals
10. One day records kept intermittently over the year may provide an estimate of usual intake by an individual	10. Validity of records may decrease as number of days increases

Table 2.1.6: Strengths and Weaknesses of 24 hour Dietary Recall method (Pao and Cypel, 1994)

Strengths	Weaknesses
1. Respondent burden is small	1. Respondent recall depends on memory.
2. Administration time is short	2. Portion size is difficult to estimate accurately.
3. Reliance on memory is minimal	3. Intakes tend to be underreported compared with other methods.
4. Time period is defined	4. Dietary adequacy of an individual's intake cannot be assessed from one day's intake.
5. Food intake can be quantified	5. Trained interviewers are required.
6. Procedure does not alter individuals habitual dietary patterns	6. One-day intakes do not represent usual intake for groups or individuals.
7. Interviewer administration allows probing for omitted foods on incomplete information and fewer callbacks	
8. Response rates are relatively high	
9. A single contact is required	
10. Procedure is often used to evaluate dietary intakes of large groups	
11. Two or more days provide data on intra and inter individual variation in dietary intakes.	
12. Multiple days are necessary to provide reliable data on less frequently eaten foods.	
13. Multiple days may yield a measure of usual intake.	
14. Repeated recalls over a year may provide an estimate of usual intake by an individual.	

quantitative where the respondents estimate portion size (Flegal et al, 1988). When portion sizes are described by the respondents themselves, different measurement aids have been used, such as photographs, drawings or household measures. Portion size information is necessary to quantitatively assess the intake of foods and nutrients. Standard portion sizes greatly simplify the administration and processing of the FFQ.

FFQs have been widely used in large epidemiological studies or to calculate a dietary diversity score which is simply the sum of the number of food groups consumed during the reference period. The larger this number, the more diversified the food intake is. Either the total score or the frequency of intake of foods by standardized food groups can be reported, or both. There is some evidence that the household dietary diversity score is positively correlated with household dietary energy availability, and that the individual dietary diversity score is positively correlated with the adequacy of micronutrient intake of the individual (Pao and Cypel, 1994). Table 2.1.7 shows the strength and weaknesses of food frequency questionnaire.

Validity of Dietary Assessment Methods

Each dietary assessment method has its advantages and limitations, and none of them measure food intake without errors. Independent tests of validity are therefore necessary to understand the relationship between what the method actually assesses and what it intends to measure. This is important for the interpretation of the assessment results. The general model of validation for dietary assessment methods is to compare one method (test method) with another, which is considered more accurate (reference method).

The purpose of validation studies is to identify errors in collected dietary data and to assess their potential impact on assessment findings. A questionnaire's instruction, contents and wording, the skill of the interviewer, and the research setting may all introduce response errors, including inaccurate recalls by the respondent (intentional or unintentional) of foods eaten, of frequency of consumption, and of portion size. Errors can also arise from coding errors and errors in food composition tables. Errors and day-to-day variability in dietary assessments will affect the validity and reproducibility of the measurements (Pao and Cypel, 1994).

Table 2.1.7: Strengths and Weaknesses of Food Frequency methods (Pao and Cypel, 1994)

Strengths	Weaknesses
1. An indication of usual dietary intake may be obtained.	1. Memory of food patterns in the past is required.
2. Highly trained interviewers are not required.	2. Recall period may be imprecise.
3. Method can be interviewer administered or self-administered.	3. Quantification of food intake may be imprecise because of poor estimation of recall of portions or use of standard sizes.
4. Administration may be simple.	4. Respondent burden is governed by number and complexity of foods listed and quantification procedure
5. Customary eating patterns are not affected.	5. Recall of past diets may be biased by current diets
6. Individuals may be ranked or classified by food intake.	6. Heterogeneity of populations influences the reliability of the method
7. Response rates are high.	7. Suitability is questionable for certain segments of the population, such as individuals consuming a typical diets or foods not on the list
8. Respondent burden is usually light.	8. Intakes tend to be over-estimated compared with some other methods
9. Relationship between diet and disease may be examined in epidemiological studies.	9. Validation of the method is difficult

Validity measures the degree to which a method measures what it supposed to measure. Validity is associated with systematic (i.e. non-random) measurement errors, or the tendency of a measurement to produce an average over- or underestimation of what the method is intended to measure, due to systematic response bias. Reproducibility is associated with random error. Random error can be due to random bias in reporting by the same individual on different days. Random errors may cancel each other out, but will increase the variance of estimated mean intake and reduce statistical power (Pao and Cypel, 1994).

High reproducibility of a method does not imply high validity, but a method with lower producibility will also have low validity.

Validity and Reliability of Food Records

Krall and Dwyer (1987) assessed the validity of food diaries by comparing diary reports with weighted portions of foods served in a metabolic research unit and found that ~9% of all food items were omitted. However another study found that the burden of having to weigh foods eaten resulted in a 13% decrease in caloric intakes, on average, compared with intakes from weekly diary records (Kim et al, 1984).

Reliability test by Todd et al (1983) found no significant differences in mean energy or protein intakes derived from data collected by two methods- weighted intakes recorded on tape and estimated food records. Similarly in another study, four sets of 7-d records kept by 173 female nurses during 1 year showed little tendency to change over time period (Willet et al, 1985).

Validity and Reliability of 24 hour Food Recall

Validity of 24 hour dietary recall has been assessed in numerous studies. These studies provide evidence that reporting errors occur, but indications of their direction and extent are not consistent from study to study or from nutrient to nutrient. Investigators found that recalled intakes compared with weighted intakes tended to be overestimated when intakes were low and underestimated when intakes were high (Madden et al, 1976; Linusson et al, 1974). Mean nutrient intakes estimated from 24 hour recalls and 3 day food records were highly correlated and not statistically different (as measured by t test) in a study of vegetarians and non vegetarians (Calkins et al, 1984).

Reliability of 24 hour dietary recall was examined by examining intra and inter-individual variation. Sources of error that affect reliability of this survey method have been pointed out by these researchers (Beaton et al, 1979). The first source of error is inaccuracy in the measurement of dietary intake for a particular day that is due to error in estimating quantities of food eaten or the omission (or inclusion) of food items. A second source of error arises because of a small sample of daily observations is used to estimate the usual or typical intake.

Validity and Reliability of Food Frequency Questionnaire (FFQ)

Willett et al (1985) compared results obtained with a 61 item FFQ with data from four 1 week food records for calorie adjusted intakes of nine nutrients. They concluded that the food frequency method was useful in measuring intake for a variety of nutrients. Pietinen et al (1988) found some nutrient values derived from a 44 item FFQ and from 12 diet records for 2-day periods were generally comparable.

Reliability of food frequency method was assessed in terms of the correlation between two administrations of the instrument. Axelson and Csernus (1983) found a significant correlation of 0.89 between two tests, 6 months apart involving 15 university students. Pietenin et al (1988) demonstrated good reproducibility (correlations of 0.46 – 0.86) for nutrients in three administrations of a food frequency questionnaire to a fairly homogenous group.

Dietary diversity has been used as a simple measure of diet quality, for which there is no standard definition. More comprehensive diet quality indexes have been developed for monitoring the population’s adherence to national dietary guidelines.

Healthy Eating Index (HEI)

U.S. Department of Agriculture has developed a healthy Eating Index (HEI), to find out how well the Americans follow the recommended dietary guidelines. The overall index has a total possible score ranging from zero to 100. Each of the 10 dietary components has a scoring range of zero to 10. Individuals with an intake at the recommended level received a maximum score of 10 points. A score of zero was assigned when no foods in a particular group were eaten. Intermediate scores were calculated proportionately. The healthy eating index was applied to the 1989 and 1990 USDA data from the continuing Survey of Food Intake by individuals.

Food Group Components of the Healthy Eating Index (1989)

The healthy eating index examines dietary intake in relation to the five major groups in the Food guide pyramid. A range of servings is shown for the grain group, vegetable group, fruit group, milk group and meat group. The number of recommended servings depends upon an individual's caloric requirements. Recommended servings for calorie levels of 1,600, 2,200 and 2,800 are presented in Table 2.1.8.

For each of the five food group components of the index, individuals who consumed the recommended levels of the servings received a maximum score of 10. A score of zero was assigned to any food group where no items from the category were consumed. Intermediate scores were calculated proportionately to the number of servings consumed. For example, if the recommended level of serving was eight and an individual consumed four servings, the component score for the individual was 5 points. A score of 7.5 points was assigned if six servings were eaten.

In developing the index, serving recommendations from food guide pyramid were interpolated to individuals with other food energy requirements. For example, food energy RDAs for children between 1 and 3 years of age are less than 1,600 kilocalories. The recommended number of servings were retained at the minimum serving level for these children, but the serving size was scaled down to be proportionate with their energy requirements. This approach was consistent with the guidance contained with the food guide pyramid. In contrast adult males between the ages of 15 and 50 years have food energy RDAs slightly greater than 2,800 kilocalories. Instead of slightly increasing the serving sizes, it was decided that food portions for these individuals would be truncated at the maximum levels recommended in the food guide pyramid (Table 2.1.9). It should be noted, based on the preliminary analysis, none of the results from the index were shown to be significantly affected even if a slightly larger serving size were used (USDA, 1992).

Table2.1.9 shows the serving recommendations (USDA) for various age/gender categories.

Table 2.1.8: Recommended Numbers of servings Per Day at Energy Levels Discussed in the Food Guide Pyramid Bulletin (USDA, 1992)

	Number of servings				
Kilocalories	**Grains**	**Vegetables**	**Fruits**	**Milk**	**Meat**
1600	6	3	2	2	2
2200	9	4	3	2	2.4
2800	11	5	4	2	2.8

Table 2.1.9: Recommended Numbers of servings Per Day for Age/Gender Categories at Energy Levels Discussed in the Food Guide Pyramid Bulletin (USDA, 1992)

Age/ Gender Category	Kilocalories	Grains	Vegetables	Fruits	Milk	Meat
Children1-3	**1300**	**6**[a]	**3**[a]	**2**[a]	**2**[a]	2[a]
	1600	**6**	**3**	**2**	**2**	2
Children 4-6	**1800**	**7**	**3.3**	**2.3**	**2**	2.1
Females 51+	**1900**	**7.4**	**3.5**	**2.5**	**2**	2.2
Children 7-10	**2000**	**7.8**	**3.7**	**2.7**	**2**	2.3
Females 11-50	**2200**	**9**	**4**	**3**	**2**[b]	2.4
Males 51+	**2300**	**9.1**	**4.2**	**3.2**	**2**	2.5
Males 11-14	**2500**	**9.9**	**4.5**	**3.5**	**3**	2.6
	2800	**11**	**5**	**4**	**2**	2.8
Males 19-50	**2900**	**11**	**5**	**4**	**2**[b]	2.8
Males 15-18	3000	11	5	4	2	2.8

[a] Portion sizes are reduced for children age 1-3
[b] is 3 for persons age 11 to 24.
RDA levels included in the Food Guide Pyramid Bulletin

Other components of the Healthy Eating Index:

Total Fat

Fat intakes less than and equal to 30 percent of the total calories were assigned a score of 10 points. The scored declined to zero when the proportion of fat to total calories reached 45 percent. Intakes between 30 percent and 45 percent were scored proportionately.

Saturated fat

A score of 10 points was assigned to saturated fat intakes at less than 10 percent of total calories. Zero points were assigned when the saturated fat intake reached a level of 15 percent of the total calories. Scores between the two cutoff values were calculated proportionately.

Cholesterol

A maximum point value for cholesterol was assigned when intake was at the level of 300 milligrams or less. Zero points were assigned when intake reached a level of 450 milligrams or more. Values between the two cutoff points were scored proportionately.

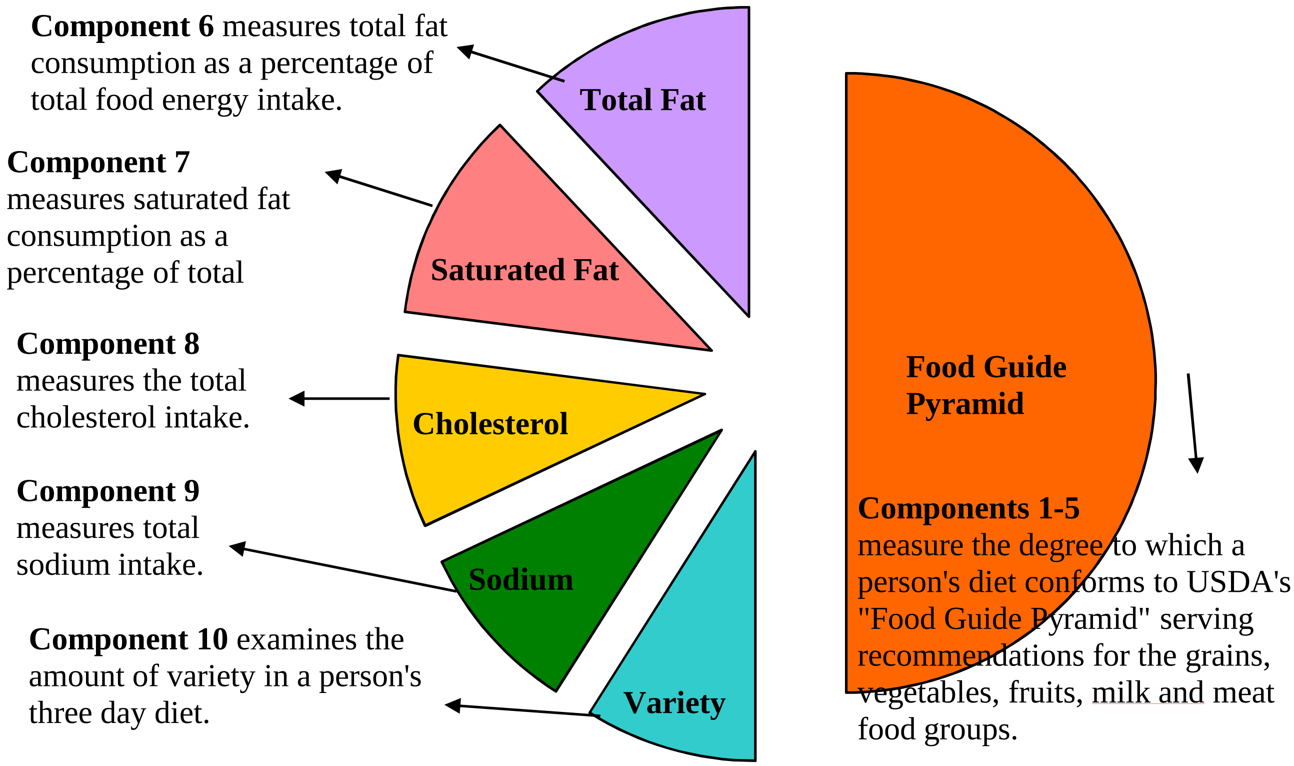
Sodium

A maximum score for sodium was assigned at an intake level of 2,400 milligrams or less. Zero points were assigned at a level of 4,800 milligrams or more. Scores between the two levels of intake were scored proportionately.

Variety

Dietary variety was assessed by totaling the number of "different" foods eaten by an individual in amounts sufficient to contribute at least one-half of a serving in a food group. Similar foods were grouped together and counted only once in measuring variety. Food mixtures were broken down into their component ingredients and assigned to the relevant food groups. Index scores for variety were calculated in a manner analogous to the method used for the other index components. Cutoff scores for variety were defined based on 3 days of recorded data. A maximum score was given if 16 or more different food items were consumed over a 3 day period. A score of zero was given if six or less different items were eaten. When based on 1 day of reported data, the cutoff scores for variety were reduced by a factor of two. Intermediate intakes were calculated proportionately. Figure 2.1.4 shows the components of HEI- 89.

Figure 2.1.3: Food group components of the Healthy Eating Index (1989)



Advantages of the HEI (1989)

- **The index provides a standard for assessing overall dietary quality**

  Based on the most current scientific information available, including the Dietary Guidelines for Americans published by USDA and DHHS, and the Food Guide Pyramid, the Index was developed to provide a single summary measure of dietary quality. The Index was based on the five major food groups from the Food Guide Pyramid and the Dietary Guidelines. The Index is a practical standard for assessing dietary quality. The Index correlates well with other conventional measures of diet quality.

  Comparisons with RDA levels confirm a positive correlation between the Index and individual nutrient intake levels. Higher Index scores are associated with improved nutrient intakes.

- **The Healthy Eating Index reflects the complexity of dietary patterns**

  Ten dietary components comprise the Index. All 10 components contribute evenly to the overall Index score. Doing well on one component does not ensure a high score on the overall Index. Overall dietary quality is reflected in the total Index score and is not determined based on any individual component score. Using one component score, such as percent of calories from fat, as an indicator of dietary quality can result in misclassifications.

- **The results of the index are useful in targeting nutrition education and health promotion activities.**

  Results of the Index provide insights into the types of dietary changes needed to improve eating patterns. The Schools Meals Initiative for Healthy Children ensures that the nutrition standards for school meals meet the dietary guidelines. This is complemented by Team Nutrition (USDA) which focuses on empowering children to make food choices for healthful diets. Targeted strategies for nutrition promotion are also needed. Results of CSFI – HEI research suggest that individuals from low-income households and less-educated people are more likely to score lower on the Healthy Eating Index. Therefore, USDA tries to integrate nutrition into all of the food assistance programs.

- **The Healthy Eating Index is a single summary measure of diet quality that can be used to monitor changes in food consumption patterns over time.**

  The Index was applied to the 1989 and 1990 CSFII (Continuing Survey of Food Intake I) data to evaluate the overall quality of American diets. Average scores for the overall Index for both years were approximately 64 percent, a score judged as “Needs Improvement." HEI values were similar for both years, indicating that dietary intake does not vary greatly from year to year. USDA uses the Index as one method to monitor changes in dietary patterns in the United States population over time. The Index is periodically published.

- **The index could provide the basis for development of a variety of additional tools.**

  The Healthy Eating Index provided one instrument that has been useful in monitoring trends in U.S. consumption patterns over time. This provided policy makers with the capability of revising and fine-tuning specific programs in a more timely manner to be responsive to the changing nutrition profile of the population. Based on HEI, the IHEI (Interactive HEI) was developed by USDA to increase awareness of diet quality and to promote healthful eating habits. The IHEI provides an immediate feedback via scoring options and targeted nutrition education messages. It was the intention of the USDA Center for Nutrition Policy and Promotion to begin developing a consumer-oriented, self-assessment guide following the public release of the Healthy Eating Index (Hiza and Gerrior, 2002).

The Index scores for weighted 1989 and 1990 CSFII data were stratified by selected indicators. The mean Index scores for the five indicators analyzed were sex, age, head of household, educational level, and income.

Results showed that females had a higher average Index than males. People in the younger and older age groups had a higher Index than those in the middle age groups. Individuals living in either joint family or female-headed house- holds had a higher Index than individuals living in male-headed households. Index scores generally increased with increasing levels of education. Average Index scores were highest for individuals having 4 or more years of college education. The Index generally responded more to increases in education than increases in income. People who had a better Healthy Eating Index score were more likely to have a better nutrient intake (USDA 1995).

Trends in the Healthy Eating Index 1990, 1996 and 2000

The diets of Americans have slightly, but significantly, improved since 1989 to 1999-2000, but have not changed since 1996. In all three periods, the average HEI score indicated that the diets of most Americans needed improvement. In 1989, the HEI score for all people 2 years old and over was 61.5, compared with 63.8 in 1996 and 1999-2000 a 4 percent increase (Basiotis et al 2002). Scores increased for all HEI components from 1989 to 1996, except for milk, meat, and sodium. Scores improved the most for the saturated fat and variety components of the Index (Bowman et al 1998).

A comprehensive model was developed to measure the extent that nutrition knowledge and diet-health awareness, among other factors, influence an individual's HEI. This was the first study that rigorously attempted to examine variation in the index across population groups by controlling for personal and household characteristics and nutrition information levels, as well as test for the endogeneity of nutrition information. Results indicated that one's level of nutrition information has an important influence on one's HEI and that nutrition information and the HEI are simultaneously determined. Other factors explaining variations in HEI's across individuals were income and education levels, race, ethnicity, and age. Evidence supports the hypothesis that higher education promotes more healthful food choices through better acquisition and use of health information (Variyam et al 1998).

HEI scores generally increased as the level of income and education increased. People with household income 50 percent of the poverty threshold or below had an average HEI score of 60. By comparison, people with household income over three times the poverty threshold had an average HEI score of 65. Whites had a higher average HEI score than African Americans had for 1994-96 (64 vs. 59). By region, people who lived in the Northeast had the highest HEI score, an average of 65 for 1994-96, and those who lived in the South had the lowest score, an average of 62. People who lived in an urban area (a Metropolitan Statistical Area in or outside a central city) also had a slightly higher HEI score. This could be because average income, which is an indicator of one's ability to purchase food, is lower in nonurban than in urban areas (Bowman et al 1998).

School-age children did better in meeting the recommendations for dairy, grains, meats, and variety than for fruits and vegetables. They scored 3.7 on fruits and 4.4 on vegetables, compared with 7.2 on dairy and 7 on grains. Children of different income levels scored similarly their consumption of food components, with the exception of the meat component. Meat-component scores for the lowest income children were higher than the meat-component scores for other children. Looking at the four nutrient components, children scored best in cholesterol (8.3 HEI score) and worst in saturated fat (5.5 HEI score). The only significant difference was found in total-fat consumption, with the higher income children scoring higher than the lowest income children (6.9 vs. 6.5) (Biing- Lin 2005).

Both HEI and Youth Healthy Eating Index (YHEI) scores from a food frequency questionnaire were calculated by Feskanich et al (1996). Girls (n=8,807) and boys (n=7,645) 9 to 14 years of age who resided across the United States were the participants. Mean HEI and YHEI scores were calculated by sex and age, and associations with age, body mass index, activity, inactivity, energy intake, and several nutrients were assessed with Pearson correlations. Linear regression was used to examine the contributions of the individual HEI and YHEI components toward the total scores. Results showed that HEI score were highly correlated with total energy intake (r =0.67), indicating a strong association with quantity of food consumption. In contrast, the YHEI was not strongly correlated with energy intake (r =0.12) but was inversely associated with time spent in inactive pursuits (r =-0.27). The HEI component for variety in food selection accounted for 60% of the variation in the total score and several HEI components were highly correlated with each other, particularly those for total and saturated fat (r =0.78).

Weinstein et al 1995, assessed the HEI, as a measure of dietary status through its correlation with nutritional biomarkers and to identify those biomarkers most associated with diet quality and healthful food intake patterns in >17 years adults. Results showed that HEI score were positively correlated with serum (r=0.25) and red blood cell (r=0.27) folate, serum vitamins C (r=0.30) and E (r=0.21), and all serum carotenoids except lycopene (r=0.17 to 0.27).

Guo et al (2004) found that a low HEI score was associated with overweight and obesity. There was a graded increase in the odds ratio of obesity across the HEI category after adjusting for age, gender, race/ethnicity, physical activity, smoking, alcohol use, income, and education.

McCullough et al (2000) stated that the HEI-f (HEI based on food frequency questionnaire) was weakly inversely associated with risk of major chronic disease (comparing highest with lowest quintile of the HEI-f, relative risk (RR = 0.89; $P < 0.001$). The HEI-f was associated with moderately lower risk of cardiovascular disease (RR = 0.72; $P < 0.001$) but was not associated with lower cancer risk in men.

Development of the HEI – 2005

Center for Nutrition policy and Promotion (CNPP) convened an interagency Working Group to begin the process of revising the HEI. The working group reviewed the original HEI and its uses.

The Working Group decided to base the revised index on the food patterns found in USDA's food guidance system, now called MyPyramid, which translates key recommendations in the 2005 Dietary Guidelines for Americans into specific, quantified dietary recommendations (Britten, Marcoe, Yamini, & Davis, 2006). Collectively, these documents specify amounts to consume from each of the major food groups and from oils and provide recommended limits for sodium, saturated fat, and discretionary calories. In addition, they advise that at least half of grain intake should be whole grain, recommend specific amounts of several vegetable subgroups, and suggest that less than half the fruit consumed should be juice. A subgroup of the HEI Working Group further developed the components of the index, constructed the scoring and weighting protocol, developed the evaluation plan, conducted the analyses, presented findings to the full Working Group, and held briefings for wider audiences.

The components of the HEI-2005 represent all of the major food groups found in MyPyramid-Total Fruit; Total Vegetables; Total Grains; Milk, which includes soy beverages; and Meat and Beans, which includes meat, poultry, fish, eggs, soybean products other than beverages, nuts, seeds, and legumes.

Additional components represent Whole Fruit (i.e., forms other than juice); Dark Green and Orange Vegetables and Legumes; Whole Grains (which must include the entire grain kernel, bran, germ, and endosperm); Oils (non-hydrogenated vegetable oils and oils in fish, nuts, and seeds); Saturated Fat; Sodium; and Calories from Solid Fat, Alcohol, and Added Sugar (SoFAAS). Whole Fruit was added because the 2005 Dietary Guidelines suggest limiting juice to less than half of total fruit intake. A new component was added for Dark Green and Orange Vegetables and Legumes because those are the three subgroups of vegetables for which current intake is furthest from recommended levels. The Whole Grains component was added because the2005 Dietary Guidelines specify that at least half of grain intake should be whole grain. New components were added for Oils to reflect the recommendations for oil found in MyPyramid and for Calories from SoFAAS, which serves as a proxy for discretionary calories and is described further below. Like the original, the HEI-2005 also includes components for Saturated Fat and Sodium (Table 2.1.10).

The components do not necessarily directly represent foods as eaten. For example, all components include foods that are ingredients in mixed foods. Whole Grains include only the whole-grain portions of foods that contain both whole and refined grains. Only the lowest fat portions of milk and meat products are included in the Milk and Meat components, respectively. The fatty portions of milk and meat products count as Solid Fat; whereas, the fatty portions of fish, nuts, and seeds count as Oils as do non-hydrogenated vegetable oils. Alcohol includes beer, wine, and distilled spirits consumed as beverages, but not as ingredients in mixed dishes.

Standards for the development of HEI – 2005

Density Standards

HEI – 2005 was chosen to represent intakes of foods and nutrients on a density basis, that is, as amounts per 1,000calories of intake. In MyPyramid, the recommendations for the amounts of food groups, oils, and discretionary calories were expressed in terms of absolute amounts that vary according to energy level (Britten et al., 2006). Thus, if an HEI standard were an absolute amount, that amount would also have to vary according to energy level. However, on a density basis, many of the recommendations are similar across energy levels (Table ()). For saturated fat and sodium, a density standard was easy to derive. The saturated fat recommendation in the Dietary Guidelines is the same for all individuals and is given on a density basis—less than 10 percent of energy. The sodium recommendation in the Dietary Guidelines is derived from the Dietary Reference Intakes(DRI) (Institute of Medicine [IOM], Food and Nutrition Board, 2004)

Table 2.1.10: Original Healthy Eating Index (HEI) and Healthy Eating Index-2005 (HEI-2005) components and standards for scoring

Component	Score 0	5	8	10	20
Original HEI					
Total Fruit	0			2-4 servings (approx. 1-2 cups[1])	
Total Vegetables	0			3-5 servings (approx. 1.5-2.5 cups[1])	
Total Grains	0			6-11 servings (approx. 6-11 oz eq[1])	
Milk	0			2-3 servings (2-3 cups[2])	
Meat (and Bens)	0			2-3 servings (approx. 5.5-7.0 oz eq[1])	
Sodium	≥4.8			≤ 2.4g	
Saturated Fat	≥ 15			≤ 10% energy	
Total Fat	≥ 45			≤ 30% energy	
Cholesterol	≥ 450			≤ 300 mg	
Variety	≤ 6			≥ 16 different foods in 3 days[3]	
HEI-2005[4]					
Total Fruit	0	≥ 0.8 cup eq/1000 kcal			
Whole Fruit	0	≥ 0.4 cup eq/1000 kcal			
Total Vegetables	0	≥ 1.1 cup eq/1000 kcal			
Dark G & O veg & legumes*	0	≥ 0.4 cup eq/1000 kcal			
Total Grains	0	≥ 3.0 ozeq/1000 kcal			
Whole Grains	0	≥ 1.5 ozeq/1000 kcal			
Milk	0			≥ 1.3 cup eq/1000 kcal	
Meat and Beans	0			≥ 2.5 ozeq/1000 kcal	
Oils	0			≥ 12 g/1000 kcal	
Saturated Fat	≥ 15		10	≤ 7% energy	
Sodium	≥ 2		1.1	≤ 0.7g/1000 kcal	
Calories from SoFAAS[5]	≥ 50				≤20%energy

[1]According to gender and age.
[2]According to age.
[3]In 1994-96 and 1999-2000, 8 or more different foods in 1 day.
[4]See Appendix 1: Foods included in components of the Healthy Eating Index-2005.
[5]Solid Fat, Alcohol, and Added Sugar.
* G – Green & O-Orange

and, although the sodium DRIs are stated as absolute amounts that varies by age group, they were derived by using a density approach. That is, recommendations for younger and older persons were set at proportionately lower levels because their average energy intakes are lower. Each of these recommendations was sufficiently similar across levels of energy intake, when expressed on a density basis, thus a scoring system based on densities was the best approach.

Density standards have the advantage of being independent of an individual's energy requirement, which is difficult to measure precisely. Consequently, this obviates the need to assign individuals to one of the 12 calorie levels found in MyPyramid (Britten et al., 2006). In effect, the density approach to setting standards allows the assessment of the quality of the mix of foods consumed, rather than the absolute amounts of foods consumed.

Food-group-based Components

For the nutrient adequacy components (food groups and oils), focus was on the 1,200- to 2,400-calorie patterns because they were used to ensure nutrient adequacy when MyPyramid was constructed. Among these, the lowest amount per 1,000 calories (that is, the least restrictive or easiest to achieve) was selected as the standard for the maximum score for each of these components. For the discretionary calories component, the least restrictive amount across all the patterns was selected; but in this case, that was the greatest amount on a per calorie basis.

For Fruits, Vegetables, Grains, Whole Grains, Milk, Meat and Beans, and Oils, the standards are the lowest amounts recommended in the patterns, expressed on a per 1,000 calorie basis. For Whole Fruit, the standard is simply half the standard for Total Fruit because the 2005 Dietary Guidelines for Americans suggest that the majority of fruit intake should be whole fruit rather than fruit juice. For Dark Green Vegetables, Orange Vegetables, and Legumes, the recommendations found in MyPyramid are expressed on a weekly basis. To develop the standards, it was converted to a daily basis. The standard is the sum of the daily recommendations for those three subgroups of vegetables, expressed on a per 1,000 calorie basis. Any combination of them counts toward meeting the vegetable subgroup standard with one exception. As is the case in MyPyramid, legumes are counted as vegetables only after the Meat and Beans standard has been met (USDA, CNPP, 2005).

Saturated Fat and Sodium Components

In the Dietary Guidelines, the recommendation for saturated fat is not expressed as a single value, but rather as less than 10 percent of energy intake. This does not clearly indicate which, if any, value less than 10 percent might be the optimal level, so other guidance was looked for where to set the standard. The Dietary Guidelines for Americans 2005 highlights two exemplary food guides as being consistent with its guidance, MyPyramid, developed by CNPP, and the Dietary Approaches to Stop Hypertension (DASH) Eating Plan, developed by the National Heart, Lung, and Blood Institute (NHLBI). The examples of these guides in this report have saturated fat levels of 7 to 8 percent of energy (HHS & USDA, 2005). Both the Dietary Guidelines Advisory Committee and the Food and Nutrition Board of the Institute of Medicine (IOM) have recommended that saturated fat consumption be as low as possible, suggesting that lower is better (Dietary Guidelines Advisory Committee, 2004) (IOM, Food and Nutrition Board, 2005). The DASH plan aims for 7 percent, and the 2006 American Heart Association (AHA) guidelines call for 7 percent or less (Lichtenstein et al., 2006). Based on these sources, 7 percent of calories were chosen as the standard for the maximum score of 10 for the Saturated Fat component. It was decided to recognize the Dietary Guideline by assigning a score of 8 to the level of 10 percent of calories.

The Dietary Guidelines recommendation for sodium for most individuals is “less than 2,300 mg/day,” but for individuals with hypertension, blacks, and middle-aged and older adults, the recommendation is “no more than 1,500 mg/day.” These values represent the Upper Limit (UL) and Adequate Intake (AI) levels, respectively, set by the Food and Nutrition Board (IOM, Food and Nutrition Board, 2004). In light of these recommendations, 1,500 mg was chosen as the basis for the maximum score of 10 and 2,300 mg as the basis for the relatively good score of 8 for the Sodium component (Table 2.1.11).

To express the sodium standard as a density, the same approach used to set the DRIs (Dietary Reference Intakes) for older adults and children was used. The DRI panel divided the DRIs that was set for young and middle-aged adults by the estimated median energy intake for that age group (2,150 calories per day) and then used those same densities (mg of sodium per calorie) to set the DRIs for younger and older individuals. The density standards were calculated the same way. The highest possible score of 10 is assigned to diets that have less than 700 mg of sodium per 1,000 calories (1,500 mg sodium (AI)/2,150 calories), and a score of 8 is assigned to 1,100 mg of sodium per 1,000 calories (2,300 mg sodium (UL)/2,150 calories).

Discretionary Calories Component

The 2005 Dietary Guidelines Advisory Committee presented the concept of "discretionary calories," defined as the "difference between total energy requirements and the energy consumed to meet recommended nutrient intakes" (Dietary Guidelines Advisory Committee, 2004). The Dietary Guidelines further explain, "At each calorie level, individuals who eat nutrient-dense foods may be able to meet their recommended nutrient intake without consuming their full calorie allotment. The remaining calories—the discretionary calorie allowance—allow individuals flexibility to consume some foods and beverages that may contain added fats, added sugars, and alcohol" (HHS & USDA, 2005). Added fats or sugars per se are not directly limited. Rather, the allowance is a defined number of discretionary calories, and these calories may come from any mix of solid fat, added sugar, alcohol, or additional amounts of nutrient-rich foods beyond the recommended levels.

Nonetheless, the population generally consumes more calories from solid fat, added sugar, and/or alcohol than the allowance permits (Basiotis, Guenther, Lino, & Britten, 2006). In effect, these calories displace those needed to obtain the recommended amounts of the food groups and oils. Because of this imbalance, it was decided by the Technical committee to develop a component that captured specifically the Calories from Solid Fat, Alcohol, and Added Sugar (SoFAAS). This approach is consistent with the objective to capture the mix of foods eaten (Guenther, 2007).

Calories from SoFAAS is not intended to be a measure of solid fat, alcohol, and/or added sugar per se, but rather a measure of the calories in the diet that are obtained from dietary constituents other than nutrient-dense foods. The standard for the maximum score is the least restrictive, or easiest to achieve, of all the discretionary calorie allowances found in MyPyramid, 20 percent of calories.

Table 2.1.11: Recommended amounts of Food Groups, expressed per 1,000 Kcal, and discretionary calorie allowances, expressed as a percentage of total calories, found in MyPyramid

Food Group	Calorie Level											
	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200
Fruits (cup eq/1000Kcal)	1	0.8	1.1	0.9	0.8	1.0	0.9	0.8	0.8	0.9	0.8	0.8
Vegetables (cup eq/1000Kcal)	1	1.3	1.1	1.2	1.4	1.3	1.4	1.3	1.4	1.3	1.3	1.3
Dark Green Vegetables	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1
Orange Vegetables	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Legumes	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Starch Vegetables	0.2	0.3	0.3	0.2	0.2	0.2	0.4	0.4	0.4	0.4	0.4	0.4
Other Vegetables	0.6	0.5	0.6	0.5	0.5	0.5	0.5	0.4	0.5	0.4	0.5	0.5
Grains	3	3.3	3.6	3.1	3.3	3	3.2	3.3	3.5	3.6	3.3	3.1
Whole Grains (ozeq/1000Kcal)	1.5	1.7	1.8	1.9	1.7	1.5	1.6	1.7	1.7	1.8	1.7	1.6
Other Grains	1.5	1.7	1.8	1.3	1.7	1.5	1.6	1.7	1.7	1.8	1.7	1.6
Milk (cup eq/1000Kcal)	2	1.7	1.4	1.9	1.7	1.5	1.4	1.3	1.2	1.1	1	0.9
Meat and Beans (ozeq/1000Kcal)	2	2.5	2.9	3.1	2.8	2.8	2.7	2.7	2.5	2.5	2.3	2.2
Oils (g/1000Kcal)	15	14.0	12	14	13	14	13	13	13	13	15	16
Discretionary Calories (%)	16.5	14.3	12.2	8.3	10.8	13.4	13.2	15.1	15.8	15.2	17.1	20.3

Application of HEI - 2005

The HEI-2005 can be used for a variety of purposes, including population monitoring; nutrition education; evaluation of nutrition interventions; epidemiologic research; economic research; and other types of research. USDA's major application is to monitor the diet quality of the U.S. general and low-income populations (USDA, 2006). CNPP plans to include the HEI-2005 in a future update of MyPyramid Tracker, the Center's dietary assessment and nutrition education tool (USDA, CNPP, 2006).

Other measures of interest may be used in conjunction with the HEI-2005 for research purposes. Anthropometric measures, such as BMI and waist circumference, can be used to evaluate the appropriateness of the level of longer term energy intake and to provide a more complete picture of nutritional status.

The HEI-2005 is a measure of diet quality as described by the key diet-related recommendations of the 2005 Dietary Guidelines. It has a variety of potential uses such as firstly, monitoring the diet quality of the US population and subpopulations, secondly, evaluation of interventions, and research. (Guenther et al 2005).

Validation of HEI - 2005

The psychometric analysis confirmed that the individual components of the HEI provide additional insight to that of the total score. The HEI-2005 has several types of construct validity, as demonstrated by the ability to distinguish between groups with known differences in diet quality, the independence of diet quality and diet quantity as measured by energy intake, and the ability to detect differences among individuals as shown by the distributions of scores. Most important, the HEI-2005 has content validity, including face validity. It is a valid reflection of the key recommendations of the 2005 Dietary Guidelines for Americans (Guenther et al, 2007).

USDA report 2008 on Healthy Eating Index (HEI- 2005)

The quality of diets consumed by Low-Income and Higher Income Americans in 2003-04 was determined using the Healthy Eating Index-2005. The HEI-2005 assesses the quality of the relative proportions of foods consumed rather than the quantity of foods consumed (Guenther, Reedy & Krebs-Smith 2008; Guenther, Reedy, Krebs-Smith & Reeve 2008).

The HEI-2005 scores were estimated using 1 day of dietary intake data provided by 8,272 participants in NHANES 2003-04. Dietary components assessed by the HEI-2005 were estimated using the population ratio method; that is, the total amount of each dietary component consumed by the population was divided by the population's total energy intake and the HEI scores were then calculated.

Differences in estimated scores between income levels were considered to be significant when the probability that the true scores were actually the same for both groups was less than .05. Results showed that in 2003-04, HEI-2005 component scores for the U.S. population ages 2 and older were below the maximum possible score for every component, except for Total Grains and Meat and Beans. The total score was 57.5 out of a possible 100. Scores were particularly low (less than half the maximum score) for Dark Green and Orange Vegetables and Legumes, Whole Grains, Sodium, and Calories from SoFAAS.

Although the average HEI-2005 total scores of the low-income and higher income populations were not significantly different (56.5 and 57.8, respectively), important differences were found in several component scores. People in low-income families had significantly lower component scores for Total Vegetables, Dark Green and Orange Vegetables and Legumes, and Whole Grains than did higher income families. People in low-income families, compared with their counterparts, however, had a significantly higher component score for Sodium, which indicates lower intakes of sodium and, thus, greater compliance with the dietary guideline. There also was no significant difference in total HEI-2005 scores for children ages 2 to 18 years old by family income level (56.4 for children in low-income families; 55.4 for children in higher income families).

The only significant difference between children in the two groups was that low-income children had a higher score for Total Vegetables. This may reflect low-income children's greater participation in the National School Lunch Program. However, for both income groups of children, HEI-2005 component scores were below their maximums for all components except Total Grains.

The Youth HEI (YHEI) is an adaptation of the HEI for use with children and adolescents. Hurley, et al 2008 compared HEI and YHEI scores among adolescents at risk for chronic disease and compared associations between the scores and health indicators. This cross-sectional study included 2 low-income, urban African American adolescent samples. HEI and YHEI scores were calculated from a FFQ and compared with BMI, body composition, and micronutrient, energy, and dietary intakes. Result showed that YHEI scores were lower than HEI scores across adolescent samples.

Females had higher HEI scores than males(P< 0.05), but there was no gender difference in YHEI scores.HEI and YHEI scores were associated with higher micronutrient and total energy intakes. In conclusion, many adolescents were consuming diets that placed them at risk for developing chronic disease. Although both the HEI and YHEI are useful in assessing diet quality, the HEI was inversely associated with body composition, a predictor of chronic disease, and accounts for gender differences in the Dietary Guidelines, whereas the YHEI discounts nutrient-poor, energy-dense foods.

Based on Spearman's correlation, significant inverse associations were found between dairy, cholesterol, fruit, grain, sodium, variety, and total HEI's with DFS and DFT for permanent teeth. In contrast, a significant positive association was found between meat HEI and both DFS and DFT for permanent teeth in children between 2 to <17 years of age (Nunn et al, 2004).

Nunn et al (2009) reported that children (2-5 years) with the best dietary practices (uppermost tertile of the HEI) were 44% less likely to exhibit severe early childhood caries (ECC) compared with children with the worst dietary practices (lowest tertile of the HEI).

After examining the diets of children aged 2 to 17 years, by analyzing their Healthy Eating Index-2005 (HEI-2005) component and total scores, as estimated from the National Health and Nutrition Examination Survey, 2003-04 (NHANES), Fungwe et al (2009)concluded that the diets of children ages 2 to17 years need improvement. Particularly, children need to increase the consumption of whole fruit, whole grains, and dark green and orange vegetables and legumes. On the other hand, children need to decrease their consumption of saturated fat, sodium, and extra calories from solid fats and added sugars.

Food Behaviour Checklist

Blackburn et al (2006) developed a short food behavior checklist (FBC) to evaluate the impact of nutrition education on fruit and vegetable intake among ethnically diverse women in the Food Stamp Nutrition Education Program (FSNEP)and the Expanded Food and Nutrition Education Program (EFNEP). To validate the FBC, interviewers collected three 24-hour dietary recalls as well as responses to 11 FBC behavioral questions about fruits and vegetables from 100 English-speaking, low-income women at baseline. A randomly selected subgroup (n = 59)provided a blood sample for analysis of total serum carotenoids at baseline and follow-up. After 6 hours of nutrition education, the treatment group reported significant improvements in three of the seven FBC questions related to fruit and vegetable intake, while no significant changes occurred in the control group. All seven FBC questions were significantly correlated with total serum carotenoids.

This short, culturally neutral FBC is a valid and reliable indicator of fruit and vegetable consumption. Compared with the 24-hour dietary recall, it is also less time-consuming to administer code and analyze, with a reduced respondent burden.

Strategies to Combat Malnutrition

Undernutrition, vitamin and mineral deficiencies, obesity and diet-related chronic diseases exist side by side in many countries. Whether food supplies are scarce or abundant, it is essential that people know how best to make use of their resources to ensure nutritional wellbeing. To be adequately nourished, individuals need to have access to sufficient and good quality food and they need an understanding of what constitutes a good diet for health, as well as the skills and motivation to make good food choices (FAO, 2010).

The causes of malnutrition are predictable and preventable and can be addressed through affordable means. Practical measures that address the immediate causes of child under nutrition include a health, hygiene, nutrition education and promotion, fortification, micronutrient supplementation, parasite control measures; and situation-specific household food security interventions (Stephenson et al 1993).

Fungwe et al (2009) stated that nutrition education efforts for children should focus on increase in the consumption of whole fruit, whole grains, and dark green and orange vegetables and legumes, preferably starting at a young age.

Nutrition education is a key element to promoting lifelong healthy eating and exercise behaviours and should start from the early stages of life. Food habits are complex in nature and multiple conditioning factors interact in their development. Young children do not choose what they eat, but their parents decide and prepare the food for them. As children grow and start school, teachers, peers and other people at school, together with the media and social leaders, become more important. Progressively children become more independent and start making their own food choices. The peer group is very important for adolescents and has a major influence in developing both food habits and lifestyles. Community trials suggest that nutrition education is an accessible effective tool in health promotion programmes with a focus on the development of healthy eating practices (Rodrigo and Aranceta, 2001).

Nutrition Communication – History and Definition

Nutrition communication evolved from primarily face to face instruction in non-formal health clinic settings in the 1950s and 60s, to a social marketing approach in the 1970s that incorporate market research methodologies and mass media. In the 1980s, new research techniques were incorporated that have proved to be especially useful in identifying behaviours susceptible to modification and in formulating specific messages (Lediard, 1991).

Defining Nutrition Communication

Gillespie (1981) defined nutrition communication as persuasive communication that attempts to change nutrition knowledge, attitudes and practices. According to Gussow and Contento (1984) nutrition communication is a process which, through education, communication and education related research, tries to promote the nutritional well being of people.

General Considerations for Nutrition Education

Nutrition education involves teaching the client about the importance of nutrition, providing educational materials that reinforce messages about healthy eating, teaching adolescents skills essential for making dietary change, and providing information on how to sustain behavior change. Information gathered during nutrition screening or assessment will provide the necessary information on which nutrition issues need to be addressed during nutrition education and counseling sessions. Prior to beginning the education process, it is helpful to assess what the adolescent already knows about nutrition, how ready they are to adopt new eating behaviors, and if there are any language or learning barriers that may need to be addressed in order to facilitate the nutrition education process (Stang and Story, 2005).

Stages of Change

There are eight stages in behaviour change (Figure 2.1.5) that will help the people change from being an uninformed person to becoming someone who may even be able to teach or influence others about their behaviour (AED, 2005)

Step 1 Pre-awareness: At this stage people are not even aware of the changes that they need to make. In order to help them become a person who has awareness, information is needed.

Nutrition education would stop at this stage without making sure that the person being educated has changed their action, practice or behaviour.

Stage 2 Awareness: At this stage, the person has heard about the need to change their behaviour, but needs extra help and persuasion to start to actually bring about the changes.

Stage 3 Contemplation: This person is contemplating (thinking) about changing their behaviour, but needs more information and continued support and persuasion about the advantages and disadvantages of changing their behaviour.

Stage 4 Intention: At this stage the person has understood the advantages and disadvantages of changing their behaviour but is not sure how they can bring about the new behaviour for themselves. The person needs encouragement to overcome obstacles of how to do the new behaviour.

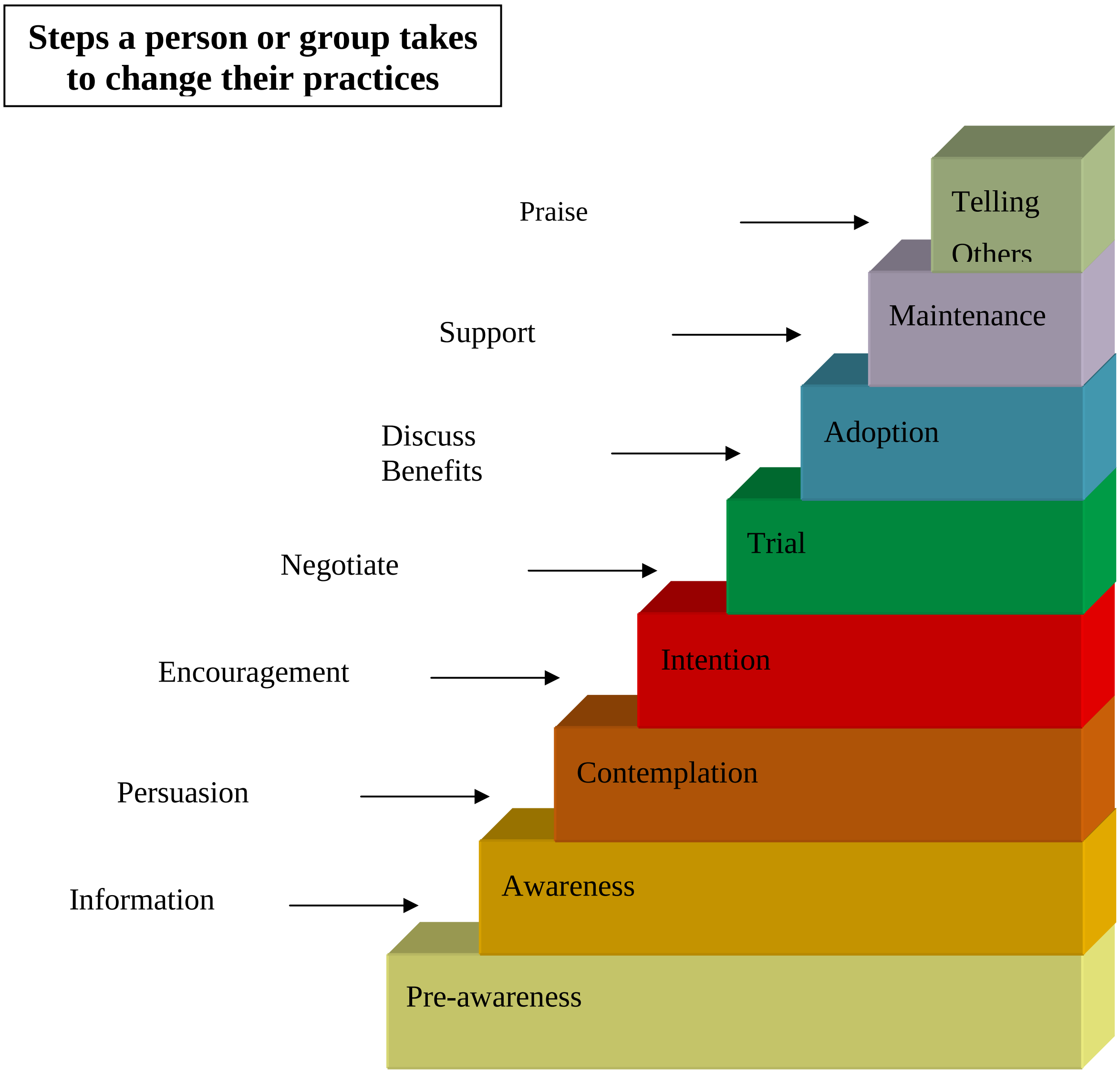
Stage 5 Trial: The person has tried the behaviour or action required, but has faced difficulties. At this time the skills of negotiating the different options will be important.

Stage 6 Adoption: At this stage, the person is demonstrating the new behaviour. They now need discussion to reinforce their behaviour and sustain the change they have made. They can be helped by encouraging and praising for the change in behaviour.

Stage 7 Maintenance: The person's behaviour by this stage has changed and they understand the benefits of the change. Now they just need support for overcoming any difficulties faced.

Stage 8 Telling others: The person has done the behaviour for a considerable length of time, it has become routine behaviour and now leads to the person convincing others about the benefits of their health related behaviour. What the person needs at this stage is praise.

Figure 2.1.4: Stages of Behaviour Change. (Linkages Project/ AED Ethiopia, 2005)



Role of Nutrition Communication Program in Behaviour Change

Singhal et al (2009) reported significant improvements in the several domains of knowledge among the intervention group in a study on adolescents in North India. In the intervention group, significantly lower proportion of children consumed aerated drinks (15.1%; $P<0.001$) and energy-dense unhealthy foods (8.9%; $P=0.03$), whereas significantly higher proportion brought tiffin (packed lunch) to school (14.9%; $P=0.004$) and brought a fruit in their tiffin (30.7%; $P<0.001$) as compared with the control group. Thus, a multi-component model of nutrition and lifestyle education was successful in improving the nutrition-related knowledge, eating habits and lifestyle practices of the Asian Indian adolescents.

Significant increase in the daily intake of all nutrients especially vitamins and minerals was observed by Kaur et al (2007) among adolescents in Punjab, after a series of lecture cum discussions in classrooms, using charts leaflets, poster and demonstrations.

Iyer and Venugopal (2004) reported improvements in physical activity levels, knowledge scores, dietary intake pattern and breakfast consumption among adolescents in urban Vadodara after imparting nutrition health education through posters and leaflets.

Improved nutrition knowledge and increased intake of nutrient rich food items was reported after a nutrition health education programme using interpersonal communication, posters and information booklets among adolescents girls in Hyderabad and Secunderabad (Saibaba et al, 2002).

Ramanna et al (2001) found improvement in nutrition knowledge of adolescent girls as well as behavioral pattern envisaged by better cooking methods after imparting knowledge through interpersonal communication, posters, information booklets, innovative games and nutritious meals.

Agarwal and Kanani (1998) reported a commendable impact of NCP on not only knowledge gain and behavioral changes, but on improvement in the nutritional status as well. Primary school age provides an ideal time to prepare children to assume primary responsibility for their own and their community’s health. School children in India are most often first generation learners and can be trained to be ‘change agents’ of the community (Vir, 1987).

In India, a health education program was carried out in Tamil Nadu covering 10,000 children and 120 school teachers in 1984. The program was found effective in imparting a basic understanding to school children regarding health and practices conducive to health and in inculcating healthy habits in children. Many parents reported that their children showed significant improvement in their personal hygiene and in their concern for a healthy environment (Saminathan, 1986).

Integrating Qualitative and Quantitative Research for Nutrition Communication Programs

Both qualitative and quantitative tools are valuable for designing, implementing and evaluating nutrition communication programs. Pope and Mays (1995) have stated that the goal of qualitative research is the development of concepts, which help us to understand social phenomena in a natural setting, giving due emphasis to the meaning, experiences and views of all participants. Further, they also pointed out the many ways in which qualitative methods compliment quantitative ones:

- Firstly qualitative work can be conducted as an essential preliminary to quantitative research, e.g. to understand the most comprehensible terms or word to use in a subsequent survey questionnaire.
- Qualitative techniques such as observations, in depth interviews and focus group discussions can be used to provide a description and an understanding of a situation or behavior.
- Qualitative methods can be used to supplement quantitative data. This can be part of the validation process, as in triangulation where three or more methods are used and the researcher examines a particular phenomenon at several a different levels and from different perspective. (Pope and Mays 1995).

Steckler et al (1992), elaborating on the strengths of the two approaches, have said that if quantitative methods produce factual reliable outcome data that are usually generalizable to some larger population, on the other hand the qualitative methods generate rich, detailed, valid process data that usually leave the study participants', perspectives intact.

For formulating comprehensive nutrition communication programs, quantitative methods give nutrition indicators related data (anthropometric indicators, biochemical parameters), which reflect the magnitude of the problem and etiological factors. In contrast, qualitative methods give insight into perceptions and reasons underlying dietary and health related behaviors in the target groups.

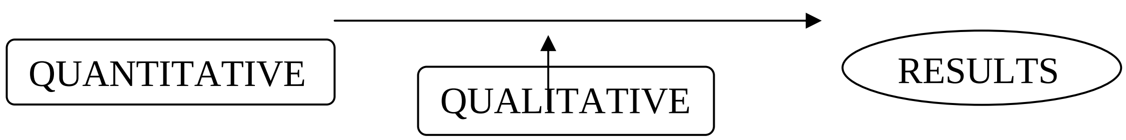
Scrimshaw (1990) stated that a combination of quantitative and qualitative research techniques is needed in order to understand the process being studied in culturally appropriate terms, to obtain accurate information on behavior and to interpret the meaning behind the behaviors.

Figure (2.1.6) illustrates four ways that qualitative and quantitative methods might be integrated in health education research and program evaluations. In the first possible approach, (Model 1) qualitative methods are used initially to help develop quantitative measures. In the second approach (model 2), a study or evaluation is pre dominantly quantitative and qualitative methods help explain numerical data. The third approach is the reverse model 2 in that quantitative results are used to help interpret predominantly qualitative findings. The final possible approach (model 4) is when the two methodologies are used equally and parallel and are used to cross – validate the study findings. That is, researchers and evaluators analyze the results of each method separately and then decide if the results from each method suggest the same conclusions. If they do, then the researchers', confidence in the results and conclusion is strengthened. If they do not, then the researcher tries to understand why, and tries to determine which results are the most valid (Steckler et al 1992).

Figure 2.1.5: Four possible ways that qualitative and quantitative methods might be integrated (Steckler et al, 1992)

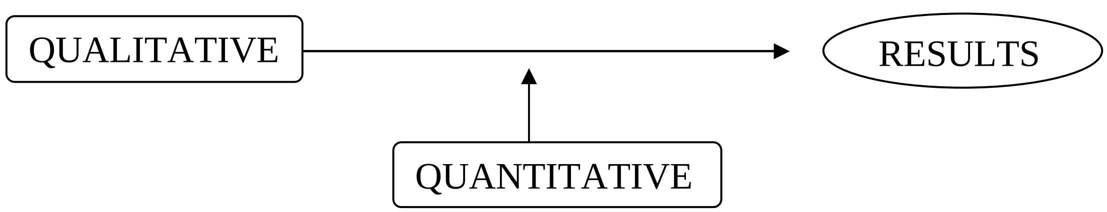
Model 1
Qualitative methods are used to help Quantitative measures and instruments

Model 2
Qualitative methods are used to help explain the Quantitative findings



Model 3

Quantitative methods are used to embellish a primarily Qualitative study



Model 4
Qualitative and Quantitative methods are used equally and parallelly

Very few studies have been carried out using both qualitative and quantitative methods together. However, some of the studies which have tried to integrate these two methods have shown that in nutrition communication research, qualitative anthropological research tools could be effectively integrated with quantitative epidemiological method (Kanani and Zararia, 1996; Agarwal and Kanani, 1998).

Justification of the Present Study

The above review amply reveals that there is a wide nutrition gap among adolescents. The dual burden of malnutrition needs to be tackled with great care so that both can be reduced. There is an urgent need for tools like HEI and FBC to be developed for adolescents in Indian context, as dietary patterns in India and USA differ a lot. Till date no such tool has been developed in India. An evaluation of dietary quality and practices would reveal the shortfalls in the healthy behaviour of adolescents.

A very few studies have been conducted in India to see the effect of a Nutrition Communication Programme on the dietary practices of adolescents. Adolescence is a stage where behavioural changes are very important as they go a long way in life. NCP are critically important for school children in view of their enhanced nutritional needs, their vulnerability to malnutrition, their central role in ensuring their own nutritional well being and that of their families in future as adults.

Thus, the present study was designed to develop a Healthy Eating Index and a Food Behaviour Checklist for adolescents in Indian context and to implement a Nutrition Communication Program to improve their dietary practices in selected schools of urban Vadodara.

METHODS AND MATERIALS

The present study was undertaken to assess the nutritional status of school going adolescent children (10-17y) in 3 schools of urban Vadodara also to develop a Healthy Eating Index and Food Behaviour Checklist for them along with assessing the impact of a Nutrition Communication Programme to improve their dietary practices.

Study Design

Sample selection

Three schools of urban Vadodara were purposively selected for the present study. Consent was obtained from the Directors, Principals of all the schools and parents of the subjects. All the students from standard V to XI standard were enrolled for the study. In all there were 1041 subjects from the 3 schools comprising 613 boys and 428 girls. Anthropometric data was obtained on all the subjects. Students of std X, XI and XII were later dropped from the study due to excess load of studies.

Socio- economic status and food and physical activity behavior data was collected for 631 subjects studying in std. V to std. IX.

Two schools (comprising 478 subjects) were randomly selected and randomly allocated as Experimental group and Control Group. In all there were 212 subjects in the experimental group, comprising 134 boys and 78 girls, whereas the control group included a total of 266 subjects, including 166 boys and 100 girls. Information was collected on anthropometric measurements, Socio-Economic status, Knowledge attitudes and practices, Cognitive development, Food behaviour, Morbidity Profile and Diet history of all the subjects from Std. V to Std. IX.

Due to a dropout of 38 students, by the end of the intervention period there were 191 subjects in Experimental group and 245 subjects in Control group. Post intervention data was collected on 436 subjects.

Biochemical estimations were carried out for a subsample of 61subjects.

Inclusion exclusion criteria

All the subjects studying in Std. V to std. XII were enrolled for the anthropometric data collection. Due to excess workload of studies standards X, XI and XII were excluded from the study thereafter. Data was collected for all the students except those who were transferred to other schools. Students admitted in the school after the initiation of the study were not included in the study but were allowed to attend the Nutrition Communication Programme sessions.

Ethical committee approval

Consent of the ethical committee was taken prior to conducting the study. A written consent was taken from the parents of the subjects. Consent was also taken from the Teachers, Principals and Directors of the schools. Biochemical tests were performed only on the students whose parents consented for the same. (Ethical clearance no. F.C.Sc/ FND/ME/90).

The study was conducted in five phases:

Phase I: Assessment of the Nutritional status of the subjects

Phase II: Healthy Eating Index and Food Behaviour Checklist – Development, assessment for subjects and validation

Phase III: Development of Nutrition Communication programme and its implementation

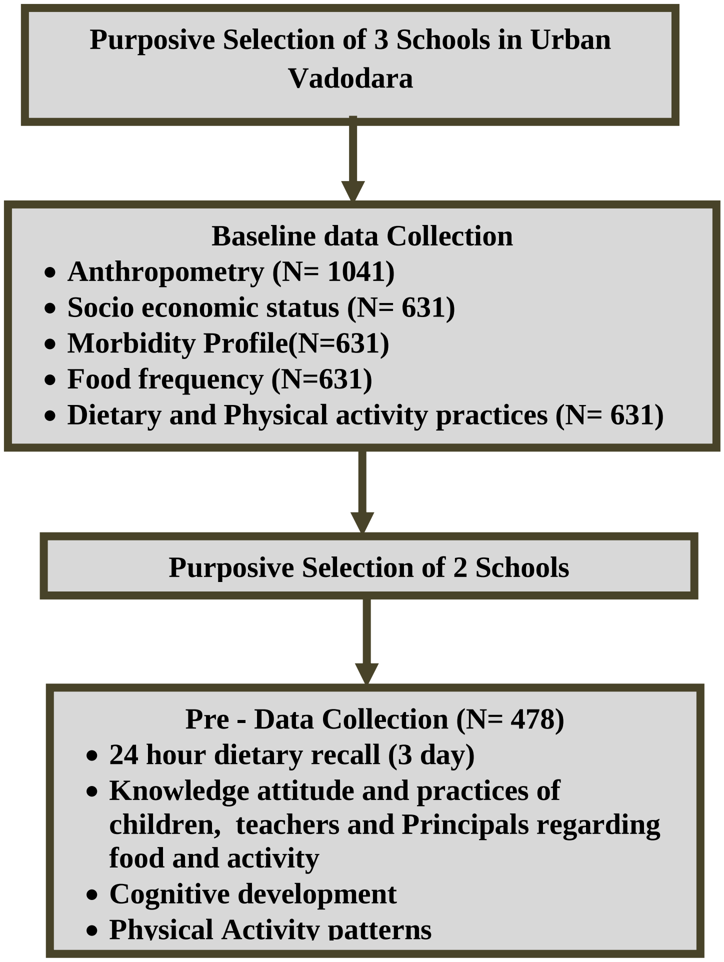
Phase IV: Assessing the impact of Nutrition Communication on the Subjects

Phase V: Data analysis, report writing and dissemination of results

Phase I: Assessment of the Nutritional status of the subjects

The main purpose of this phase was to assess the magnitude of malnutrition among school going adolescents. Figure 3.1.1 shows the experimental design of Phase I.

Figure 3.1. 1: Formative research – Enrollment profile of the study subjects



The major variables/parameters included in formative research were

Socio Economic Status

Information on the socio economic profile of the subjects was collected using a pre-tested structured questionnaire. Information regarding date of birth, sex, religion, family composition, parent's education and occupation, per capita income, dietary habits etc. was collected (Appendix- I)

Anthropometric measurements

To assess the prevalence of malnutrition, indices namely, BMI for age, Height for age (WHO 2007 standard) and Weight for age (CDC, 2000) were calculated.

Weight **(Principle)**

Weight is a key anthropometric measurement of body mass. It is a sensitive indicator of malnutrition and can be useful for diagnosing acute protein calorie malnutrition in children of all age groups.

Procedure

Weight measurement was done for all the subjects using a calibrated digital weighing scale. It is portable and can be conveniently used in the field. The subject was asked to stand erect on the scale without touching anything, with no heavy clothing or foot wear and looking straight ahead. It was ensured that the children were not wearing any heavy jewellery while taking the weight. The weight was then taken twice in order to ensure accuracy.

Height **(Principle)**

Height is a linear measurement made up of the sum of four components: legs, pelvis, spine, and skull (Jelliffe, 1966). A given deficit in height may represent a period of growth failure in a person's life.

Procedure

Height measurements of all the subjects were taken using a flexible, non-stretchable fiberglass tape. The tape was fixed vertically on a smooth wall of the school perpendicular to the ground, ensuring that the floor was smooth. The subject was asked to stand erect with the shoulders, hips and heels touching the wall and with no footwear, heels together and looking straight ahead. The head was held comfortably erect, arms hanging loosely by the sides. A thin smooth scale was held on top of the subject's head in the center, crushing the hair at the right angles to the tape and the height of the subject was read from the lower edge of the ruler to the nearest 0.1 cm.

Body Mass Index (BMI)

BMI or the Quetelet's index was calculated using the following formula

$$BMI = \frac{\text{Weight (Kg.)}}{\text{Height (m)}^2}$$

Waist and Hip measurements

Each child stood with weight evenly balanced on both the feet and the feet about 25-30 cms apart. The child was asked to breathe normally and at the time of making measurement was asked to breathe out gently. This prevented them from contracting their muscles or from holding their breath.

Waist

The measurements were obtained by measuring the distance around the smallest area below the rib cage and above the umbilicus (belly button) with the use of a non stretchable tape measure. The reading was taken to the nearest 0.1 cm.

Hip

The measurement was done at the point yielding the maximum circumference over the buttocks with the tape held horizontally.The reading was taken to the nearest 0.1 cm.

Waist Hip Ratio (WHR)

WHR was calculated using the given formula

$$WHR = \frac{\text{Waist (cm)}}{\text{Hip (cm)}}$$

Mid Upper Arm Circumference (MUAC)

Mid upper arm circumference was measured halfway between the acromian process of the scapula and the olecranon process of the ulna. A non stretchable fiber glass tape was used for the measurements which were taken to the nearest 0.1 cm.

Morbidity Profile

Information pertaining to coughs and colds, diarrhea, fever, malaria etc was elicited using a morbidity checklist using a reference period of 15 days (Appendix II). Haemoglobin levels are known to be sensitive to certain infections and thus morbidity data was collected for correct interpretation of the change in the levels of these parameters.

The terms for infectious episodic morbidities were explained if not understood as follows

Diarrhea	Defined as passing of more than three loose stools in a day.
Cold	Characterized by running nose or blocked nose.
Cough	Based on subject's history.
Malaria	Characterized by the high fever, shivering and pain in the abdomen and as diagnosed by the physician.

Biochemical Indicators

Haemoglobin and Red cell morphology was assessed to map the prevalence and severity of anaemia along with the red cell morphology.

Haemoglobin Levels

The most feasible quantitative measure for iron deficiency anaemia is estimation of haemoglobin levels (Gillespie 1998). Cyanmethaemoglobin method, the international reference method to determine the total haemoglobin concentration in blood, is considered as a Gold standard for assessing haemoglobin levels.

Principle

On treating haemoglobin with Drabkin's reagent, haemoglobin present in blood reacts with potassium ferricyanide forms methaemoglobin and this compound is reduced by potassium cyanide to form cyanmethaemoglobin a rust colored compound, which is estimated spectrophotometrically at 540 nm.

Standardization

Cyanmethaemoglobin reference standard was obtained from "Qualigens Pvt Ltd". Spectrophotometer was calibrated using this method.

Procedure

Suitable aliquot of 0.75 ml, 2.25 ml and 3.75 ml haemoglobin standard was taken in separate test tubes and the volume was made up to 5ml by Drabkin's solution. In one test tube undiluted aliquot of 5 ml was taken as top standard. These were read at 540 nm on a spectrophotometer after 30 minutes after adjusting the instrument to zero with blank solution (Drabkin's reagent). A factor for estimation of haemoglobin was calculated from the optical density obtained.

The estimation of haemoglobin was done according to the following steps:

1. Any one finger of the hand was selected specifically the middle one. It was then wiped with a cotton swab dipped in ethanol and was allowed to dry.
2. Then with a disposable lancet a bold prick was made.
3. The first drop of blood was wiped off.
4. Then a big drop of blood was allowed to form on the finger and then 20 mcl of blood was pipetted using a calibrated micropipette.
5. The blood sample was added to 5 ml Drabkin's reagent and mixed thoroughly.
6. This solution was allowed to stand (away from sunlight) for 30 minutes before being read on a spectrophotometer at 540 nm.
7. Duplicate samples were collected from each subject.

Calculation

The haemoglobin concentration was calculated using the optical density of the samples as follows

OD x Factor = Haemoglobin Concentration (g/dl)

Serum Total Protein

Serum Total protein, as the name implies, represents the sum total of numerous proteins, many of which vary independently of each other.

Principle

Proteins form a purple coloured complex with cupric ions in alkaline solution. The reaction takes its name from the simple compound biuret which reacts in the same way. The intensity of the purple colour is measured at 540 nm / yellow green filter and compared with a standard serum of known protein concentration.

Procedure

1. Pipette 2.5 ml Sodium Chloride diluents in the blank tube.
2. Pipette 2.45ml, 2.4ml and 2.35ml of the sodium chloride diluent in S1, S2, and S3 tubes respectively.
3. Add 0.05ml, 0.1 ml and 0.15 ml of bovine serum standard to S1,S2 and S3 tubes respectively.
4. For the test sample take 2.4ml of sodium chloride diluent and 0.1 ml of test sample in the tube marked test.
5. Add 3 ml of Biuret reagent to all the tubes.
6. Incubate at room temperature (25-35^{o}C) for 15 minutes.
7. Set the spectrophotometer to zero using blank at 540 nm and measure the absorbance of standards and test .

Calculation

Plot the absorbance values of standards against their respective concentrations. The measurable range with this graph is from 0.5 to 10 g/dl. Plot the absorbance values of test on the calibration graph and read off the concentrations.

Results are calculated using the formula:

Test absorbance

-------------------------------X Concentration of standard--------------- d/dl

Standard Absorbance

Peripheral Blood Smear

Principle

A peripheral blood smear (peripheral blood film) is a glass microscope slide coated on one side with a thin layer of venous blood. The slide is stained with a dye, Leishman’s stain, and examined under a microscope

Peripheral Blood Smear Preparation

The wedge slide ("push slide") technique developed by Maxwell Myer Wintrobe (1974) remains the standard method for the preparation of peripheral blood smears (films). Figure () shows the steps involved in the preparation of peripheral blood smears.

Procedure

1. A 1" x 3" glass microscope slide with a frosted end on a flat surface was used.
2. A label on the slide, specimen identification number, and date of preparation was attached on the frosted surface.
3. Any one finger of the hand was selected, especially the middle one. It was wiped with cotton swab, dipped in ethanol and allowed to dry.
4. Then with a disposable lancet a bold prick was made.
5. The first drop was wiped off and the second drop (a 2 - 3 mm drop of blood) was placed approximately 1/4" from the frosted slide, using a wooden applicator stick or glass capillary tube.
6. The slide was held by the narrow side between the thumb and forefinger of one hand at the end farthest from the frosted end.
7. A second slide ("spreader slide") was grasped between the thumb and forefinger of the other hand at the frosted end. The spreader slide was pushed forward at a 30^{o} angle with a rapid, even motion.
8. The edge of the spreader slide was placed on the lower slide in front of the drop of blood (side farthest from the frosted end).
9. The spreader slide was pulled toward the frosted end until it touched the drop of blood. The blood was permitted to spread by capillary motion until it almost reached the edges of the spreader slide.
10. The smear was dried quickly by waving it in air.

Figure 3.1. 2: Wedge slide technique for preparation of a peripheral blood smear

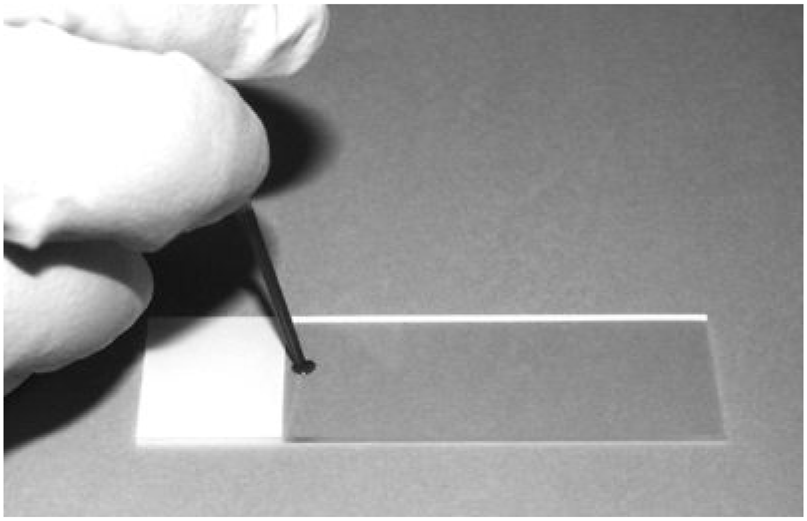
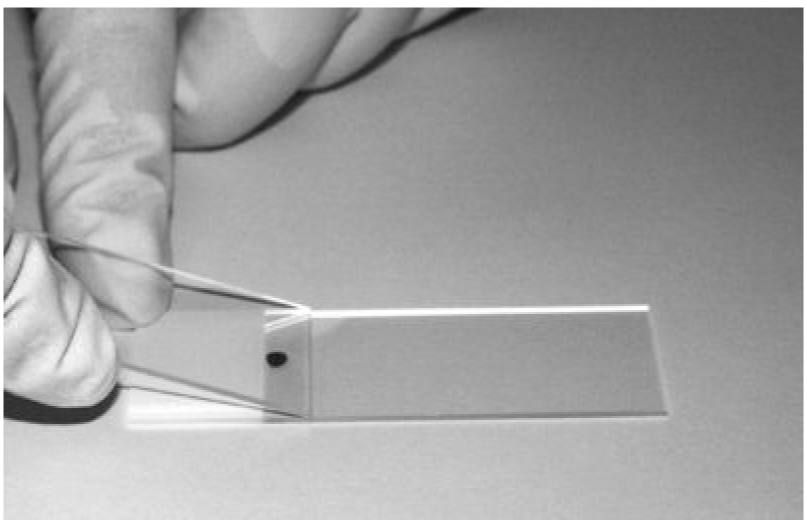
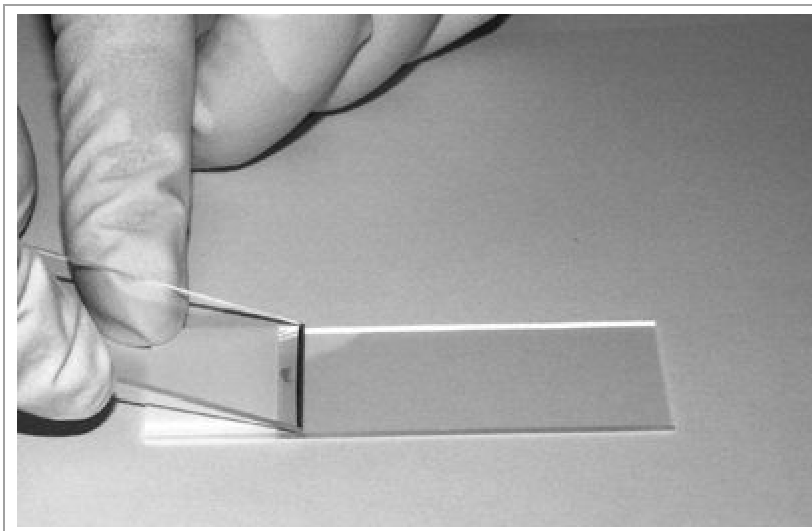
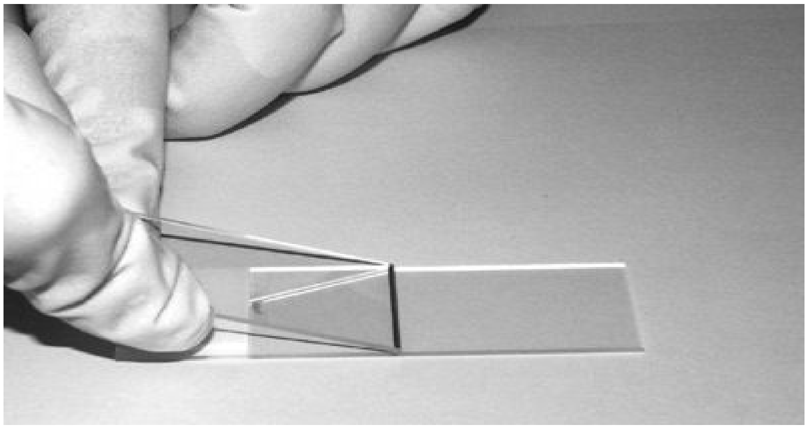
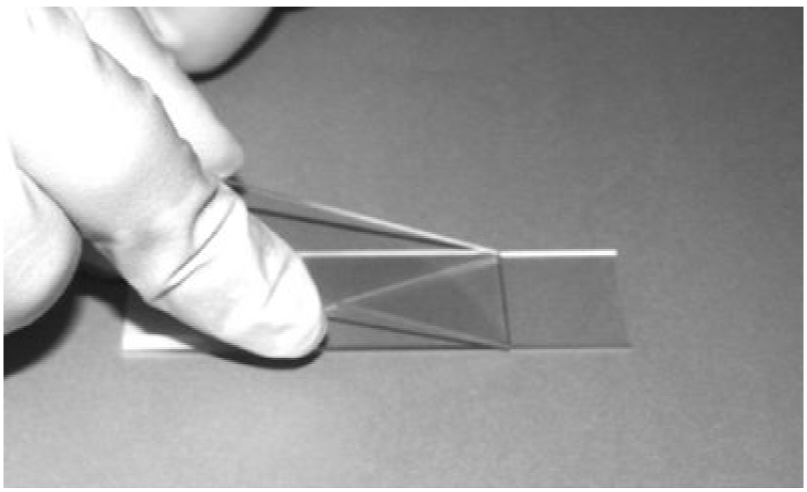
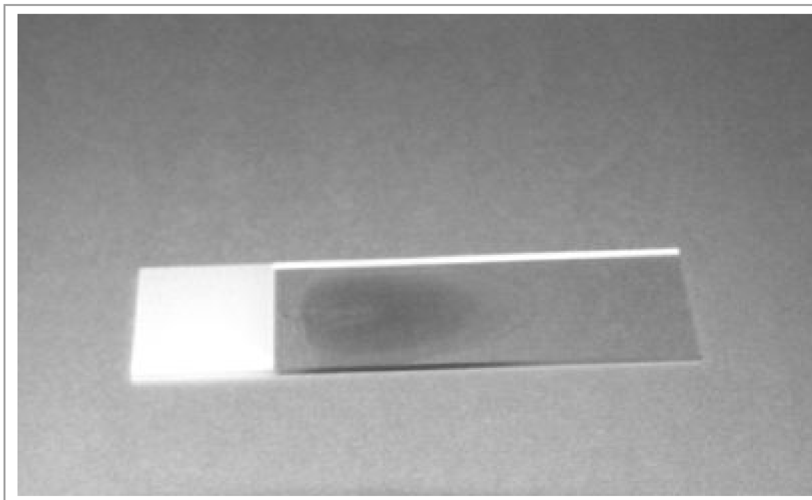
	Step 1. Placing a small drop of venous blood on a glass microscope slide, using a glass capillary pipette. A wooden applicator stick can also be used for this purpose.
	Step 2. A spreader slide has been positioned at an angle and slowly drawn toward the drop of blood.
	Step 3. The spreader slide has been brought in contact with the drop of blood and is being drawn away. Note layer of blood at the edge of the spreader slide.

Fig.3.1.2: Wedge slide technique for preparation of a peripheral blood smear (contd.)

	Step 4. The spreader slide is further pulled out, leaving a thin layer of blood behind.
	Step 5. The blood smear is nearly complete.
	Step 6. End result. A glass slide with a well-formed blood film. After drying for about 10 minutes, the slide can be stained manually or placed on an automated slide stainer.

1. The slide was stained with 8-10 drops of Leishman's stain till the stain got fixed.
2. The slide was washed with buffered water and dried.
3. The fixed stain slide was then read under the microscope for identification of size and shape of the red blood cells.

Diet History

Food frequency, dietary pattern (6 days), nutrient intake (one day 24 hour dietary recall) were collected. The dietary pattern was used to develop the Food behaviour checklist and the dietary intake was used to arrive at the Healthy eating Index scores for adolescent children.

Diet Habits and Practices

Dietary habits and practices data was obtained from the adolescent subjects regarding frequency of meals, breakfast consumption, fruits intake, consumption of accessories with meals, fast foods and soft drink intakes, frequency of eating out etc.

24-Hour Dietary Recall

The diet surveys were done to have an estimate about the subject's intake of energy, protein, fat, calcium and iron. Information on dietary intake was collected for 3 days (1 holiday and 2 working days) before and after the period of intervention for all the subjects in the control and experimental groups.

Principle

According to Rivera et al (1985) 24-hour dietary recall is a simple and valid method for assessing food and nutrient intakes of populations, the method is based on the process of recall of food consumption over a specified period of time (24 Hrs) prior to the survey. It is one of the most common methods used for the diet survey.

Procedure

The respondents were questioned about the foods eaten for different meals as well as the amount of food consumed. Their mothers or the cooks were then asked about the raw ingredients used for the preparation of each food item for the entire household and were asked to show the amount of raw ingredients taken in terms of household measures and this was then recorded in terms of the standard volumetric measures. This was later converted into grams. The volume of the cooked food was also recorded. This was also done in the terms of household measures and then was converted in terms of standard measures.

Then the subject’s consumption of the cooked food in terms of household measures was taken and then converted in standard volumetric measures. Using this information the subject’s intake of raw ingredients was calculated (Appendix-II). Nutritive value of the foods consumed by the children were calculated based on the value given in the food consumption tables of the Nutritive Value of Indian Foods (NIN 1998).

Food Frequency

Food frequency method is used to assess habitual food intake of the subjects, qualitatively. An exhaustive list of the commonly consumed foods was prepared and the respondent was asked as to how frequently each of the listed food was consumed by him/her. The frequency was daily, alternate days, twice a week, once a week, twice a month, once a month, rarely and never (Appendix- III)

Dietary pattern

For the Food Behaviour Checklist information on the dietary pattern of the subjects was collected (Appendix IV). A checklist was prepared with the common patterns like:

- Breakfast consumption, frequency and items
- Mid morning food consumption
- Vegetable especially Green leafy vegetable and yellow and orange vegetable consumption
- Evening snack consumption, items and frequency.
- Outside food consumption etc.
- Different activities carried out and their duration

Physical activity

The general activity information was obtained using a pretested structured questionnaire. An exhaustive list, which was representative of the physical activities of children of the present study, was made (Appendix). These activities were then classified into light, moderate and heavy activities as per the description of FAO/WHO expert committee’s report on energy requirements (FAO/WHO 1985); light activity which involved 75% sitting and 25% standing and moving, Moderate activity mainly involving standing and walking but no other physical activity and Heavy activity which included heavy physical activity.

Cognitive development

Malnutrition adversely affects the ability of adolescents to learn. The mental functions of the subjects were assessed by using a set of selected tests from the Wechsler Intelligence Scale for children (WISC IV) and other standard methods used previously in the department (Bhardwaj and Gopaldas, 1986 and Bhatt M C 1973). WISC IV is a battery of tests for 6-17 year olds that evaluates intellectual abilities. The various tests used were Digit Span (Forward and backward), Visual memory test and maze test. As class performance is also considered as cognitive development therefore the marks obtained by the subjects in the examinations were also noted down.

Digit Span

It is a measure of short term auditory memory for non- meaningful information, concentration and ability to remember a sequence of numbers both forwards and backwards.

Procedure:

1. **Digit Span Forward:** A series of numbers were read out which gradually increased in length. Each list of numbers was presented once and the subjects were asked to recall and writs each set of the numbers in the same sequence
2. **Digit Span Backward:** Another set of numbers were called out and the subjects were asked to recall and write it down in reverse sequence.

Different series of numbers were presented for forward and backward recall. Each set of numbers were called out once only and the subjects were previously instructed to be attentive. They were instructed to write only after the whole set of numbers was read out completely (Appendix-V).

Scoring: The written series were checked for the correct order and scores were given separately for forward and backward recall as per the method of description. Both the scores were added and a total score was given. Seventeen was the maximum score.

Visual Memory Test

Visual memory test is a test to measure short term memory of the subjects.

Procedure: Fifteen commonly used items are placed on a table such as toothbrush, pen , eraser etc.(Appendix-VI). The subjects were allowed to observe the objects for one minute and then the objects were covered with a cloth. Subjects were then asked to recall and list down the items which they had seen within 2 minutes.

Scoring: One point was given for each item listed correctly. The scores were calculated as the ratio of the total number of items correctly listed to the total number of itemsi.e.15. the highest score was one.

Maze Test

It is used to measure psychomotor coordination; planning, visual motor coordination and speed; and fine motor coordination, planning, following directions. Performance is also based on time.

Procedure: The maze tests have complex pathways having blind alleys. Papers containing seven mazes were given and the subjects were asked to find their way out of the mazes using a pencil, without making any errors within specific time given for completion of each maze. There were seven mazes increasing in complexity (AppendixVII). The subjects were not allowed to draw lines approaching from outside to inside. They were asked not to lift their pencils.

Scoring: Each maze was checked for the number of errors and accordingly scores were given (AppendixVIII)

Error:

1. If the line of the maze was touched it was counted as one error
2. Crossing the imaginary line into a major blind alley is one error
3. Crossing lines (walls of the maze) is one error. A line is crossed if any white space can be seen between the printed line and pencil line on the wrong side of the printed line.

Knowledge Attitude and Practice

Data was collected by interviewer administered method using a pre tested semi- structured questionnaire. Information regarding Diet, healthy eating habits, meal consumption pattern, Food Pyramid, etc. was obtained from the subjects (Appendix-IX). Also data was obtained on the Knowledge and attitudes of the teachers regarding adolescents (Appendix-X)

Table 3.1.1 shows the sample size for all the parameters studied.

Table 3.1. 1: Sample size and parameters studied in the present study

Indicators	Pre intervention (N)	Post intervention (N)
Anthropometric measurements • Height • Weight • Waist • Hip • MUAC • Wrist	1041	436
Socio economic status	631	----
Morbidity profile	478	436
Biochemical estimations	61	----
Physical activity	478	436
Dietary data		
• 24 hour dietary recall	478	436
• Food Frequency	631	436
• Food behaviour pattern	631	436
KAP		
• Children	478	436
• Teachers and Principals	15	----
Cognitive development	478	436

Phase II: Healthy Eating Index and Food Behaviour Checklist – Development, Assessment for subjects and Validation

Healthy Eating Index (HEI)

U.S. Department of Agriculture (USDA) has developed a healthy Eating Index (HEI), to find out how well the Americans follow the recommended healthy eating patterns.

The overall index has a total possible score ranging from zero to 100. Each of the 10 dietary components has a scoring range of zero to 10. Individuals with an intake at the recommended level received a maximum score of 10 points. A score of zero was assigned when no foods in a particular group were eaten. Intermediate scores were calculated proportionately. The healthy eating index was applied to the 1989 and 1990 USDA data from the continuing Survey of Food Intake by individuals.

Food Group Components of the Healthy Eating Index (1989)

The healthy eating index examines dietary intake in relation to the five major groups in the Food guide pyramid. For each of the five food group components of the index, individuals who consumed the recommended levels of the servings received a maximum score of 10. A score of zero was assigned to any food group where no items from the category were consumed. Intermediate scores were calculated proportionately to the number of servings consumed. For example, if the recommended level of serving was eight and an individual consumed four servings, the component score for the individual was 5 points. A score of 7.5 points was assigned if six servings were eaten.

Other Components of the Healthy Eating Index

Total Fat

Fat intakes less than and equal to 30 percent of the total calories were assigned a score of 10 points. The scored declined to zero when the proportion of fat to total calories reached 45 percent. Intakes between 30 percent and 45 percent were scored proportionately.

Saturated fat

A score of 10 points was assigned to saturated fat intakes at less than 10 percent of total calories. Zero points were assigned when the saturated fat intake reached a level of 15 percent of the total calories. Scores between the two cutoff values were calculated proportionately.

Cholesterol

A maximum point value for cholesterol was assigned when intake was at the level of 300 milligrams or less. Zero points were assigned when intake reached a level of 450 milligrams or more. Values between the two cutoff points were scored proportionately.

Sodium

A maximum score for sodium was assigned at an intake level of 2,400 milligrams or less. Zero points were assigned at a level of 4,800 milligrams or more. Scores between the two levels of intake were scored proportionately.

Variety

Dietary variety was assessed by totaling the number of “different” foods eaten by an individual in amounts sufficient to contribute at least one-half of a serving in a food group. Similar foods were grouped together and counted only once in measuring variety. Food mixtures were broken down into their component ingredients and assigned to the relevant food groups. Index scores for variety were calculated in a manner analogous to the method used for the other index components. Cutoff scores for variety were defined based on 3 days of recorded data. A maximum score was given if 16 or more different food items were consumed over a 3 day period. A score of zero was given if six or less different items were eaten. When based on 1 day of reported data, the cutoff scores for variety were reduced by a factor of two. Intermediate intakes were calculated proportionately.

Development of the HEI – 2005

CNPP (Center for Nutrition Policy and Promotion) USDA convened an interagency Working Group to begin the process of revising the HEI. The working group reviewed the original HEI and its uses.

The Working Group decided to base the revised index on the food patterns found in USDA's food guidance system, which was then called My Pyramid, which translates key recommendations in the 2005 Dietary Guidelines for Americans into specific, quantified dietary recommendations (Britten, Marcoe, Yamini, & Davis, 2006). Collectively, these documents specify amounts to consume from each of the major food groups and from oils and provide recommended limits for sodium, saturated fat, and discretionary calories. In addition, they advise that at least half of grain intake should be whole grain, recommend specific amounts of several vegetable subgroups, and suggest that less than half the fruit consumed should be juice. A subgroup of the HEI Working Group further developed the components of the index, constructed the scoring and weighting protocol, developed the evaluation plan, conducted the analyses, presented findings to the full Working Group, and held briefings for wider audiences (Guenther et al, 2007).

The components of the HEI-2005 were considered to be of two types. The food-group and Oils components were the "adequacy components" because the recommendations on which they were based were established to ensure adequacy of nutrient intake. The "moderation components" were Saturated Fat, Sodium, and Calories from SoFAAS. The components of HEI- 2005 are shown in Table 3.2.1 with their maximum scores. The minimum score for all the components was zero. Intermediate scores were calculated proportionately. A total score of more than 80 points implied that the dietary quality was 'good'. A score between 51 to 80 suggested that the diet quality 'needed improvement' and a score of 50or less implied that the diet was of a 'poor quality'.

Table 3.2. 1: Components of HEI -2005 with maximum and minimum scores

Components	**Max Score**	**Min Score**
Total Fruit	5	0
Whole Fruit	5	0
Total Vegetables	5	0
Dark Green and Orange Vegetables and Legumes	5	0
Total Grains	5	0
Whole Grains	5	0
Milk	10	0
Meat and Beans	10	0
Oils	10	0
Saturated Fat	10	0
Sodium	10	0
Calories from SoFAAS	20	0
Total HEI Score	**100**	**0**

Healthy Eating Index for Adolescents (HEIA) Development and Assessment – Present Study

The Healthy Eating Index for Adolescents had a total score of 100. It consisted of 10 dietary components. If the diet scored above 80 points then it was considered as a good quality diet. If the score ranged between 51 and 80 then the diet needed improvement and if the score was less than or equal to 50 then it was considered to be of poor dietary quality. Each component had been allotted a maximum score. Based on the dietary guidelines, the intakes at different levels were given scores. The most desirable intake of a component was given the maximum score. Minimum score was allotted to the most undesirable intakes. Intermediate scores were calculated proportionately to the amounts consumed. The maximum and minimum scores according to age and sex are shown in Table 3.2.2.

Food Behaviour Checklist

A short food behavior checklist (FBC) was developed to evaluate the impact of nutrition education on fruit and vegetable intake among ethnically diverse women in the Food Stamp Nutrition Education Program (FSNEP) and the Expanded Food and Nutrition Education Program (EFNEP (Blackburn et. al, 2006). This short, culturally neutral FBC is a valid and reliable indicator of fruit and vegetable consumption. Compared with the 24-hour dietary recall, it is also less time-consuming to administer, code and analyze, with a reduced respondent burden.

Food Behaviour and Activity Checklist for Adolescents (FBACA) – Present Study

Food Behaviour and Activity Checklist for Adolescents (FBACA) was developed to assess the quality of diet and activity patterns of the adolescent children according to frequency. The FBACA checklist was administered for 6 days to ascertain the trend. Frequencies for breakfast, mid morning, vegetables, fruits, local fruits, intake of processed foods, fried foods, water intake, and for activity patterns according to playtime, leisure time and study time were seen. The frequencies were given scores of 0 to 5. Zero was given to the most undesirable action for any dietary component or activity pattern and a maximum score of 5 was given to the most desirable frequency of food item consumption or activity pattern (Table 3.2.3). Different components of foods and activity patterns were included in the checklist and scores were allotted accordingly. The score guide for FBACA is given in (Appendix-XII)

Table 3.2. 2: Healthy Eating Index for Adolescents - Scoring system

S.no.	Individual Component	Age (y)/ Sex	Cut Off Value	Max Score	Min. Score
1	% of RDA consumed from Total Grains	< 9-9.11	≥ 180 g	10	0
		10-12.11 G	≥ 240g		
		10-12.11 B	≥ 300g		
		13-15.11 G	≥ 330g		
		13-15.11 B	≥ 420g		
2	% of RDA consumed from Pulses(P) or Egg/ Meat/ Chicken/ Fish (M)	<9-9.11	≥ 60 g of P OR 30g of P and 50 g of M OR 100g of M	10	0
		10-12.11 G			
		10-12.11 B			
		13-15.11 G			
		13-15.11 B	≥ 75 g of **P** OR 38g of **P** and 75 g of **M** OR 150g of **M**		
3	% of RDA consumed from Total Vegetables	< 9-9.11	≥ 300 g	5	0
		10-12.11 G			
		10-12.11 B			
		13-15.11 G			
		13-15.11 B	≥ 350 g		
4	% of RDA consumed from Green, Yellow & Orange Vegetables	< 9-9.11	≥100 g	5	0
		10-12.11 G			
		10-12.11 B			
		13-15.11 G			
		13-15.11 B			
5	% of RDA consumed from Fruits	< 9-9.11	≥ 100 g	10	0
		10-12.11 G			
		10-12.11 B			
		13-15.11 G			
		13-15.11 B			
6	% of RDA consumed from Milk	< 9-9.11	≥ 500 ml	10	0
		10-12.11 G			
		10-12.11 B			
		13-15.11 G			
		13-15.11 B			

Table 3.2.2: Healthy Eating Index for Adolescents - Scoring system (Contd.)

S. No	Individual Component	Age (y)/ Sex	Cut Off Value	Max. Score	Min. Score
7	% of RDA consumed from Edible Oil	< 9-9.11	≤ 30g[1]	10	0
		10-12.11 G	≤ 35g[1]		
		10-12.11 B	≤ 35g[1]		
		13-15.11 G	≤ 40g[1]		
		13-15.11 B	≤ 45g[1]		
8	% of RDA consumed from Sugars	< 9-9.11	≤ 20g	10	0
		10-12.11 G	≤ 30g		
		10-12.11 B	≤ 30 g		
		13-15.11 G	≤ 25g		
		13-15.11 B	≤ 20g		
9	Variety	< 9-9.11	≥8 items/ day – ≥3 items/day	10	0
		10-12.11 G			
		10-12.11 B			
		13-15.11 G			
		13-15.11 B			
10	Calories from Sofaas[2]	< 9-9.11	≤ 20% of energy	20	0
		10-12.11 G			
		10-12.11 B			
		13-15.11 G			
		13-15.11 B			
	Total			100	0

[1]A score of 8 is given to the diets having the maximum required RDA for oils. Even if the RDA is 30 g yet maximum score is given for 24gms.

[2]SOFAAS -Solid fats and added sugars.

Table 3.2. 3: Food Behaviour and Activity checklist scoring system

S.No.	Food Behaviour and Activity Checklist For Adolescents (Components)	Max Scores
1	Breakfast Consumption Y/N	5
2	Breakfast Food Item	5
3	Mid Morning Y/N	5
4	Mid Morning Food Item	5
5	Carry Lunch To School	5
6	Vegetable Consumption Y/N	5
7	Green Leafy Vegetables	5
8	Roots & Tubers	5
9	Yellow & Orange Vegetables	5
10	Other Vegetables	5
11	Fruit Consumption	5
12	Any Fruit	5
13	Local Fruits Consumption	5
14	Evening Snacks	5
15	Evening Snacks Food Item	5
16	Outside Food	5
17	Water Intake	5
18	Activity (Playtime Outdoor In School And Home)	5
19	Activity (Leisure Time Watching TV, Computer Or Video Games, Etc.)	5
20	Activity (Study Time)	5
	Overall Score	**100**

Evaluation Psychometric properties of HEIA and FBACA

HEIA and FBACA were evaluated by assessing several types of validity and one type of reliability. To do this 3 day dietary intakes were obtained from the sample and several sets of exemplary menus.

Data sources

For analysis data was obtained from 478 subjects. A 3 day intake in the form of 24 hour recall was obtained from each subject. Sample menus for assessing validity were used from the 'Dietary guidelines for Indians – A manual' published by National Institute of Nutrition.

Validity

Content Validity

It examines qualitatively the extent to which an index represents the variety of attributes that make up the diet quality as specified the 'Dietary guidelines for Indians- 2010'.

The main question in evaluating content validity is whether the index is able to capture the various key aspects of diet quality in 'Dietary Guidelines for Indians-2010'? For this purpose the set of components were checked against the key recommendations of 'Dietary Guidelines for Indians-2010'.

Construct and criterion Validity

It evaluates how well the index measures the diet quality. It was done in 4 ways.

Firstly, to evaluate construct validity the first and foremost important question that needs to be answered is whether the index gives maximum scores to menus developed by nutrition experts to illustrate high diet quality? For this sample diet menus given by experts were used.

Another important question is whether the index has concurrent criterion validity i.e. does HEIA distinguish between groups with known differences in diet quality for example under nourished and well nourished?

Thirdly, HEIA should be able to assess diet quality independent of diet quantity, as measured by diet's energy value. Because nutrient intake is positively correlated with energy intake, a diet quality index could lead to an overrating of high calorie diets. To evaluate this independence, Pearson correlations of the HEIA and FBACA total and components cores with the energy intake were seen.

Fourthly, the underlying structure of the index was examined through principal component analysis (PCA). On the basis of the correlations among the components, the PCA was used to determine the number of independent factors that compromise the HEIA and FBACA. The main objective of PCA was to find out whether one or more than one factor accounted for the systematic variation observed in the data.

Reliability

HEIA and FBACA were checked for one form of reliability, internal consistency, the degree to which multiple components within an index measure the same underlying, unidimensional, latent construct, by using Cronbach's coefficient alpha. This statistic is mathematically equivalent to the average of the correlations among all possible split-half combinations of the 10 components of HEIA, and thus captures any systematic variation underlying the dietary components that are measured.

Also to get an understanding of the inter component relationships among components, inter component correlations were observed.

Phase III: Development of Nutrition Communication programme and its implementation

Creating **H**ealthy **A**ctive **L**earning **K**ids (**CHALK** Programme)

A nutrition communication programme was developed using PowerPoint presentations, charts posters, video clips etc. to increase awareness among kids regarding Healthy foods, healthy eating habits, junk foods, physical activity etc. The key concepts from phase I and Phase II were taken and 7 sessions were developed accordingly. Table 3.3.1 shows the key messages involved in the development of CHALK programme.

The sessions were conducted on a weekly basis for boys and girls separately over a period of 3- 4 months. The information provided was reinforced by sessions conducted fortnightly for a period of 2 months. These reinforcement sessions were mainly a recap of the above mentioned sessions along with questions answer session.

Phase IV: Assessing the impact of Nutrition Communication on the Subjects

Final data of the subjects were assessed at the end of six months of nutrition communication program. The anthropometric measurements i.e. weight, height, waist, hip and mid upper arm circumference were taken. Data on morbidity profile was collected using a reference period of 15 days. Dietary intake data was collected using 24 hour dietary recall (3 day recall) and food frequency questionnaire for all the subjects. Data on knowledge, attitudes and practices regarding food and activity was collected using the same questionnaire as was used for baseline. Subjects were asked to fill the food behavior checklist also at the end of nutrition communication program. Cognitive development data was also collected using the same procedure as the baseline.

Table 3.3. 1: Key Messages for the Development of CHALK programme

Key concepts for Nutrition Communication
• Correct concept of Growth and Development of Adolescents
• Healthy food (Balanced diet) and Healthy Eating Behaviours
• Functions of foods and various food groups
• Meal Patterns and Breakfast consumption
• Dietary guidelines and Food Pyramid
• Healthy food choices (outside as well as at home)
• Fruit consumption
• Fast foods and soft drinks consumption
• Physical Activity
• Appropriate weight
• Self perception

Phase V: Data analysis, report writing and dissemination of results

The data was entered and then analyzed using Microsoft excel (2007), Epi info version and Spss 16 and above.

- Frequency distribution and percentages were calculated for all parameters that were expressed in a rank order fashion.
- Means and standard errors were calculated for all parameters that were expressed numerically.
- Analysis of variance and independent‘t’ test was used to compare differences between the means in different groups.
- Paired‘t’ test was used to assess the differences between the means of the same group before and after the Intervention period.
- Chi-square test was used to assess the differences between the frequency distribution of the groups.
- Correlation Coefficients were computed between indicators of nutritional status and other parameters of interest.
- Stepwise multiple regression analysis was done to identify independent variables that had a significant role in influencing the dependent variables like Height for age, Weight for Age, BMI for age, HEIA scores etc.

RESULT AND DISCUSSION

This chapter deals with the findings of the present study, to develop a Healthy Eating Index and Food Behavior Checklist for adolescents in the Indian context and to assess the impact of a Nutrition Communication Programme (NCP) on dietary practices of school children in urban Vadodara.

Three schools of urban Vadodara were purposively selected for the present study. All the subjects in standards V to XI falling majorly in the age range of 10-19years, were enrolled for the study. In all, a total of 1041 subjects from the 3 schools were enrolled comprising 613 boys and 428 girls.

Phase I included baseline data collection on anthropometric measurements, socioeconomic status, data on dietary intake, Food behaviour pattern and activity profile, Biochemical tests and cognitive development was assessed on a sub-sample. Anthropometric data was obtained for all the subjects. As there was a time constraint for class X, XI and XII subjects, therefore they were excluded from the rest of the study.

Socio- Economic status, food frequency and food behavior data for the Food Behaviour and Activity Checklist for Adolescents (FBACA), was collected for 631 subjects studying in std. V to std. IX

Two schools were randomly selected, comprising 478 subjects, for collection of data regarding dietary intakes (24 hour recall) – used for assessment of diet quality through Healthy Eating Index for Adolescents, cognitive development, morbidity profile and knowledge attitudes and practices of the subjects.

Biochemical estimations were carried out for a subsample of 61subjects. Data was collected for knowledge attitudes and practices of the teachers, physical education instructors and the Principals of the schools. Table (4.1.1) shows the sample size and the various parameters assessed at baseline.

Table 4.1.1: Sample size and Parameters assessed

Parameters	Pre intervention (N)	Post intervention (N)
Anthropometric measurements • Height • Weight • Waist • Hip • MUAC • Wrist	1041	436
Socio economic status	631	----
Morbidity profile	478	436
Biochemical estimations	61	----
Physical activity	478	436
Dietary data • 24 hour dietary recall • Food Frequency • Food behaviour pattern	 478 631 631	 436 436 436
KAP • Children • Teachers and Principals	 478 15	 436 ----
Cognitive development	478	436

The results are presented in four sections covering one phase each.

Section I: Formative Research

- School profile
- Socio Economic profile of the subjects
- Nutritional Status of the study subjects
- Dietary and Nutrient Intakes of the subjects
- Biochemical estimations
- Morbidity profile of the Study Subjects
- Physical Activity Profile of the Study Subjects
- Cognitive Abilities of the Study Subjects
- Knowledge, Attitude and Practices (KAP) of the subjects regarding Healthy Eating and Dietary Habits
- Knowledge, Attitude and Practices of Teachers and Principals regarding Adolescents

Section II: Healthy Eating Index for Adolescents (HEIA) and Food Behaviour and Activity Checklist (FBACA) – Development, Assessment for Subjects and Validation

- Development of Healthy Eating Index for Adolescents (HEIA) and Food Behaviour and Activity Checklist for Adolescents (FBACA) in the Indian context.
- Assessment of the dietary quality of the study subjects using HEIA
- Evaluation of the quality of behaviour patterns of the subjects regarding diet and activity
- Assessment of the psychometric properties of HEIA and FBACA

Section III: Creating Healthy and Active Learning Kids (CHALK) Programme – Planning, Development and Implementation of the Nutrition Communication Program for Adolescents

- Formative Research for the development of CHALK Program
- Selection of key messages and development of the CHALK Programme
- Implementation of the CHALK program strategy in the school

Section IV: Assessing the Impact of Nutrition Communication Programme (CHALK Programme) on the Dietary Practices of the Subjects

- Assessment of the knowledge levels regarding healthy eating and physical activity practices, followed dietary practices and food and nutrient intakes of the subjects in the experimental and control groups

- Evaluating the Impact of Nutrition Communication Programme (CHALK Programme) on the Knowledge levels, Dietary and Physical Activity Practices of the Subjects in the two groups

SECTION I: FORMATIVE RESEARCH

School profile

For the current study three regular, co-educational and non-boarding schools were purposively selected in urban Vadodara such that they represented children from different socio economic groups. All the three schools were English medium schools. All the schools had playground for outdoor activities as well as a physical education teacher appointed for the same. None of the schools had a school meal program. One school had canteen facility whereas one of the schools had a local vendor coming during recess to sell vegetable puffs - a snack item. Two schools had an annual health checkup facility wherein height, weight measurements were recorded and eyesight checkup of the children was done. Private vans were used as a means of transport by most of the children as none of the schools provided bus facility. Two schools were under Central board and one was under the Gujarat State board of education.

Socio Economic profile of the subjects

Background profile of the subjects

Table (4.1.2) shows the background profile of the subjects. Nearly 94 % of the subjects were Hindus, followed by a very low percentage of subjects belonging to other religions. Majority (73%) were staying in a nuclear family, followed by extended family and joint family, as most of the fathers occupational profile involved transfer or change from one place to another. Mean family size was 4.71 ± 1.56 members ranging between minimum 3 to maximum 15 members in a family. More than half of the families had a family size of four members. Per capita income ranged from as low as Rs. 600 to as high as Rs. 50,000 per month with the mean per capita income being Rs. 5873.07 ± 4.75.

More than 80% of the fathers were in service whereas 90% of mother's were housewives. The most common profession amongst mothers was teaching/tuition. Almost 65% of the fathers were either graduate or above while only 38.9% mothers belonged to the same category. Vegetarianism was the most common (56.7%) dietary habit followed by non-vegetarianism (31.1%) and ovo - vegetarianism (12.2%).

Table 4.1.2: Socio Economic Profile of the study subjects

Variable	Boys (N=389) % (n)	Girls (N=242) % (n)	Total (N=631) % (n)
Religion			
Hindu	94.9(368)	93.4 (227)	94.3(595)
Muslim	1.3(5)	2.1(5)	1.6 (10)
Sikh	2.3 (9)	2.9 (7)	2.5 (16)
Christian	1.5 (6)	1.6 (4)	1.6 (10)
Family Type			
Joint	9.5 (37)	10.7 (26)	10 (63)
Nuclear	72.7 (282)	72.8 (177)	72.7 (459)
Extended	17.8 (69)	16.5 (40)	17.3 (109)
Family Size			
≤ 4	64.7 (251)	60.1(146)	62.9 (397)
5-8	32.2 (125)	35 (85)	33.3 (210)
>8	3.1 (12)	4.9 (12)	3.8 (24)
Per Capita Income			
≤999	1.3 (5)	2.9 (7)	1.9 (12)
1000- 4999	44.8 (174)	60.1(146)	50.7 (320)
≥ 5000	53.9 (209)	37(90)	47.4 (299)
Father's Occupation			
Expired	0.5 (2)	1.6 (4)	1 (6)
Job/ service	81.7 (317)	84.8 (206)	82.9 (523)
Business / Self	14.9 (58)	11.1 (27)	13.5 (85)
employed	1.3 (5)	0.8 (2)	1.1 (7)
Teacher/ Tuition	1.6 (6)	1.6 (4)	1.6 (10)
Others			
Mother's Occupation			
Expired	0.3 (1)	0.4 (1)	0.3 (2)
Job/ service	1.3 (5)	3.7 (9)	2.2 (14)
Business / Self	0.5 (2)	1.2 (3)	0.8 (5)
employed	7(27)	5.8 (14)	6.5 (41)
Teacher/ Tuition	91(353)	88.5 (215)	90 (568)
Housewife	0 (0)	0.4 (1)	0.2 (1)
Others			
Father's Education			
Expired	0.5 (2)	1.6 (4)	1 (6)
Elementary	5.2 (20)	6.2 (15)	5.5 (35)
Secondary	21.4 (83)	21.8 (53)	21.6 (136)
Diploma	20.1 (78)	9.9 (24)	16.2 (102)
Graduate	35.6 (138)	39.1 (95)	36.9 (233)
Post Graduate	16.5 (64)	20.2 (49)	17.9 (113)
PhD	0.8 (3)	1.2 (3)	1 (6)
Mother's Education			
Expired	0.3 (1)	0.4 (1)	0.3 (2)
Illiterate	1 (4)	0.8 (2)	1 (6)
Elementary	19.1 (74)	18.1 (44)	18.7 (118)
Secondary	34.8 (135)	31.7 (77)	33.6 (212)
Diploma	7 (27)	8.6 (21)	7.6 (48)
Graduate	25.3 (98)	28.8 (70)	26.6 (168)
Post Graduate	11.1 (43)	11.5 (28)	11.3 (71)
PhD	1.5 (6)	0 (0)	1 (6)
Dietary habits			
Vegetarian	56.3 (219)	57.5 (139)	56.7 (358)
Non-Vegetarian	31.9 (124)	32.2 (78)	32.0 (202)
Ovo-Vegetarian	11.8 (46)	10.3 (25)	11.3 (71)

Age and sex profile of the study subjects

A total of 1041 students were enrolled for the study, out of which 58.9% was boys and 41.1% were girls. Mean age of the children was found to be 12.45$\pm$ 0.07 years. The distribution of children according to age is shown in Figure 4.1.1. Almost 66% of boys and nearly 61 % of girls were between 10- <14 years of age. Nearly 25% children fell in the age range of 14-18 years, while 12.3% of total children were < 10 years. . Thus, most of the children fell in the age group of 10-<14 years.

Nutritional Status of the study subjects

Changes in body dimensions reflect the overall health and welfare of individuals and populations. Anthropometry is used to assess and predict performance, health and survival of individuals. Anthropometry is a widely used, inexpensive and non-invasive measure of the general nutritional status of an individual or a population group (Cogil, 2003).Thus, for the present study, anthropometric data was collected on 1041 subjects from three schools to get an idea of the prevalence of malnutrition (under and over nutrition) in urban middle income group school children.

Anthropometric measurements of the subjects

To assess the nutritional status various parameters were studied namely, height, weight, BMI, waist circumference (WC), hip circumference (HiC), waist hip ratio (WHR), waist stature ratio (WSR) and mid upper arm circumference (MUAC).

Mean age for girls was slightly higher than boys. Mean weight for the subjects was found to be the same irrespective of the sex. Overall, boys had a significantly higher value for mean height whereas the girls had significantly higher mean BMI values (Table 4.1.3). WC, WHR and MUAC values were higher in boys as compared to girls but the difference was insignificant.

Growth patterns

As expected the height correlated positively with the age ($p<0.01$, 2-tailed), increasing as age advanced. In boys, mean height ranged from 134.4 $\pm$ 1.20cm at age <9 years to 177 $\pm$ 0 cm at 18 years (Figure 4.1.2).

Figure 4.1.1: Population Pyramid (N=1041)

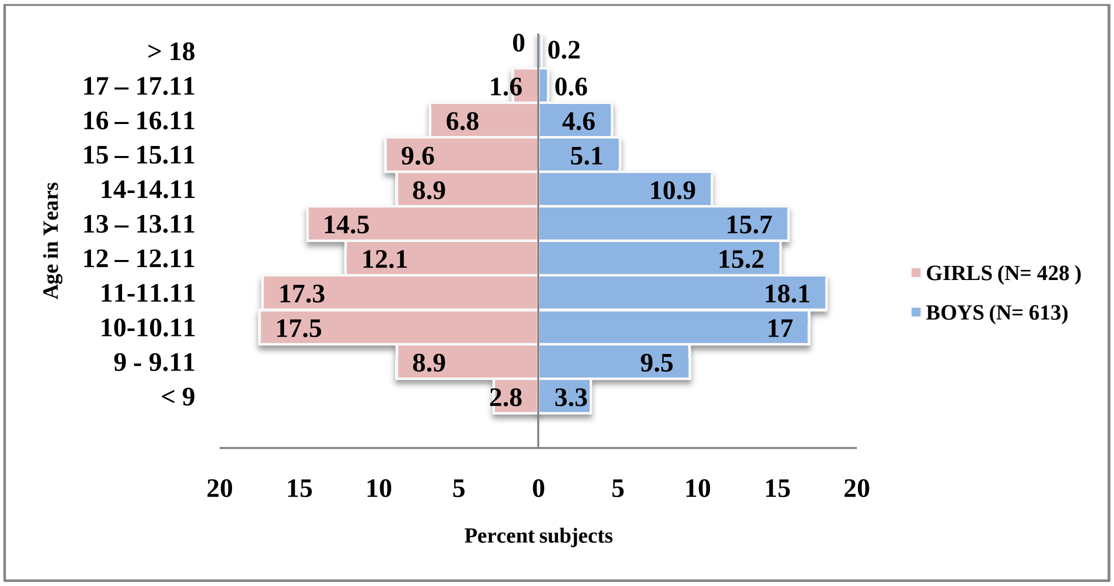


Figure 4.1.2: Growth Pattern in Boys at Different ages (N=613)

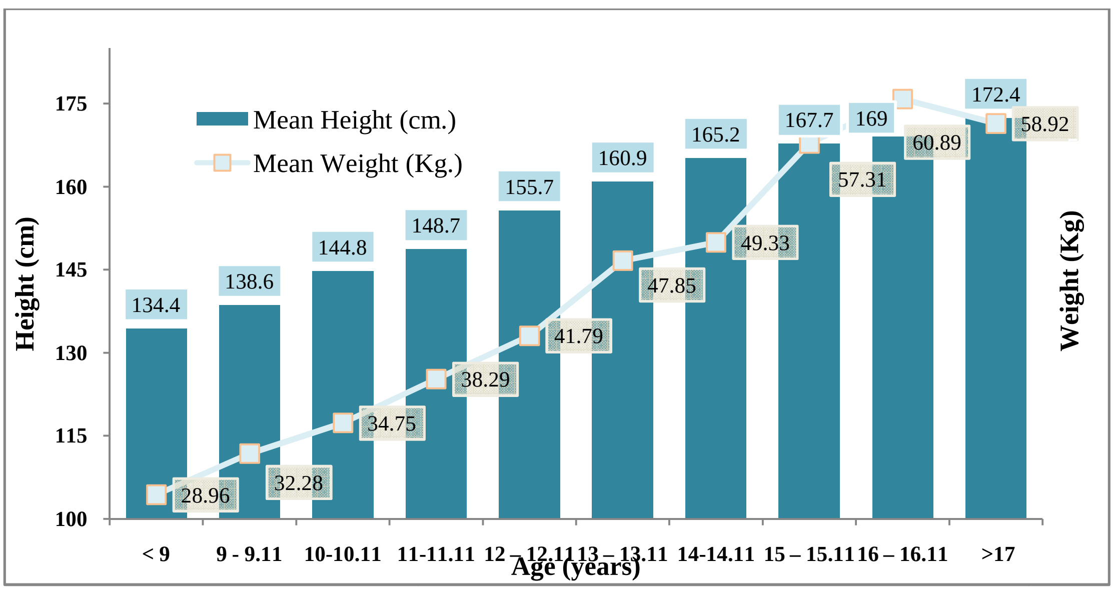


Table 4.1.3: Growth Parameters of the study subjects

Parameters(Mean± SE)	Boys (n= 613)	Girls (n=428)	Total (N= 1041)
Age (yrs.)	12.34± 0.08	12.59± 0.11	12.45± 0.07
Weight (Kg.)	42.25± 0.49	42.25± 0.51	42.25± 0.36
Height (cm)	153.53± 0.51***	150.76± 0.44	152.39± 0.36
BMI (Kg/m^2)	17.63± 0.13	18.38± 0.16***	17.94 ± 0.10
Waist Circumference	65.48 ± 0.38	64.16 ± 0.4	64.94 ± 0.24
Waist Hip Ratio	0.83 ± 0.00	0.80 ± 0.01	0.82 ± 0.00
Mid upper arm circumference (cm)	21.85 ± 0.13	21.67 ± 0.14	21.78 ± 0.10
Waist Stature Ratio	0.43± 0.00	0.43± 0.01	0.43± 0.00

*** significant at $p<0.0001$

Similarly, in girls, mean height ranged from 137.64 $\pm$ 2.97 cm at age <9 years to 158.88 $\pm$ 2.13 cm at 17 years age (Figure 4.1.3). The mean height of boys at 17 years was 171.25 $\pm$ 1.75 cm which was significantly higher than girls at the same age. As can be observed, while girls started off with a slightly higher height than boys at age 9, the boys outgrew the girls in height by age 17, the changes becoming quite evident from age 13 onwards. Peak Height velocity for boys and girls as shown in Figure 4.1.4, shows the maximum mean increment in height in boys was at 12 years of age while for girls it was at 11 years of age. The maximum increment in mean height was 7 cm and 5.89 cm in boys and girls respectively.

Similarly for weight, it was observed that mean weight of the girls at age < 9 years was31.55 $\pm$ 2.1 kg while for boys it was comparatively lower (28.96 $\pm$ 1.40 kg.) at the same age. By 17 years of age there was a reversal as boys had a higher mean weight (57.65 $\pm$ 8.42kg) than girls (54.43 $\pm$ 4.75kg). Figure 4.1.5 shows the peak weight velocity (PWV) of the subjects. It was observed that the maximum mean increment in weight was observed for boys at 15 years whereas for girls it was at 16 years. Another important observation was that an almost similar increment was seen in girls at an earlier age of 11 years, thus, 11 years of age can be attributed as the PWV for girls. The maximum mean increment was 7.98 kg in boys, 5.28 kg (at 16 years) and 5.04 kg (at 11 years) in girls.

Thus, it is clearly evident that boys fared better than girls by the age of 17 years even though girls had better initial values for weight and height.

In the same way the mean BMI value for boys (15.89 $\pm$ 0.51kg/m^2) was lower than girls (16.48$\pm$0.61 kg/m^2) at < 9 years of age (Figure 4.1.6). As expected from the above trends the mean BMI values continued to be higher for girls throughout. However, the mean BMI value for boys was higher between 15 - 16 years of age and again became lower than girls at 17 years of age.

Figure 4.1.3: Growth pattern in Girls at Different Ages (N=428)

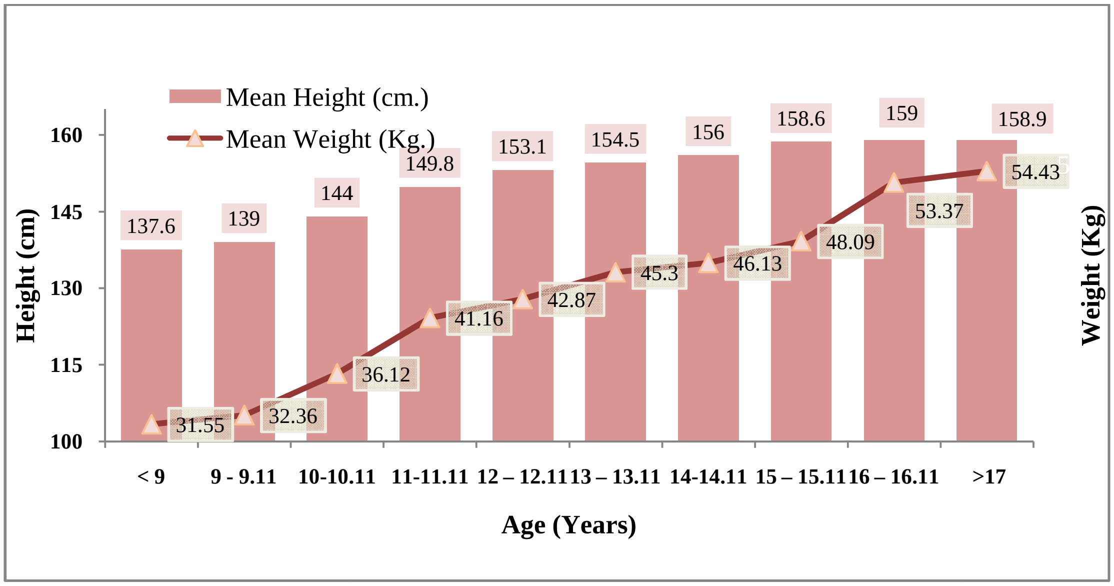


Figure 4.1.4: Peak Height Velocity of the Study Subjects (N=1041)

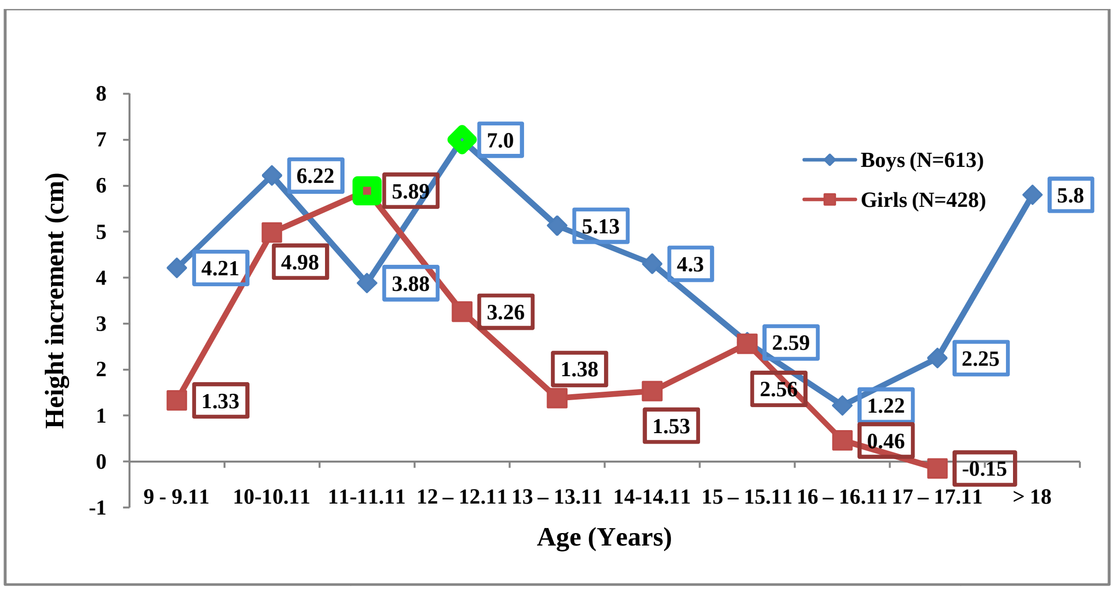


Figure 4.1.5: Peak Weight Velocity of the Study Subjects (N=1041)

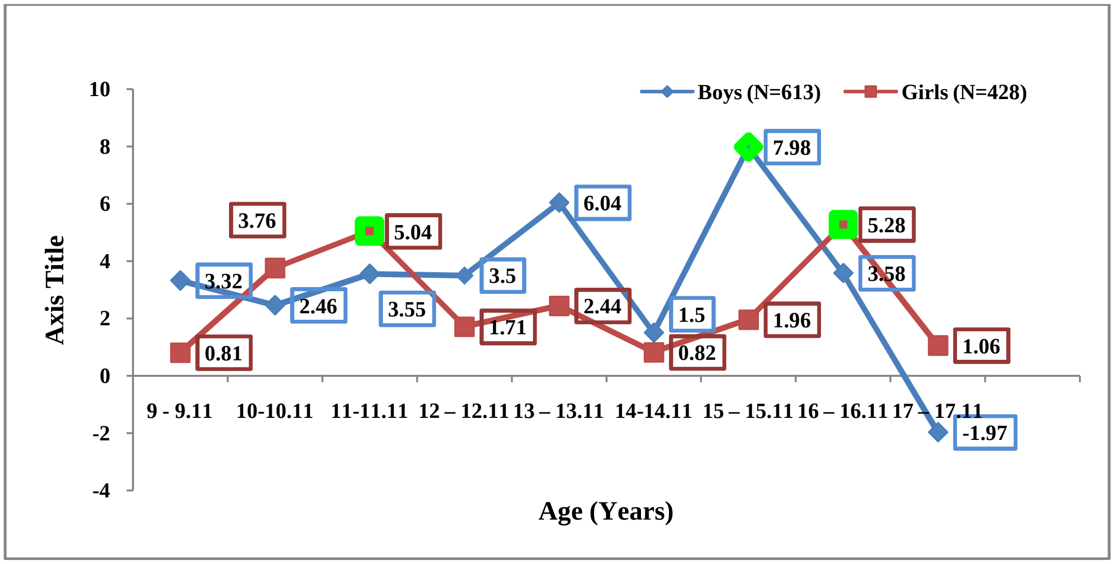
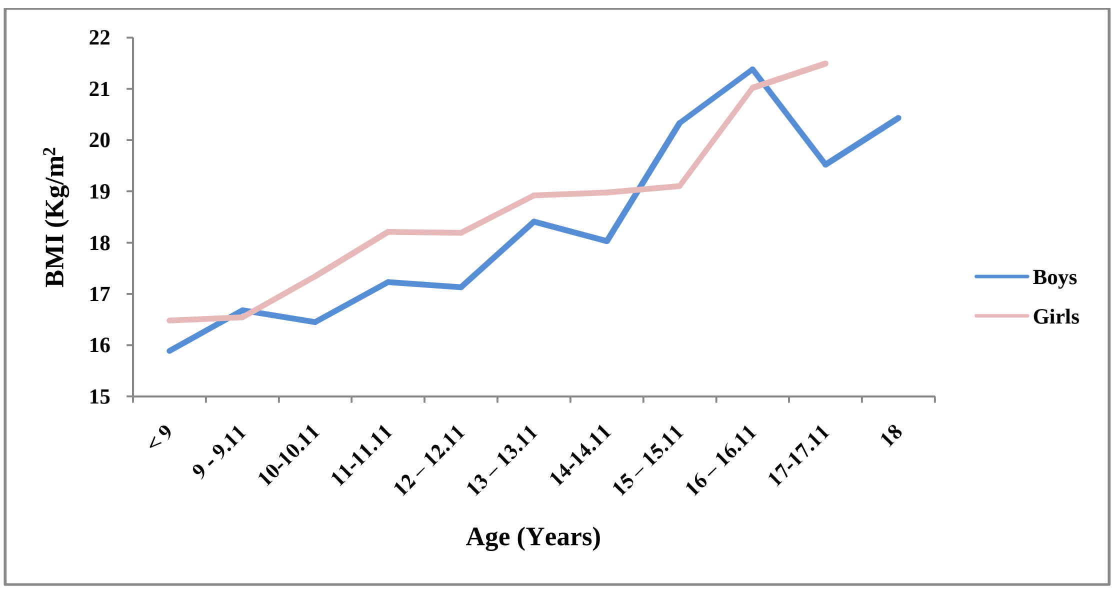


Figure 4.1.6: Growth Pattern (Mean BMI) Boys V/s Girls at different ages (N=1041)



Comparison with various reference standards

Anthropometric measurements and indicators found in the present study were compared with reference standards, wherever available. The reference standards used for comparison included, NCHS (2000), WHO (2007) and Standards by Agarwal et al (1993). On comparison of mean height of the boys in the present study with the reference standards, it was observed that till 12 years of age their height was more than the other standards (Figure 4.1.7). However after 16 years it at all ages was below the NCHS and WHO standards. Boys in the present study were taller than the subjects of Agarwal study at all ages. This could be attributed to the fact that Agarwal study was conducted almost 21 years back. Data from the present study shows that although boys were better off initially but later there was a marked deceleration in growth.

In case of girls, they were taller than the subjects at all ages upto 12 years of age with an exception at 8 years. Beyond 12 years, girls from the present study had lower values for height as compared to WHO and NCHS subjects. As seen in the case of boys', girls also had better height than the subjects from Agarwal study except at 16.5 years. These observations indicate that the subjects are not able to keep up the pace of growth with which they enter adolescence. Thus, early care is strongly recommended for these children for an optimal adolescent growth (Figure 4.1.8).

On comparison of weight for age median values with the widely used standards, it was observed that boys had a high initial weight for age than all the standards whereas 11.5 years onwards the values were lesser than the NCHS standards at all ages except between 16.5 to 17 years. The weight for age values were higher than the Agarwal standards at all ages except at 17.5 years (Figure 4.1.9).

In case of girls the weight for age values were lower than the NCHS standards at all ages above 11.5 years which is similar to boys. Only at 17.5 years the weight for age values were higher than the NCHS standard value. Only at 15 years and 16.5 years the values were lower than the Agarwal standards showing the inability of the subjects to attain full growth during the late stages of adolescence (Figure 4.1.10).

Comparison of BMI for age values of boys showed lower values for the present study except at 11, 16.5 and 17 years of age than the WHO or NCHS standards (Figure 4.1.11). Similarly for girls it was observed that values were higher than WHO or NCHS at 7.5,8.5, 13 and 17.5 years. While the values for BMI for age were lower in the present study as compared to NCHS and WHO at most of the ages, BMI for age at 9.5 and 10.5 years were higher than WHO values (Figure 4.1.12).

Figure 4.1.7: Comparison of Height for Age with other Reference Standards – Boys (N=613)

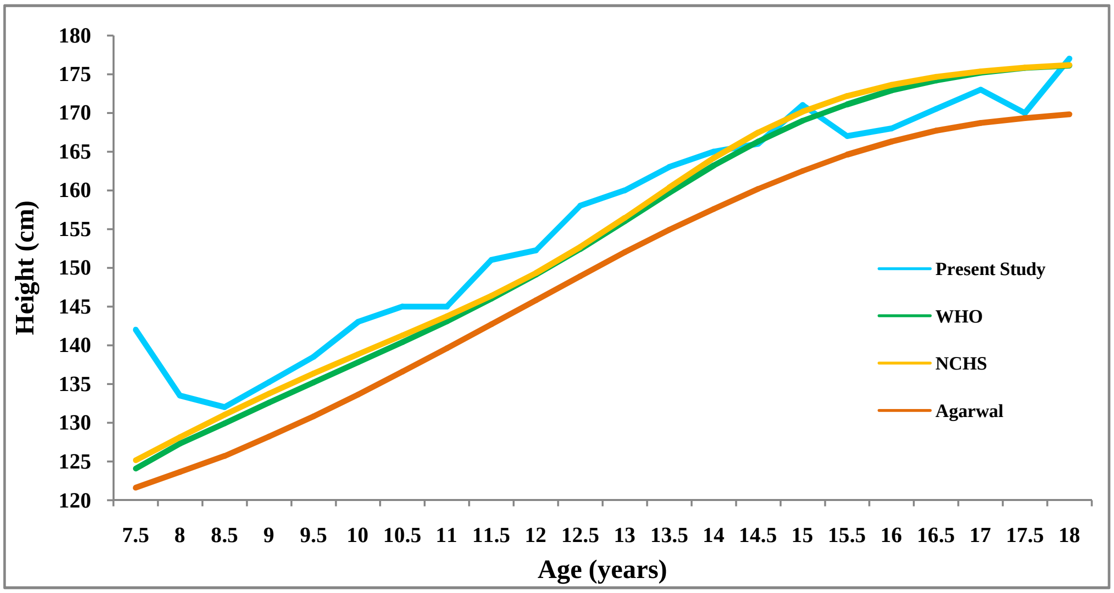


Figure 4.1.8: Comparison of Height for Age with other Reference Standards – Girls (N=428)

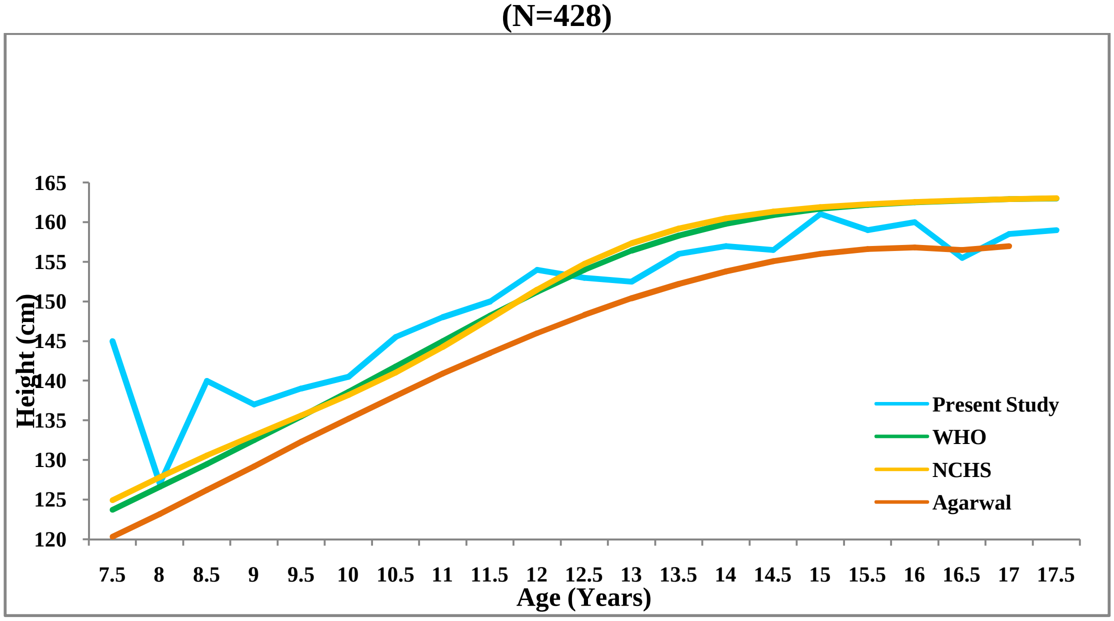


Figure 4.1.9: Comparison of Weight for Age with other Reference Standards – Boys (N=613)

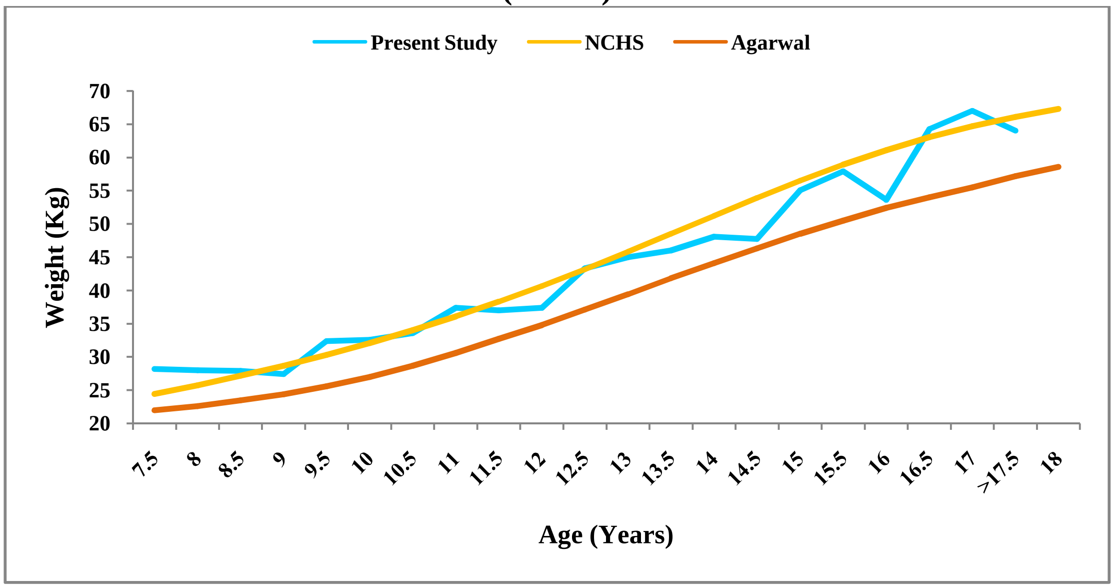


Figure 4.1.10:Comparison of Weight for Age with other Reference Standards – Girls (N=428)

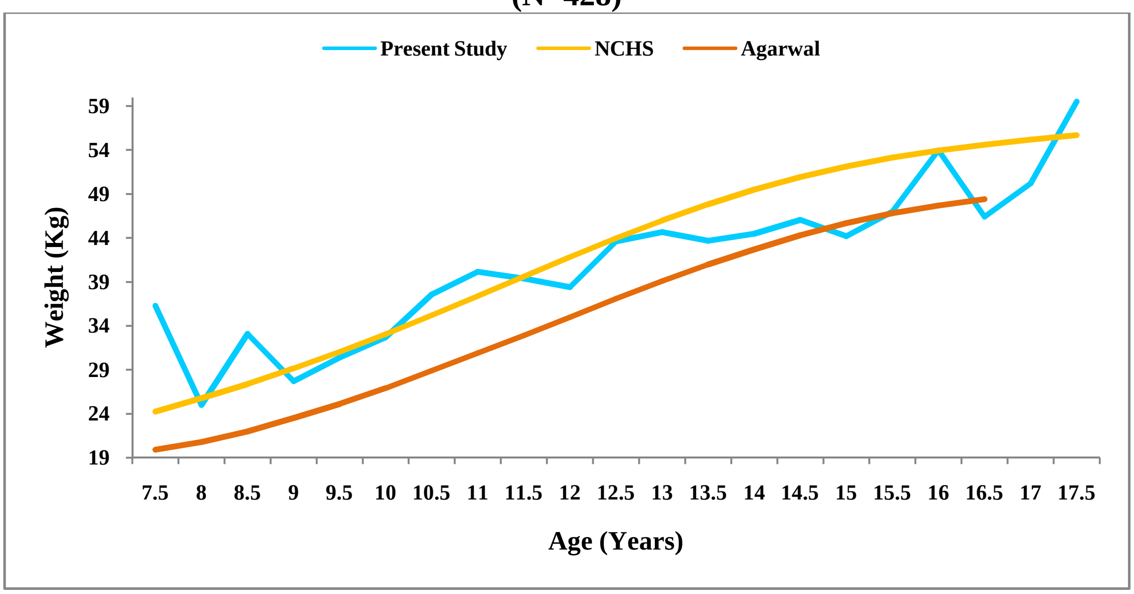


Figure 4.1.11: Comparison of BMI for Age with other Reference Standards – Boys (N=613)

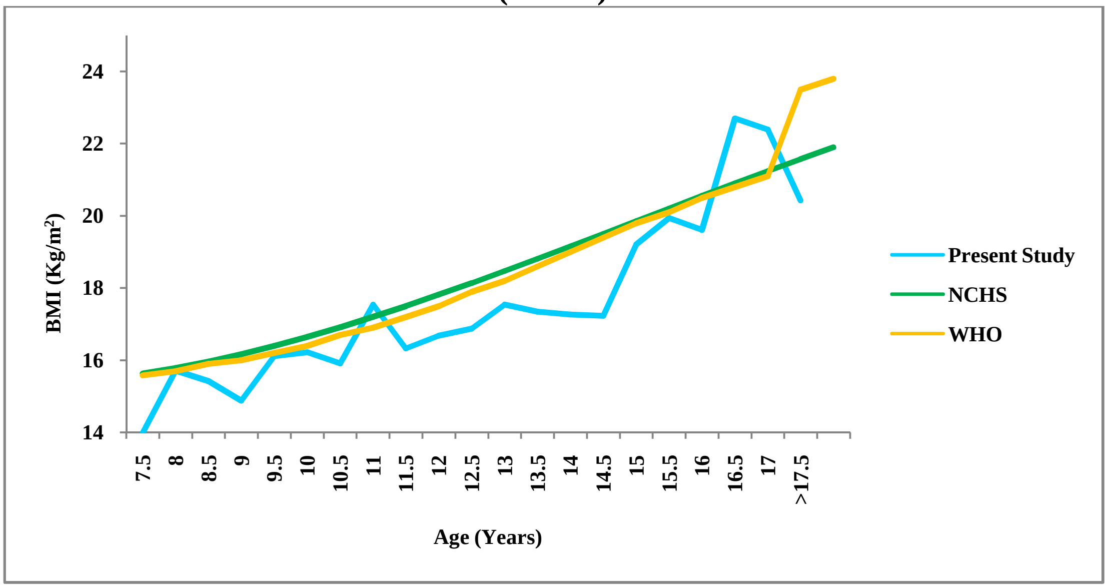
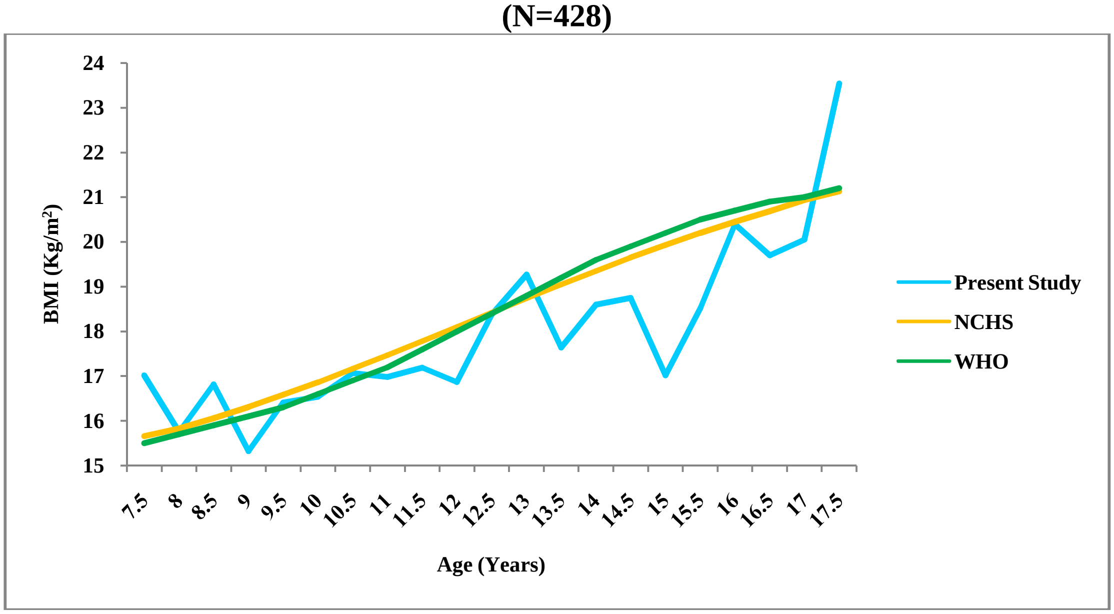


Figure 4.1.12: Comparison of BMI for Age with other Reference Standards – Girls (N=428)



Waist Circumference

Waist circumference (WC) is a highly sensitive and specific measure of central adiposity and is a good way to detect risk for heart health at an early stage (WHO, 2008).

Mean WC was found to be 65.48 cm and 64.16 cm in boys and girls respectively. Waist circumference values for boys were higher than girls at all ages except during pre-adolescence and at 17 years of age (Figure 4.1.13).

According to the WHO (WHO 2008) cut offs for waist circumference ($\leq$94 cm men, $\leq$ 80 cm for women) 0.02% subjects were above the normal levels of which 17.4% were boys and the rest 82.6% were girls while according to the International Diabetes Federation cut offs ($\leq$ 90 cm for men and $\leq$ 80 cm for women) for south Asians (IDF, 2006) 0.03% were above the cut off values of which 32.1% were boys and 67.9% were girls. Thus, it can be clearly seen that girls were at a higher risk as compared to boys with regards to waist circumference. Overall a very small percentage of subjects had high waist circumference.

Waist circumference cut-offs for adults were used in the present study as no cut offs for waist are available for adolescents. Several studies have been conducted to derive waist circumference percentiles for various populations and a comparison with those studies is shown in Table (4.1.4). As can be seen the WC for age values were higher for boys at all ages in the present study when compared with UK (2001) and Hong Kong (2008) values and lower than NHANES III (2004). However, when the data was compared with the findings of an Indian study carried out on 9060 children between 3 – 16 years in urban BANGLORE – the PEACH study (Rebecca et al, 2011), it was found that boys in the present study had similar WC values as their PEACH counterparts till 13years of age, but had lower WC at all later ages. Similarly girls had higher WC values than the Hong Kong and UK at all ages. Girls from the present study had lower WC than the subjects from NHANESIII and PEACH study at all ages, although initially at 7-8 years of age they had higher values. At age 15 years WC values of the girls were even lower than values from UK study.

Figure 4.1.13: Mean Waist Circumference According to Age and Sex (N=1041)

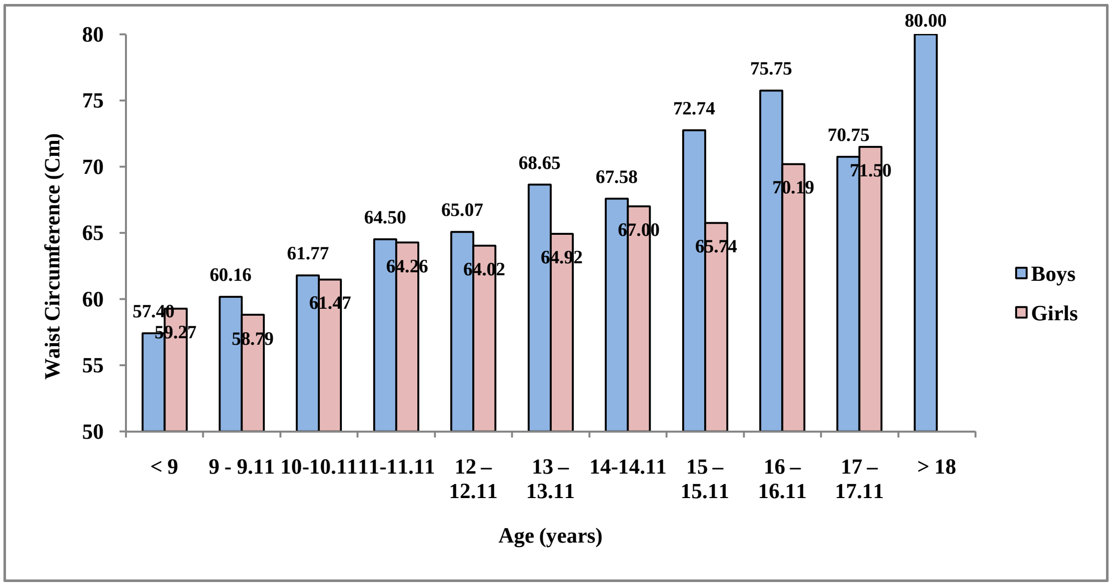


Table 4.1.4: Waist Circumference values - Comparison with other Reference standards

Age (Year)	Waist Circumference values (cm)											
	Present Study		UK (2001)		NHANES (2004)		Hong Kong (2008)		Canada (2004)		PEACH 2011 Bangalore India	
	B	G	B	G	B	G	B	G	B	G	B	G
7	--	63	--	52.7	--	56.9	--	--	--	51.7	--	54.8
8	56	59	54.7	54.1	59.3	58.9	--	--	55.3	53.2	56.6	56.8
9	58	58	56.4	55.3	61.3	60.8	--	--	57	54.7	58.4	59
10	60	61.5	58.2	56.7	63.3	62.8	--	--	58.8	56.2	60.4	61.3
11	62.75	62	60.2	58.2	65.4	64.8	62.3	60.2	60.4	57.8	62.5	63.7
12	64	62.5	62.3	60	67.4	66.7	64	61.6	61.8	59.2	64.7	--
13	66.5	62	64.6	61.7	69.5	68.7	66.1	63.8	63	60.3	67	66
14	66	66.5	67	63.2	71.5	70.6	68.8	65.7	64.3	61.1	69.4	68.2
15	70	63.5	69.3	64.4	73.5	72.6	71.4	67	65.7	61.7	72	70.2
16	73.5	69	71.6	65.3	75.6	74.6	73	67.4	66.9	62.2	74.7	72.1
17	70.25	69.5	--	--	77.6	76.5	74.3	67.8	68	62.6	--	73.6
18	80.5	--	--	--	79.6	--	75.5	--	68.8	--	--	--

Hip circumference

Mean hip circumference (HiC) was found to be 79.3 cm and 81 cm in boys and girls respectively. For boys mean HiC showed a steady increase from <9 yrs. to 13 yrs of age and again a sharp increase between 15-<17 years. On the other hand for girls it showed a steady increase throughout. Figure 4.1.14 and 4.1.15 show changes in waist and hip circumference of boys and girls at different ages.

Although waist circumference showed a steady rise at all ages except at 14 years and 17 years of age for boys, the mean hip circumference increased gradually till 16 years of age and showed a decline only at 17 years.

The maximum increase in mean waist and hip circumference in a year in case of boys was observed between 17 and 18 years of age that accounted for a 10 cm rise in WC and 5 cm increase in HiC (Figure 4.1.14).

Throughout there was a gradual increase in mean waist circumference levels of girls at all ages except at 9, 12 and 15 years of age. However there was gradual increase in the hip circumference at all ages.

For girls the maximum increase in mean waist and hip circumference in an year was seen at 11 years of age which was approximately 3 cm each (Figure 4.1.15).

Waist Hip Ratio (WHR)

Waist hip ratio (WHR) is an useful measure for predicting disease risk. An increase in WHR is associated with increased disease risk, and this association is evident in diverse populations (WHO, 2008).

In the present study, mean WHR was 0.83 and 0.80 in boys and girls respectively. WHR showed a decline during the early years of adolescence till the age of 14 and 13 years for boys and girls respectively. According to the WHO cutoffs for WHR of >0.9 for males and >0.85 for females, 6.2% boys and 8.9% girls had higher WHR. Figure4.1.16 and 4.1.17 show the WC and WHR of the subjects at various ages. Highest values for WHR in boys were seen at >18 years of age whereas for girls it was at <9years of age.

Figure 4.1.14: Waist and Hip Circumference at Different Ages- Boys (N=613)

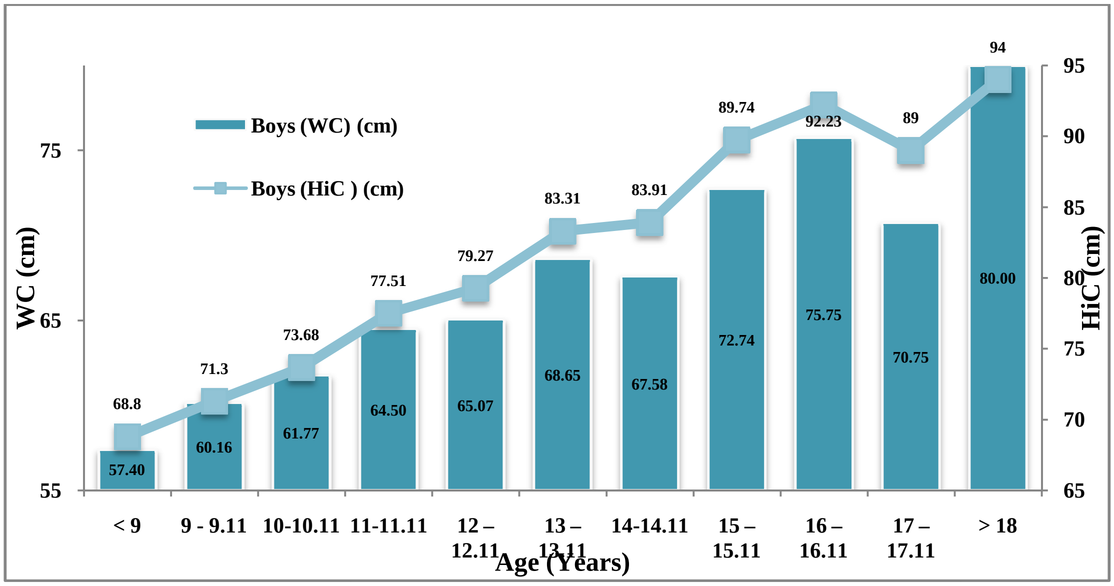


Figure 4.1.15: Waist and Hip Circumference at Different Ages- Girls (N=428)

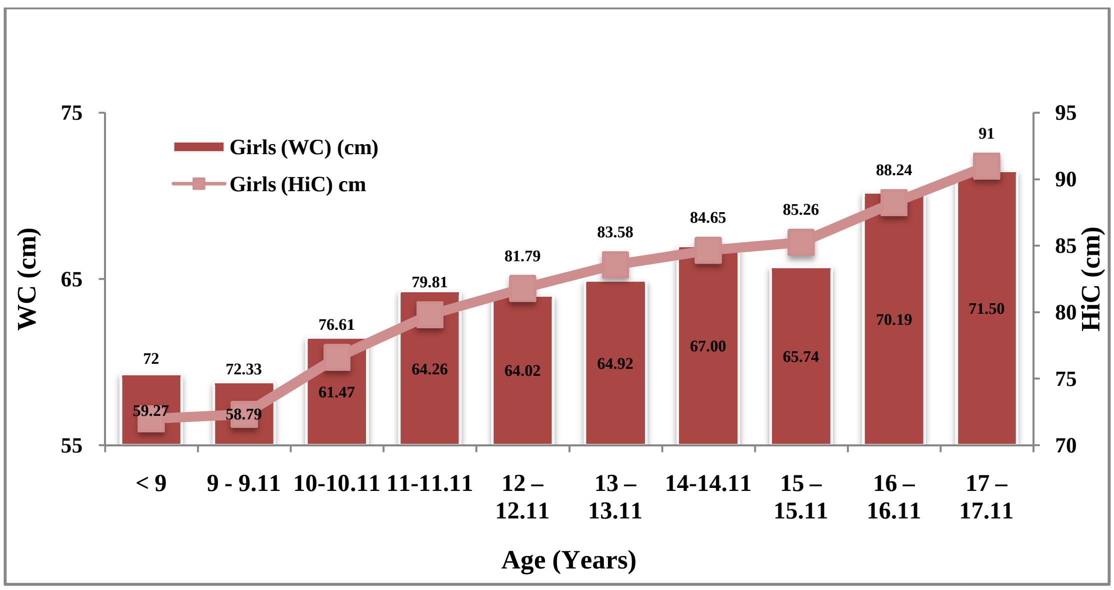


Figure 4.1.16: Waist Circumference and Waist Hip Ratio at Different Ages - Boys (N=613)

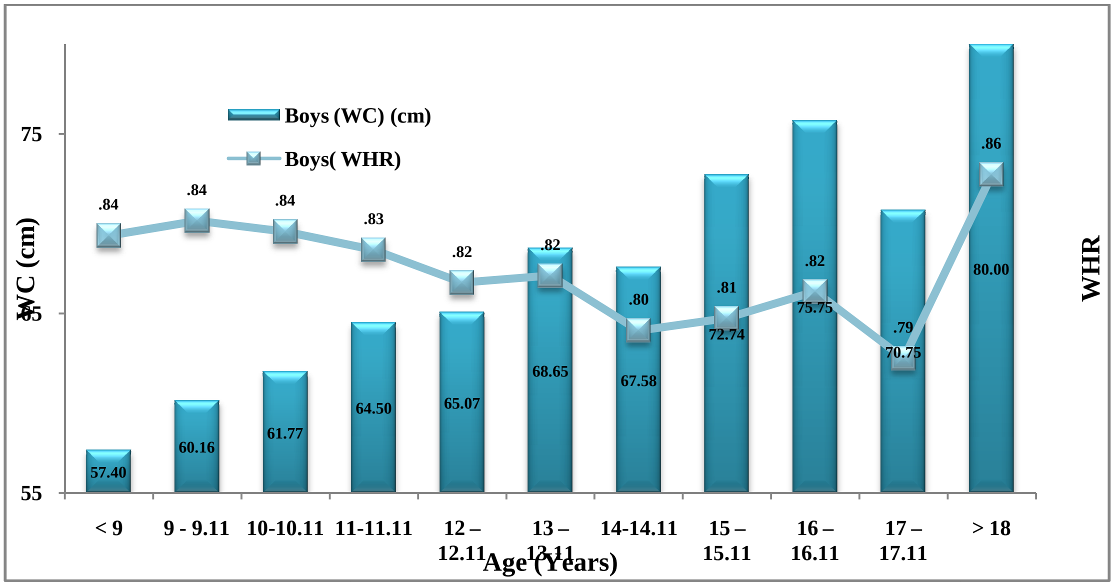
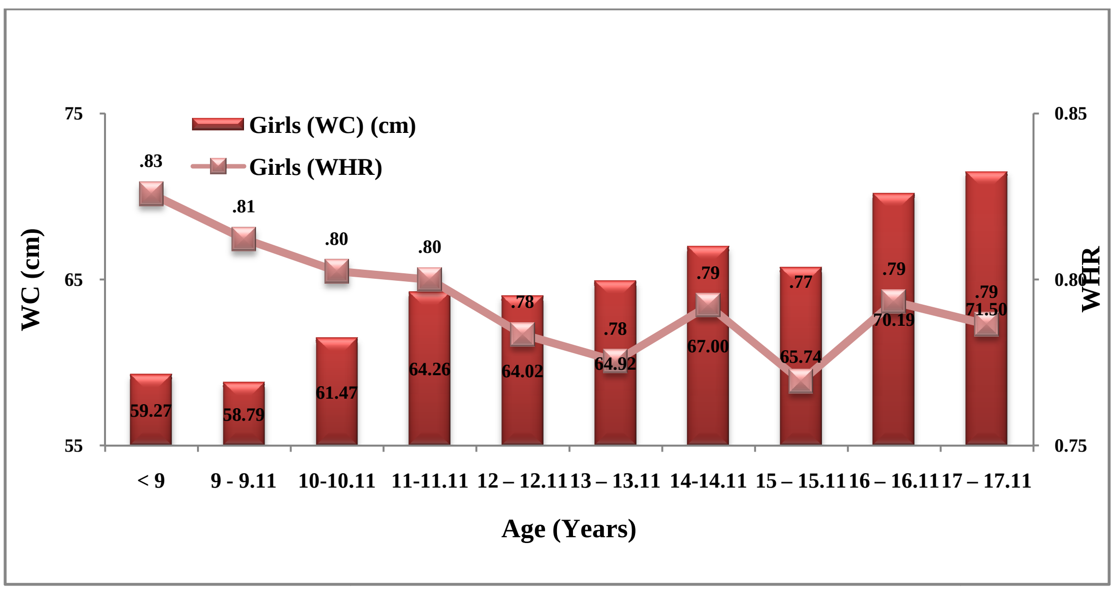


Figure 4.1.17:Waist Circumference and Waist Hip Ratio at Different Ages - Girls (N=428)



Mid Upper Arm Circumference

Mid upper arm circumference (MUAC) measurement is a reliable and a feasible method of assessing nutritional status of adolescents (Dasgupta et al, 2010).

Mean MUAC was 21.87cm in boys and 21.70cm in girls. Both girls and boys showed increase in the MUAC except at 17 years for boys and 15 years for girls (Figure 4.1.18). Girls showed a steady increase in MUAC measurements with age, but only after 16 years was there a noticeable difference. Boys showed rapid changes in MUAC measurements from 14 years onwards with an exception at 17 years. Until 12 years of age girls had higher MUAC values than boys (except at 10 years),beyond which MUAC was higher in the boys, except at 17years of age.

Available MUAC standards for Indian adolescents were given by Agarwal et al (1993). On comparison with Agarwal et al standards, the mean values of the subjects for mid upper arm circumference were found to be higher at all ages except at 17.5 years and 15.5 to 16 years for boys and girls respectively. At these points the mean MUAC values were lower than the Agarwal values indicating undernutrition in these stages (Figure 4.1.19 and 4.1.20).

Waist Stature Ratio

A waist to height ratio commonly known as WSR (Waist Stature Ratio) is an effective predictor of metabolic risks. Due to better measurement of relative fat distribution amongst subjects of different ages and stature WSR is regarded as an important indicator to assess the nutritional status (Hsieh, 2003). A WSR of <0.5 is recommended as normal (Ashwell and Hsieh, 2005).

Mean WSR was found to be0.43 irrespective of the sex. WSR ranged from 0.32 to 0.62 and 0.31 to 0.65 for girls and boys respectively. Almost ninety two percent of the subjects had a WSR of <0.5 which is well within the desired level. Amongst those with WSR >0.5, 29.4% were girls and 70.6% were boys.

On comparing subjects with a WSR (>0.5) with WAZ scores it was observed that 73.6 percent of these children had a z score of $\geq$ 2 SD. Of all the subjects with WSR > 0.5, 41.7% were overweight ($>$1SD BAZ) and 12.5% were obese ($>$2SD BAZ). WSR was significantly correlated to weight, BMI and waist circumference ($p<0.01$, 2-tailed). Age had no effect on the waist stature ratio.

Figure 4.1.18: Mean Mid Upper Arm Circumference According to Age and Sex (N=1041)

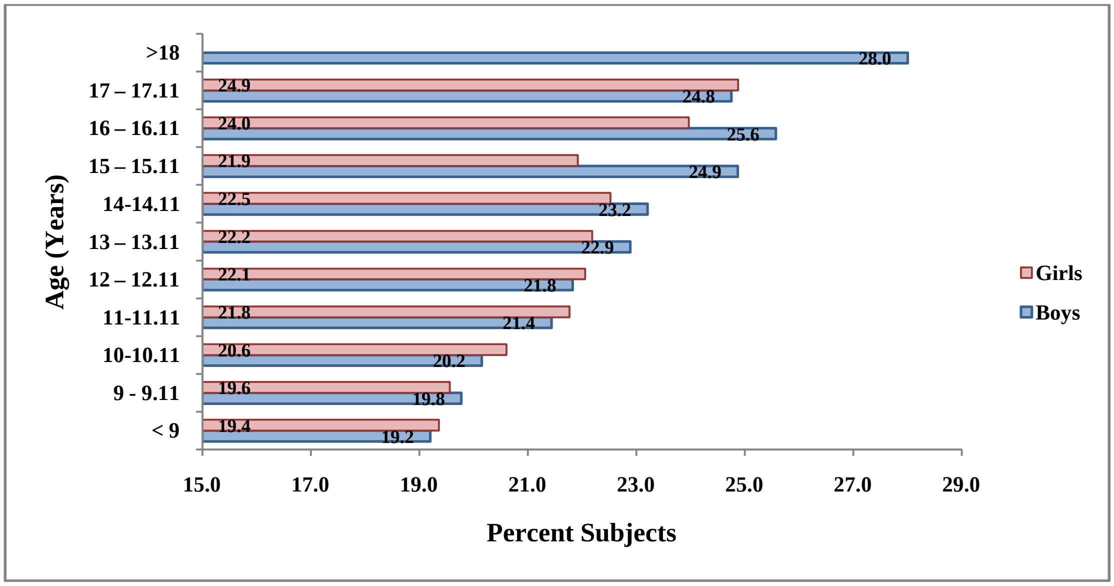


Figure 4.1.19: Comparison of MUAC with Different Standards – Boys (N=613)

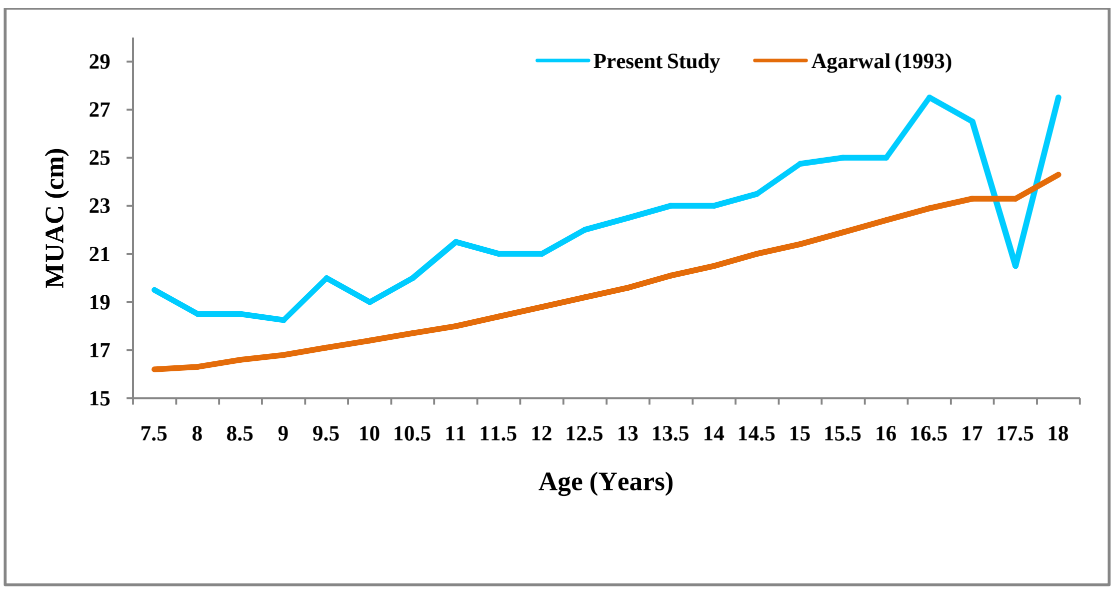
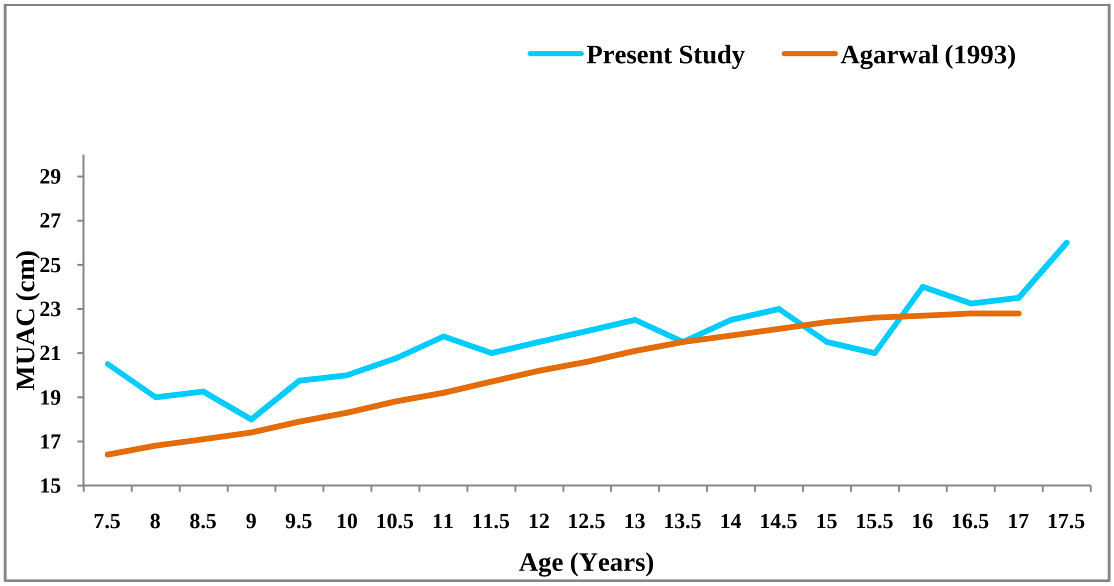


Figure 4.1.20:Comparison of MUAC with Different Standards – Girls (N=428)



Prevalence of malnutrition (Over nutrition and under nutrition)

To assess the prevalence of malnutrition, indices namely, BMI for age (BAZ), Height for age (HAZ) (WHO 2007 standard) and Weight for age (WAZ) (CDC, 2000) were used.

The WHO Global Database on Child Growth and Malnutrition uses a Z-score cut-off point of <-2 SD to classify low weight-for-age, low height-for-age and low weight-for-height as moderate and severe undernutrition, and <-3 SD to define severe undernutrition. The cut-off point of >+2 SD classifies high weight-for-height as overweight in children.

Weight for Age

Mean weight was 42.25$\pm$ 0.36 kg. while mean weight for age Z score was found to be -0.26 $\pm$ 0.03 kg. According to the CDC 2000 standards for weight for age of adolescents it was found that prevalence of underweight among subjects in the present study was 24.6% (Table 4.1.5). Mild form (<-1 to -2 SD) was more prominent (18.9%) as compared to moderate (4.8%) and severe forms (0.9%) (Figure 4.1.21)

Prevalence of underweight was highest during early and mid-stages of adolescence. On further analysis according to various stages of adolescence it was found that prevalence was highest in boys during early-adolescence whereas girls had the highest prevalence during mid-adolescence (Figure 4.1.22). Thus, there is a need to start interventions well before the onset of adolescence so as to avoid under nutrition among these children.

Height for Age

Mean height and mean height for age z score were found to be 152.39$\pm$ 0.36 cm. and 0.12 $\pm$ 0.03 cm. respectively. On using WHO 2007 growth standards for height for age, stunting was seen in 14.3% subjects. Mild (11.8%) form was more as compared to moderate (2.2%) and severe (0.3%) forms (Table4.1.6). As shown in Figure 4.1.23 mild form of stunting was more in girls as compared to boys. It was also observed that stunting was highest in early and mid-adolescence. Stunting was highest amongst girls during mid-adolescence whereas amongst boys it was observed that almost an equal percentage of children were stunted during early and mid-adolescence (Figure 4.1.24).

Table 4.1.5: Nutritional status of the study subjects (WAZ scores)

Nutritional status (Z scores)	Percent Subjects		
Weight for age- Z scores			
	Total (N =1041) % (n)	Boys (N = 613) % (n)	Girls (N = 428) % (n)
≤ -3	0.9 (9)	0.8(5)	0.9(4)
-2.99 to -2	4.8 (50)	4.9(30)	4.7 (20)
-1.99 to < -1	18.9(197)	17.1 (105)	21.5 (92)
-1 to +1	62.8 (654)	63.8(391)	61.4 (263)
1 to 1.99	11.0(114)	11.9 (73)	9.6(41)
2 to 2.99	1.6(17)	1.5(9)	1.9 (8)

Figures in the parenthesis indicate number of subjects

Table 4.1.6: Nutritional Status of the Study Subjects (HAZ Scores)

Nutritional status (Z scores)	Percent subjects		
Height for age- Z scores			
	Total (N =1041) % (n)	Boys (N = 613) % (n)	Girls (N = 428) % (n)
≤ -3	0.3 (3)	0.3 (2)	0.2 (1)
-2.99 to -2	2.2 (23)	2.3 (14)	2.1(9)
-1.99 to ≤ -1	11.8 (123)	8.8 (54)	16.1 (69)
-0.99 to < +1	65.8 (685)	64.8 (397)	67.3 (288)
1 to 1.99	14.1 (147)	16.6 (102)	10.5 (45)
2 to 2.99	4.6 (48)	5.9 (36)	2.8 (12)
≥ 3	1.2 (12)	1.3 (8)	0.9 (4)

Figures in the parenthesis indicate number of subjects

Figure 4.1.21: Prevalence of Underweight (N=1041)

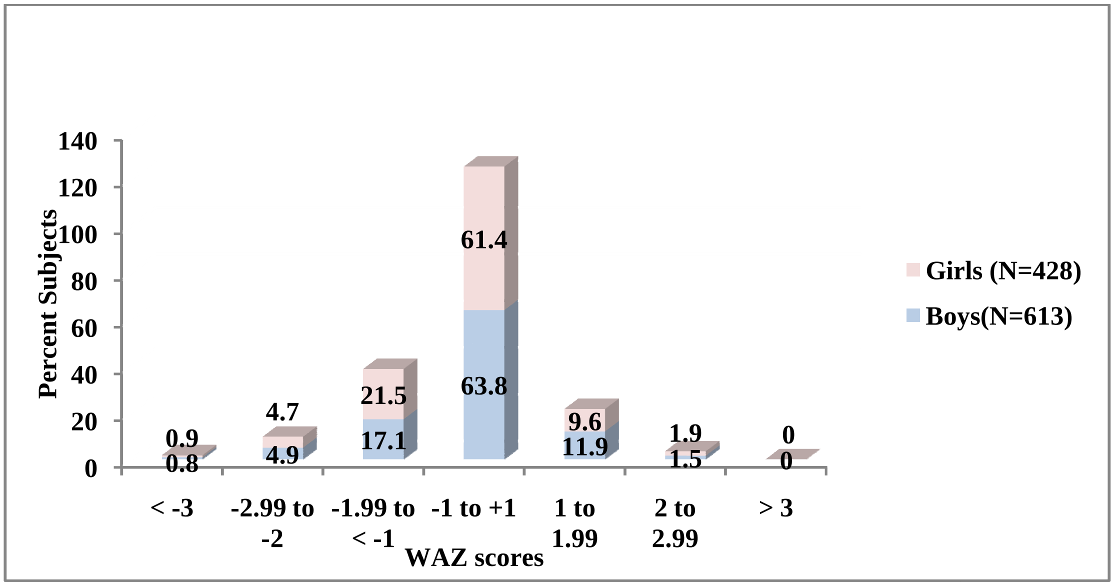


Figure 4.1.22: Prevalence of Underweight according to the Stage of Adolescence

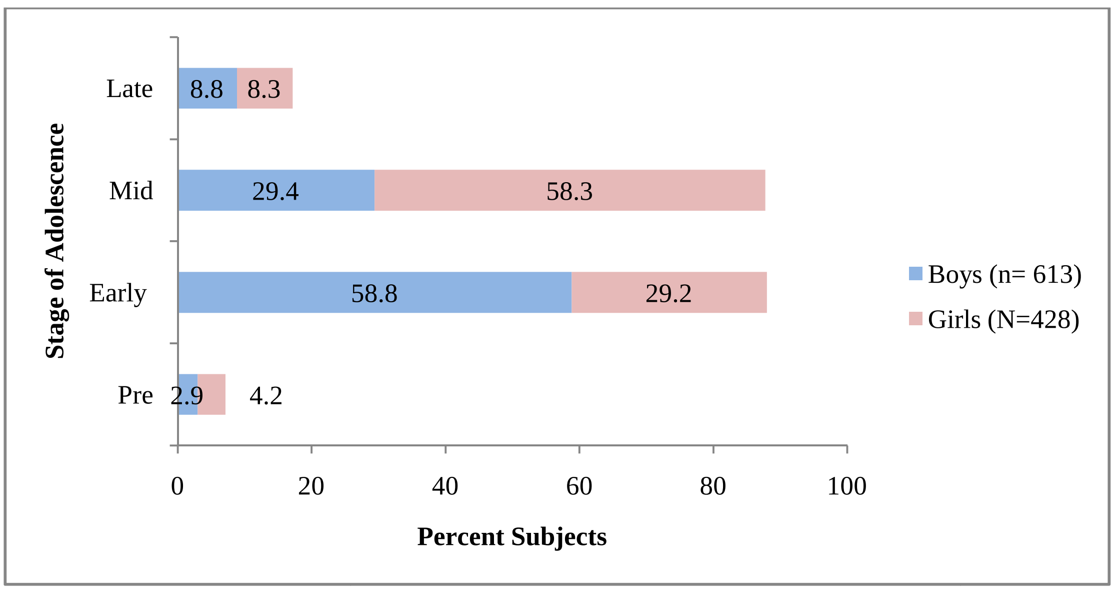


Figure 4.1.23: Prevalence of Stunting (N=1041)

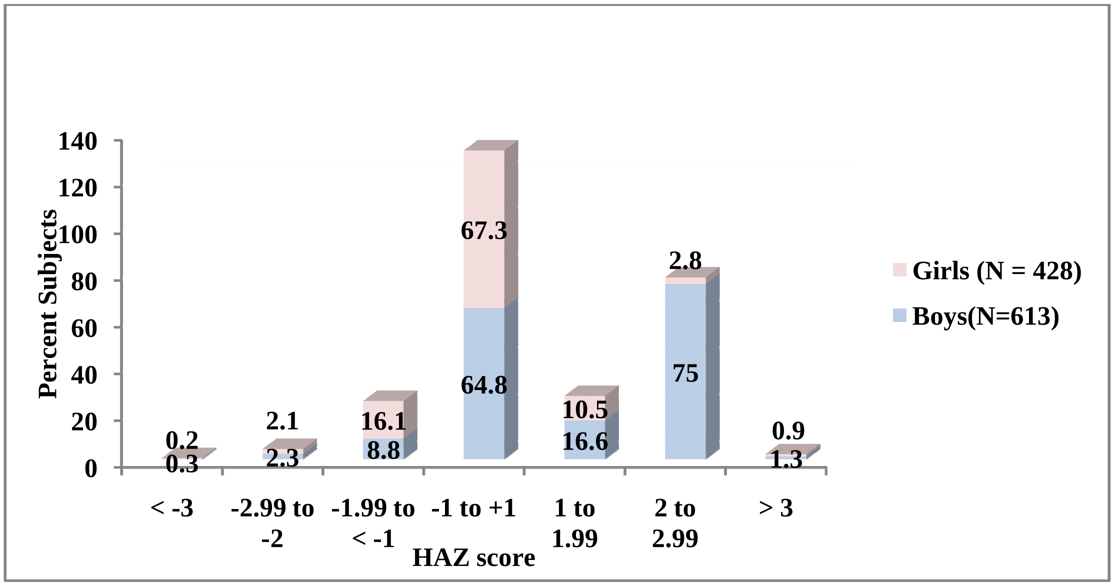
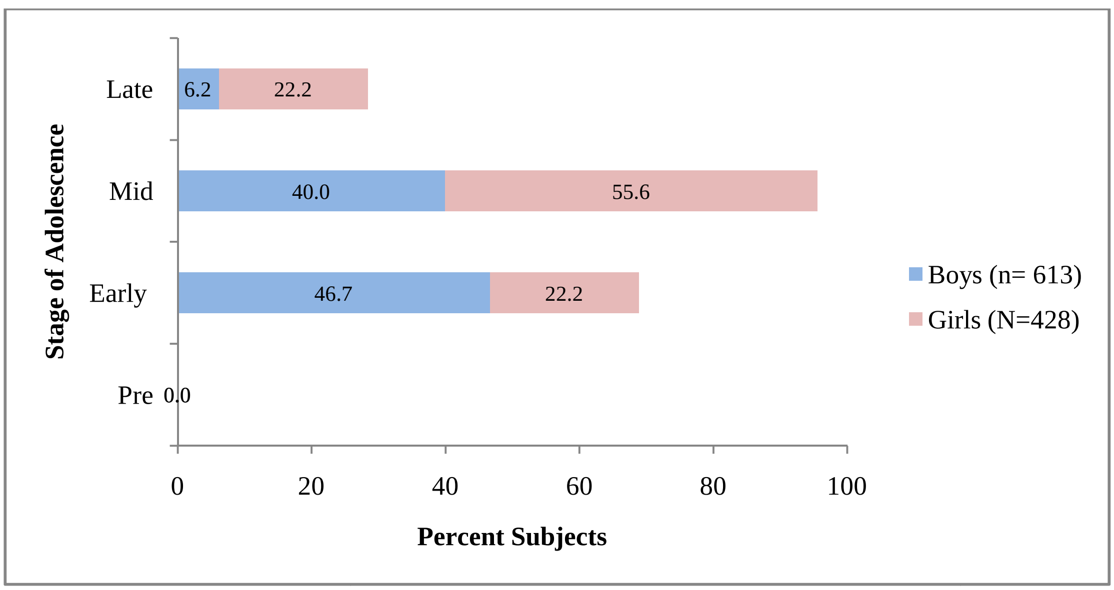


Figure 4.1.24: Prevalence of stunting according to the Stage of Adolescence (N=1041)



BMI for Age

Mean BMI and Mean BMI for age were found to be 17.94 $\pm$ 0.10 kg/m^2 and -0.35 $\pm$ 0.04 kg/m^2 respectively. Nearly 33% children were found to be thin (Table 4.1.7). Mild thinness (< -1 SD of BMI-for-age z-score) and severe thinness (< -3 SD of BMI-for-age z-score) were observed in 22.6% and 2.2% (95% CI 2.1-3.6) children respectively (Figure 4.1.25). Children between 13 - <16 years were less likely to be thin as compared to children between 10 - <13 years. Highest prevalence of thinness was during the early-adolescence stage followed by mid-adolescence (Figure 4.1.26).

On comparing the data for BMI for age with the WHO 2007 standards, a clear shift towards left was evident, indicating higher prevalence of thinness as compared to overnutrition (Figure 4.1.27).

On using WHO 2007 growth standards, mean BMI for age z-score was found to be -0.35 $\pm$ 0.04 kg/m^2. Overall prevalence of over nutrition was assessed to be 16.9%. Prevalence of overweight (> +1 SD of BMI-for-age z-score) and obesity (> +2SD of BMI-for-age z-score) were found to be 13.4% and 3.5% respectively (Figure 4.1.28). More girls were overweight whereas obesity prevalence was higher in boys. Further analysis revealed that gender had no significant association with overall prevalence of over nutrition. Almost 80% of the overweight or obese children belonged to early and mid-adolescence irrespective of gender (Figure 4.1.29).

Figure 4.1.30 and 4.1.31 show the prevalence of dual burden of malnutrition amongst the study subjects. In boys the malnutrition was highest during early-adolescence whereas in girls it was highest during pre-adolescence. Majority of overweight or obese boys were found in early-adolescence whereas for girls most of them were in their mid-adolescence. Prevalence of thinness was highest amongst boys during mid-adolescence while amongst girls it was highest during pre-adolescence.

Thus, the above scenario clearly indicates that dual burden of malnutrition (according to BMI for age) does exist in urban Vadodara school children and efforts need to be directed towards them since early years of life, before the onset of adolescence, so that malnutrition can be reduced during adolescence.

Table 4.1.7: Nutritional Status of the Study Subjects (BAZ scores)

Nutritional status (Z scores)	Percent subjects		
BMI for age- Z scores			
	Total (N =1041)	Boys (N = 613)	Girls (N = 428)
≤ -3	2.2 (23)	2.8(17)	1.4 (6)
-2.99 to -2	7.9 (82)	9.3 (57)	5.8 (25)
-1.99 to < -1	22.6 (235)	22.8 (140)	22.2 (95)
-1 to +1	50.5 (526)	48.6 (298)	53.3 (228)
1 to 1.99	13.4 (139)	12.6 (77)	14.5(62)
2 to 2.99	3.2 (33)	3.6 (22)	2.6(11)
≥ 3	0.3 (3)	0.3 (2)	0.2(1)

Figures in the parenthesis indicate number of subjects

Figure 4.1.25: Prevalence of Thinness (N=1041)

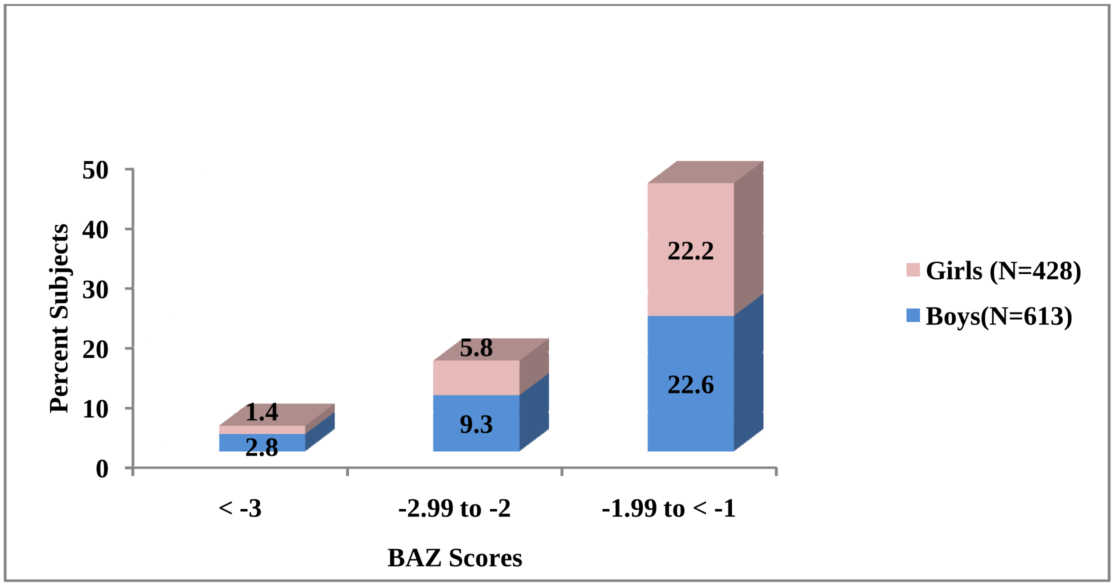


Figure 4.1.26: Prevalence of Thinness According to the Stage of Adolescence (N=1041)

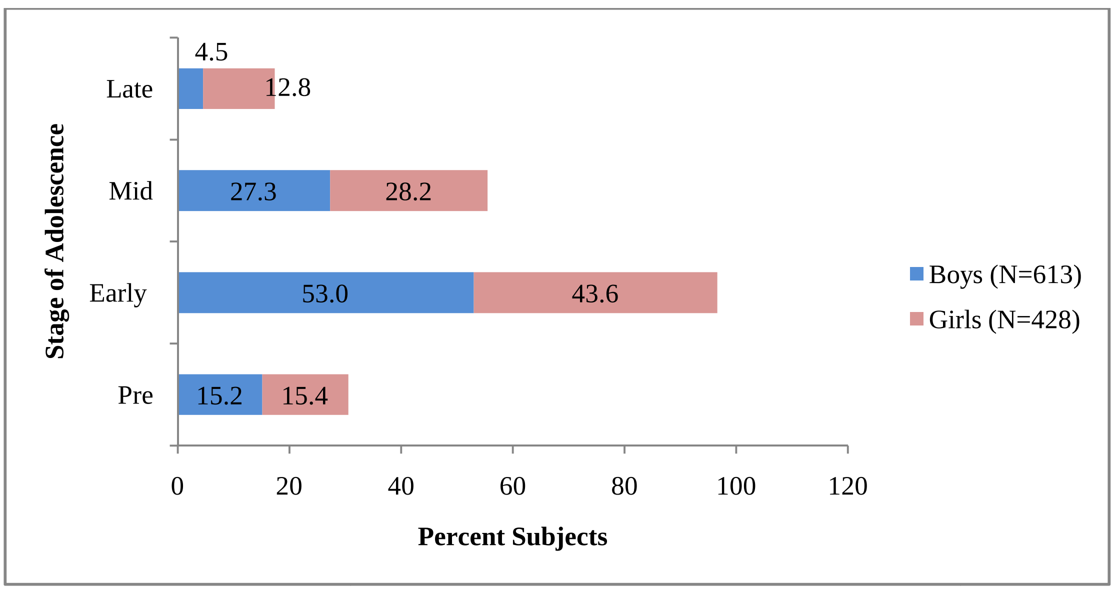


Figure 4.1.27: BAZ scores (Present study) in comparison to WHO 2007 BAZ scores

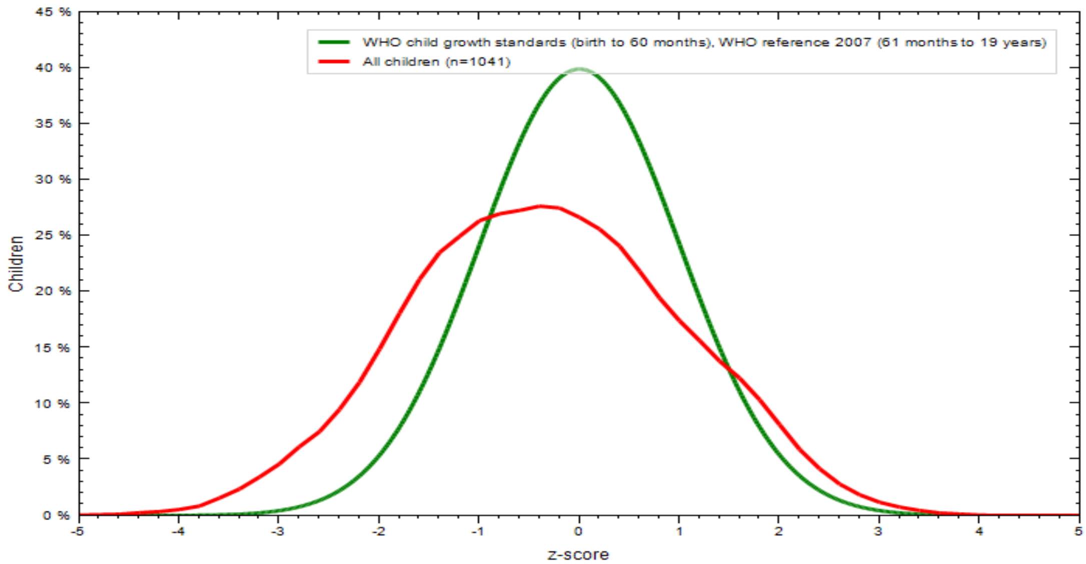


Figure 4.1.28: Prevalence of Overweight and Obesity (N=1041)

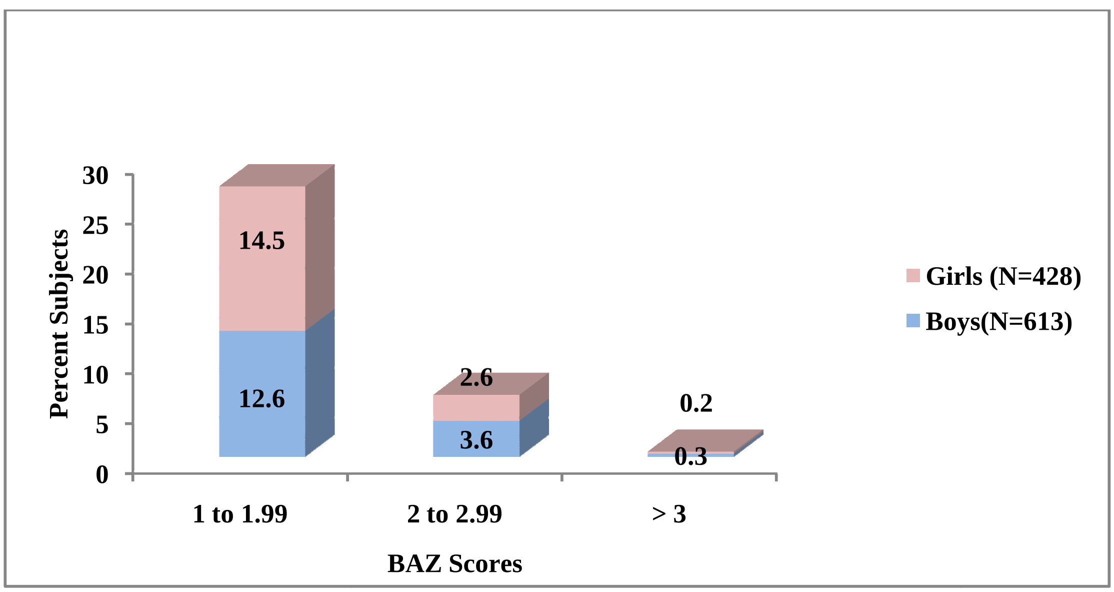


Figure 4.1.29: Prevalence of Overweight and Obesity According to the Stage of Adolescence

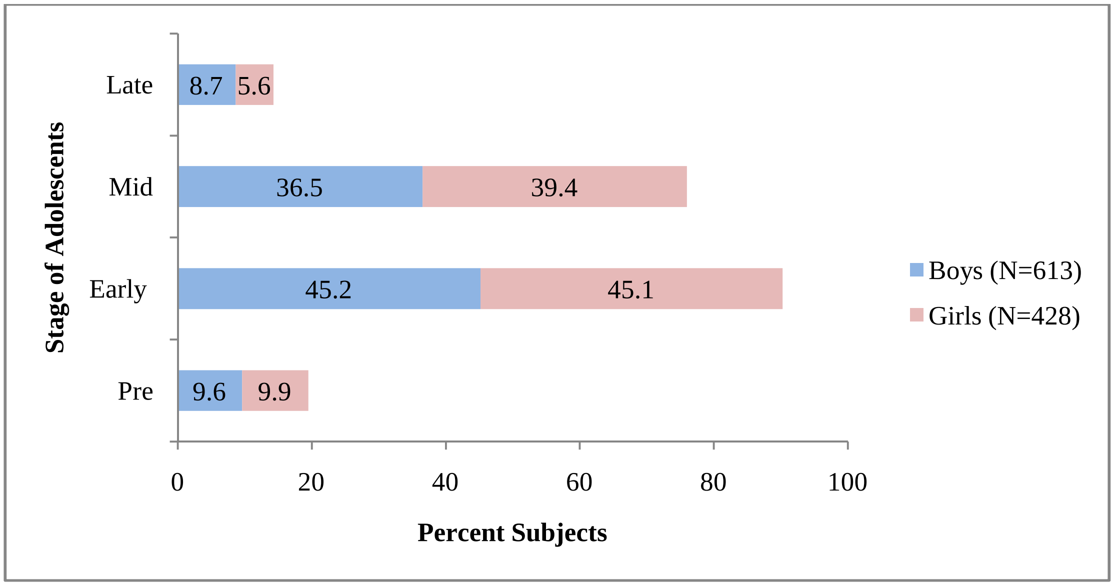


Figure 4.1.30: Prevalence of Dual Burden of Malnutrition – Boys (N=613)

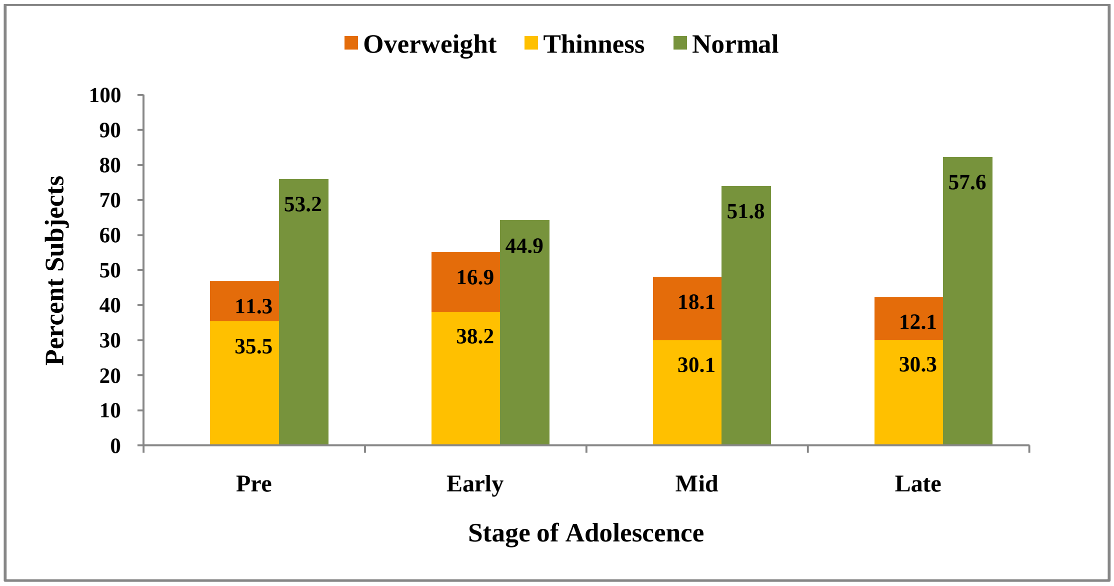
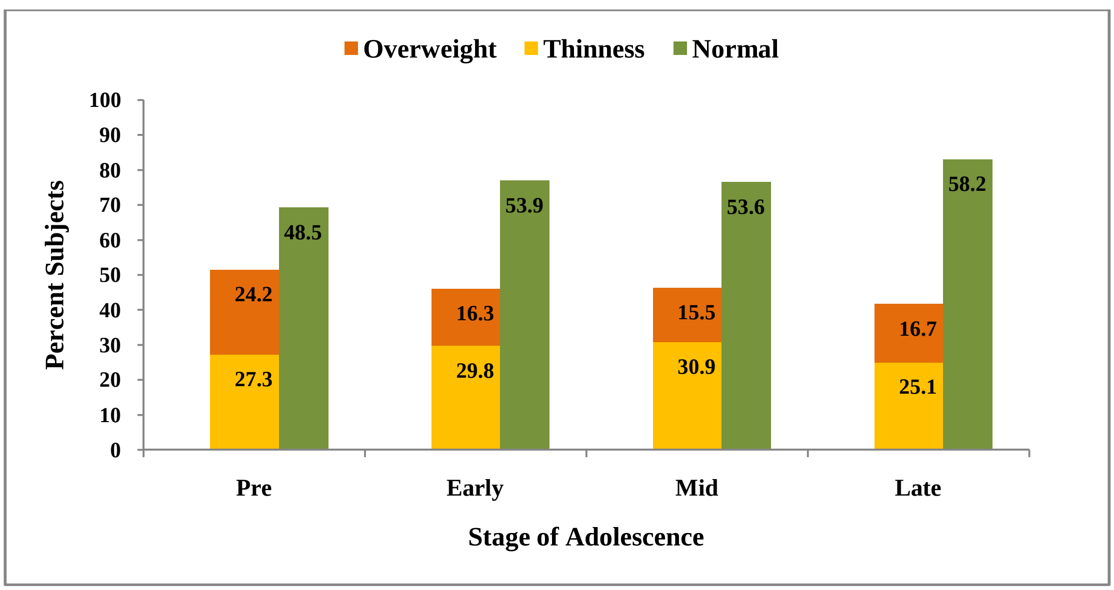


Figure 4.1.31: Prevalence of Dual Burden of Malnutrition – Girls (N=428)



Determinants of Nutritional Status of the Children in the Present Study

Multivariate analysis was carried out to assess the factors that were significantly correlated with the nutritional status of the children. For this the z scores of weight for age, Height for age and BMI for age were each taken as the dependent variables and factors related to the socioeconomic status of the children were taken as the independent variables. Multiple regression analysis was then carried out taking each of the anthropometric indicator as the dependent variable.

Factors significantly associated with Weight for Age Z Scores – Multiple Regression Analysis

On carrying out multiple regression analysis taking weight for Z score as the dependent variable, four factors were found to exert an independent effect on it (Table 4.1.8) Father's education was the first factor to enter the equation and explained 1.6% of the variation seen in weight for age for children. Age entered on the second step and accounted for 0.8% of the variation. Per capita income entered the third step and explained 0.6% of the variation. Family size was the fourth factor accounting for 0.7% of the variation. The four factors together explained 3.7% of the variation in weight for age Z score.

Factors significantly associated with BMI for Age Z Scores – Multiple Regression Analysis

A total of three factors entered the equation of multiple regressions when BMI for age was taken as the dependent variable Table 4.1.9. Per capita income was the first factor to enter the multiple regressions and explained 3.2% of the variation seen in BAZ scores. Sex entered the second step and explained 1% of the variation seen. Father's education entered the third step accounting for 0.7% of variation seen in BMI for age z scores. All the three factors together accounted for 4.9% of the variation as observed in BAZ scores.

Factors significantly associated with Height for Age Z Scores – Multiple Regression Analysis

Three factors were found to have an independent effect on height for age z scores. Age was the first factor to enter the equation and explained for 5.7% of the variation in HAZ scores (Table 4.1.10). Sex entered on the second step and accounted for 2% of the variation. Dietary habits of

Table 4.1. 8: Factors significantly associated with Weight for Age Z Scores – Multiple Regression Analysis

Variable	Adjusted R^2	SE	Variation Explained	'F' Value
Father's Education	0.016	1.10	1.6	8.64***
Age	0.024	1.10	0.8	6.8***
Per Capita Income	0.030	1.10	0.6	5.86***
Family Size	0.037	1.10	0.7	5.54***

Table 4.1. 9: Factors significantly associated with BMI for Age Z Scores – Multiple Regression Analysis

Variable	Adjusted R^2	SE	Variation Explained	'F' Value
Per Capita Income	0.032	1.38	3.2	16.6***
Sex	0.042	1.37	1.0	11.41***
Father's Education	0.049	1.37	0.7	9.11***

Table 4.1. 10: Factors significantly associated with Height for Age Z Scores – Multiple Regression Analysis

Variable	Adjusted R^2	SE	Variation Explained	'F' Value
Age	0.057	1.17	5.7	29.5***
Sex	0.077	1.16	2.0	20.7***
Dietary Habits	0.084	1.16	0.7	15.4***

the subjects entered the third step and explained for 0.7% of the variation in height for age z scores. Thus, multiple regression analysis could explain for the variations seen in the nutritional status of the subjects. Age of the subjects, per capita income, father's education and sex were found exert an independent effect on the nutritional status of the subjects.

Key Findings

- Three urban middle income group schools were purposively selected and all the students from standard V to XI were enrolled for the study.
- Majority of the subjects were in the age group of 10- 14 years.
- Anthropometric measurements were carried out on 1041 subjects. Peak height velocity (PHV) of girls was observed between 11 - <12 years of age and for boys it was between 12 - <13 years. PHV was 5.89cm and 7 cm in girls and boys respectively.
- Peak weight velocity (PWV) of girls was found between 11- 12 years while for boys it was between 15-16 years of age. PWV was 5.28 kg and 7.98 kg for girls and boys respectively.
- Prevalence of underweight (Weight for age z scores <-1 SD) was found to be 24.6% including 5.7% subjects with WAZ scores <-2 SD.
- Prevalence of stunting (Height for age z scores <-1 SD) was 14.3% which includes 2.5% subjects with HAZ scores below -2SD.
- BMI for age z scores below -1 SD, as indicative of thinness, were found in 33% of the subjects including 101% subjects with BAZ scores <-2 SD.
- Thirteen percent subjects were found to be overweight (BAZ score>1 SD) while 3.5% subjects were obese (BAZ scores >2SD) in the present study.
- The dual burden of malnutrition was highest amongst the early and mid-adolescents.
- Age, sex, father's education and per capita income exerted an independent effect on the nutritional status of the subjects.

Discussion

Adolescence is characterized by an exceptionally rapid rate of growth. Only during the fetal life and early infancy the rate of growth exceeds adolescent growth (Tanner, 1978). As adolescents look comparatively healthy than other life cycle groups they receive low priority (Delisle, 2005, Anand, 1995 and McPherson, 2005). WHO suggests that in South East Asian region a large number of adolescents suffer from malnutrition which adversely impacts their health and development (Adolescent Nutrition, 2006).

Anthropometry is considered a good indicator of nutritional status and health risks in this group (WHO physical status, 1995).

In the present study, mean height was found to be 153.53 cm in boys and 150.76 cm in girls, while the mean weight of the subjects irrespective of gender was 42.25 kg. Boys had a significantly higher mean height than girls whereas girls had significantly higher values for BMI than boys. A comparison with the standards shows that although the height and weight for age values of the subjects were higher that Agarwal standards (Indian Standards) and the initial values were higher than the WHO or NCHS standards still the subjects had lower values as the age progressed, indicating the need for proper nutrition and health care during adolescence. Mean height and weight of the subjects between 12-18 years of age were consistent with a previous study on school children in urban Vadodara (Mani et al, 2008). Mean BMI was 17.63 kg/m^2 and 18.38 kg/m^2 for boys and girls respectively which quite similar to a previous study conducted in high income groups of Vadodara (Gandhi, 2004). Girls had higher values for mean BMI than boys, a trend which was similar to that observed in the study by Gandhi and Iyer (2004) and Mani et al (2008). BMI for age was lower than the standards at almost all the ages indicating improper growth in these subjects.

Better utilization of health care services and healthy dietary practices during an early age has a positive impact on the growth profile of children (CDC, 1996). Thus, the deceleration in growth observed in the current study could have been avoided with better health care utilization pre and early-adolescence.

Waist circumference values for the present study were lower than the NHANES III values irrespective of sex. These values mostly were similar to the Bangalore study (PEACH study) on urban adolescents (Rebecca et al, 2006).

Mean waist hip ratio of the subjects was 0.83 and 0.80 for boys and girls respectively. WHR showed a plateau pattern initially until 10 years in boys and then later dropped till 14 years of age. Amongst girls WHR dropped till 10 years, showed a plateau between 10-11 years, dropped again at 11-12y and plateaued between 12-13 years. The mean WHR were found to be similar to that shown by Mani et al (2008). The above observations were consistent with previous studies (Mushtaq, 2011Pakistan/ Haas G 2011).

Mid upper arm circumference values for the present study were found to be higher than the Agarwal standards (1993), ICMR values (1996) at all ages. The mean MUAC values for boys at all ages was also higher than the values reported by Dasgupta et al (2010). However, these values were quite low as compared to the NCHS values at all ages (McDowell MA,2008). A similar trend was observed in case of girls.

Mean WSR values were found to be 0.43 irrespective of the sex. These were lower in comparison to 0.45 in Pakistan (Mushtaq M, 2011)

Prevalence of underweight in the present study was found to be 24.6% which was quite low as compared to that reported by Dambhare (2011) and Srivastava (2012) among school going adolescents in peri-urban areas. However, prevalence of underweight was highest during early-adolescence in all the three studies. Stunting was 14.3% which was higher than the Rohtak study in urban adolescents (Vashist and Goel, 2009). However it was lower than that reported by other studies among urban school going children (Mehanand Pal, 2009; Srivastava et al, 2012).

A higher percentage of boys had HAZ scores lesser than -2SD as compared to girls but the difference was insignificant. Studies suggest that boys are more likely to be stunted as compared to girls (Vashist and Goel, 2009; Proceedings Nutrition Society, 1998).

Thinness as measured by low BAZ scores was found to be 33% which was similar to the study conducted by Mehan et al (2009) in urban schools of Vadodara and also close to what was observed in Uttar Pradesh (Srivastav et al,2013). These values were although very high as compared to thinness prevalence in Rohtak (Vashist and Goel, 2009) and West Bengal (Ghosh and Bandhyopadhyay, 2009) (Table 4.1.11).

Prevalence of overweight was reported to be 17% in the present study which was quite close to the prevalence reported by Jain et al (2012), Bisai et al (2012) and Ramachandran (2002) among adolescents. However it was lower than the prevalence reported by Marwaha (2006) and Mehan (2009) in school going children in New Delhi and Vadodara respectively.

India is going through a nutrition transition phase and therefore the problems of under and over nutrition co-exist. Out of a compilation of 12 studies, eight studies reported prevalence of overweight (8.5-29%) and obesity (1.5-7.4%) (Srihari G, 2006). Thus, a great deal of work is needed in the nutrition and health sector to provide an optimal and normal growth to adolescents in India.

Table 4.1.11: Comparison of Prevalence of Malnutrition with Other Studies

Studies, year	Place	N	Underweight	Stunting	Thinness	Overweight
Present study, 2013	Vadodara	1041	24.6	14.3	33	17
Mehan and Pal, 2009	Vadodara	273	----	19.4	33.3	23.4
Srivastava, 2012	Bareily	512	38.4	19.9	----	----
Vashist and Goel, 2009	Rohtak	1000	----	6.5 % - 15%	11.5% – 34.1%	----
Srivastav et al , 2013	Uttar Pradesh	392	----	14%	30.6%	----
Ghosh and Bandhyopadhyay, 2009	West Bengal	1153	----	----	16.9% – 28.4%	6.7% - 12.04%
Bisai et al , 2012	West Bengal	974 Boys	----	----	20.8	18.7

Dietary and Nutrient Intakes of the subjects

Proper nutrition during the growing stages of life, not only helps to promote health but also prevents the occurrence of deficiency diseases and other health hazards. Ingesting too much or too little of a nutrient can interfere with health and wellbeing (Srilakshami, 2004).

Thus, mean intakes of various food groups and nutrient intakes were obtained as 24 hour recall taken for three consecutive days, the first day being Sunday followed by two working days, to get an accurate idea of the eating patterns of the subjects. This data was obtained for 300boys and 178 girls.

Intake of various food groups

Day wise analysis of the intake of various foods during the 3 days 24 hour recall shows that consumption of non-vegetarian foods was highest on Sundays. This could also explain the fact that total vegetable consumption was lowest on Sundays. Milk and fruit intakes however remained low on all the days (Table 4.1.12).

Figure 4.1.32 shows sex wise analysis of the mean intakes of various food groups. As can be observed boys had a higher consumption of all the food groups except fruit. Milk, grains and vegetable consumption were considerably higher in boys.

Mean Intake of various Food Groups as % RDA

On comparing the intake of various food groups with the RDA, it was found that the oil intake as a percent of RDA was the highest among the boys and the second highest among the girls. Milk intake was very low being less than 40% of the required amounts.

Data was analysed to assess the difference in the consumption of various food groups at different ages and between boys and girls. The agewise analysis revealed that boys less than 10 years of age had the highest consumption of Total grains and oil, while their older counterparts between 10-<13 years had highest intakes of pulses and vegetables (Figure 4.1.33). In case of girls a similar pattern was seen except that milk consumption was comparatively lower in the older girls (13-15years) (Figure 4.1.34).

Table 4.1.12: Mean Intake of Various Food Groups for 3 Consecutive Days

DAY	Mean Food group intake							
	Total Grains (g)	**Total Pulses (g)**	**Meat /Chicken /fish/egg**	**Total Vegetables (g)**	**Total Fruits (g)**	**Total Milk (g)**	**Total oil (g)**	**Total sugar (g)**
Day 1	198.96 ±53.73	41.96± 28.09	6.54 ±30.19	163.48 ±99.24	17.45 ±58.57	194.17 ±120.95	22.95 ±8.05	11.44 ±7.17
Day 2	194.6 ±55.94	39.3 ±24.03	1.88 ±10.61	182.67 ±110.9	16.35 ±56.8	187.47 ±123.01	21.88 ±8.57	12.31 ±8.62
Day 3	192.72 ±56.07	34.64 ±24.7	3.06 ±17.38	194.16 ±145.71	13.45 ±45.26	187.48 ±123.15	22.72 ±8.98	11.8 ±7.46

Figure 4.1.32: Mean Intakes of Food groups (N=478)

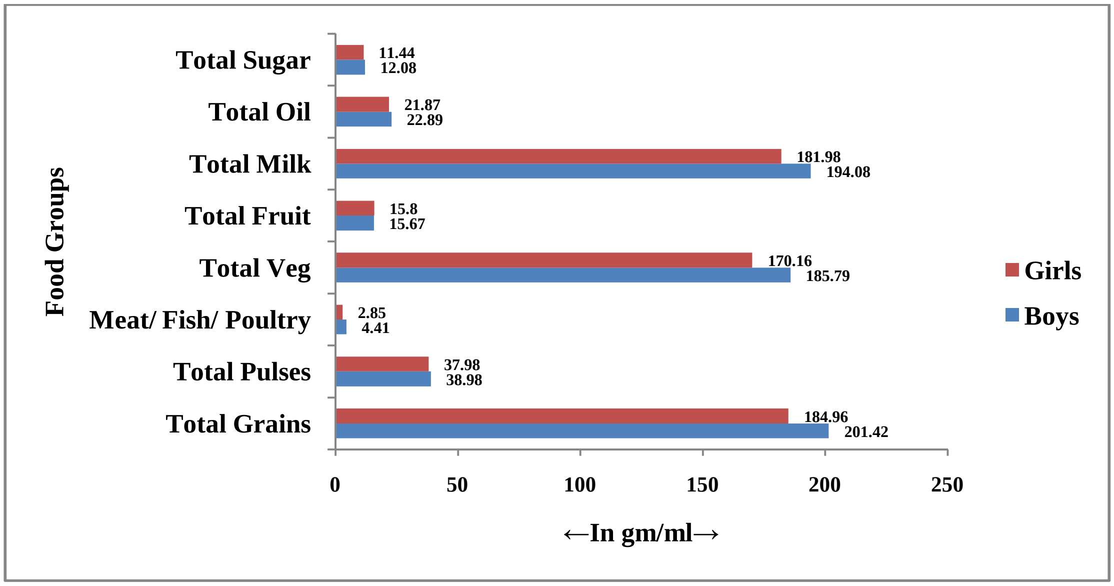
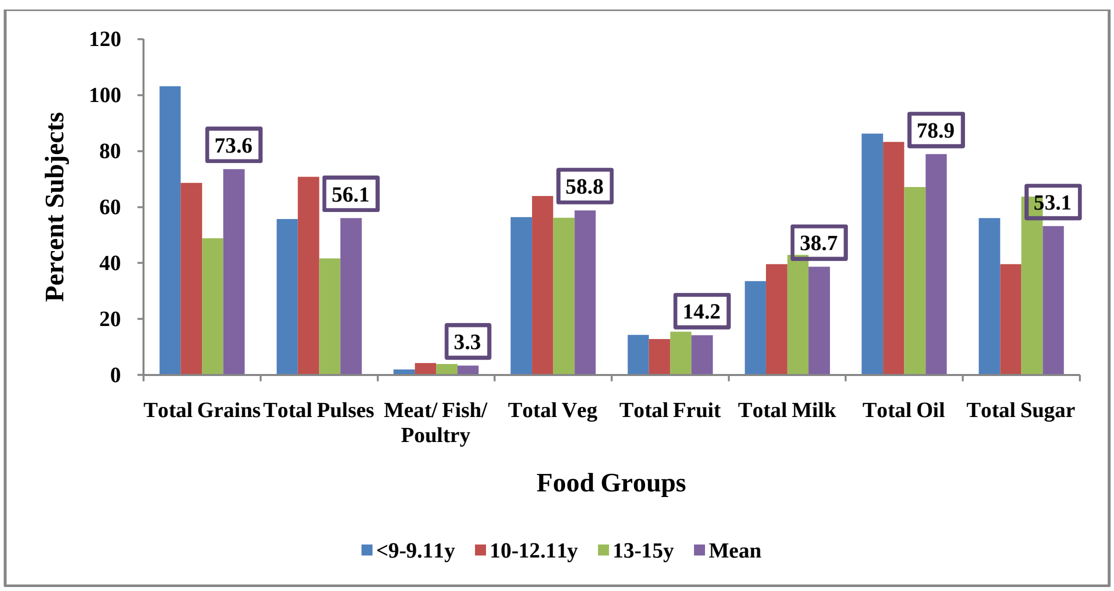


Figure 4.1.33: Mean Intake of Food Groups as % RDA – Boys (N=300)



The oldest age group (13-15years) had the highest consumption of milk and sugar. High sugar consumption can be explained by the fact that sugar is added to milk and also to the changes in their dietary habits due to consumption of sugary drinks. This food consumption pattern is reflected in the deficit nutrient consumption as discussed later in this section.

Sexwise analysis shows that barring total grains and total oil intakes, consumption of the rest of the food groups was less than 60% of the recommended amounts by the boys. In case of girls they had a slightly higher consumption of pulses (61%).For the rest of the foods groups the intake was less than 55% of the required amounts. The lowest intakes were observed for total fruits in both the sexes.

Food intake analysis revealed a very disturbing fact, a complete change in the food pyramid. Based on the consumption pattern a food pyramid was constructed for the present study according to sex (Figure 4.1.35). Similar findings were seen in boys and girls. The main faults in the intakes can thus be pointed out as:

- Total oil which should appear on the top of the pyramid was found to be at the base
- Total fruits and total milk were at the top, which should come down closer to the base.
- Total grains, which should have formed the base of the pyramid were found at the second place.

This kind of a topsy turvy pyramid reflects inappropriate dietary intakes and emphasizes an urgent need to create awareness amongst school children regarding various healthy and unhealthy foods and eating behaviour.

Figure 4.1.34:Mean Intake of Food Groups as % RDA – Girls (N=178)

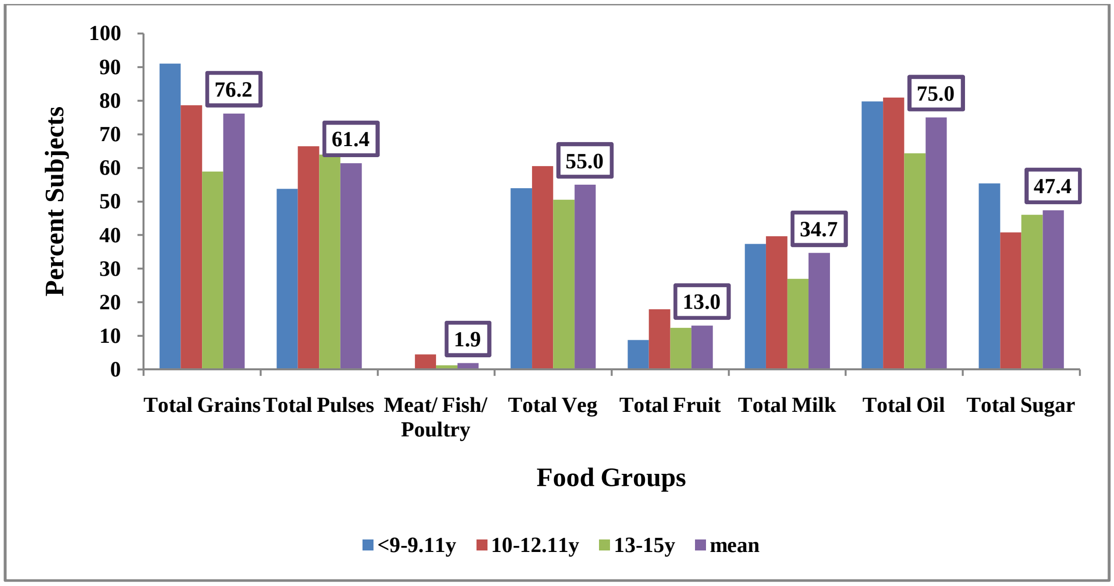
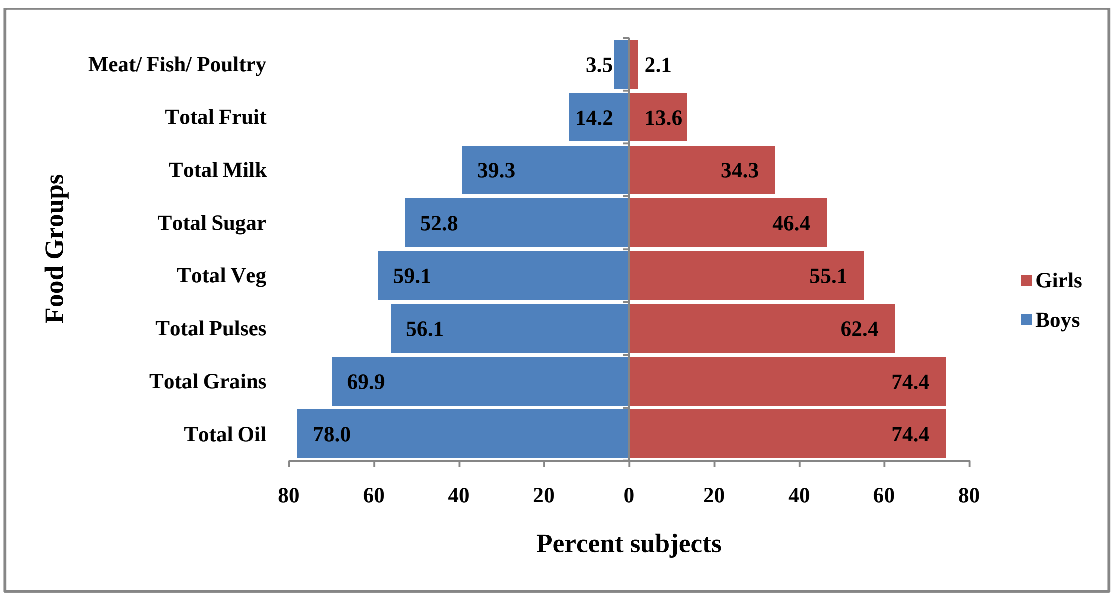


Figure 4.1.35: Food Pyramid Based on the Intakes of the Subjects - Present Study (N=478)



Nutrient Intakes by the Subjects

The dietary intakes of the subjects were taken for 3 consecutive days. Table 4.1.13 shows the mean nutrient intakes for 3 consecutive days. It was observed that mean intake for all the nutrients were higher on day 1 i.e. Sunday.

Table 4.1.14 shows the mean nutrient intake of various nutrients by the study subjects. Boys had significantly higher intakes of all the nutrients as compared to girls.

A further sex and age wise analysis revealed that the older subjects were consuming lesser nutrients as compared to their younger counterparts (Table 4.1.14). The mean intakes amongst boys for energy, protein and iron at 15 years of age were lower than boys at 10 years while mean fat and calcium intakes were almost similar. In case of girls the mean intake at 15 years of age was the lowest for all the nutrients. A drastic change in the mean intakes towards the lower side was observed from 13 years of age irrespective of the sex.

Analysis of variance (ANOVA) revealed, that sex and age significantly affected the intake of all the nutrients except fat, while there was no significant effect of both the parameters together on the nutrient intakes (Table 4.1.15).

A stepwise multiple regression analysis was used to identify factors that accounted significantly for the variation in the intakes for various nutrients.

Table 4.1.13: Mean Nutrient Intakes for 3 Consecutive Days

DAY	Mean Nutrient intake				
	Energy (Kcal.)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)
Day 1	1533.69±378.69	44.08±14.35	49.77±19.77	393.15±153.14	10.77±3.22
Day 2	1464.27±353.83	43.71±16.66	45.72±19.05	382.01±152.42	10.75±3.25
Day 3	1439.52±350.87	42.48±14.45	46.25±18.83	391.49±148.36	10.69±3.51

Table 4.1.14: Mean Nutrient Intake by the Subjects (N=478)

Age	Sex	N	Energy (Kcal.)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)
<9	B	19	1424.35± 377.31	41.52±12.63	49.06±19.40	363.97±100.58	10.15±2.94
	G	9	1289.71± 208.34	34.12 ± 5.12	37.53± 9.16	390.45± 119.62	8.51± 1.49
9-9.11	B	45	1388.7±316.67	40.11±10.38	43.21±15.16	339.56±116.35	10.67±2.79
	G	25	1238.46 ± 259.2	39.35±13.58	36.80±8.36	317.55±26.56	9.41±1.76
10-10.11	B	55	1520.83±383.70	46.53±15.28	48.09±18.11	371.71±116.9	10.92±2.75
	G	31	1436.88±322.53	42.92±10.7	47.50± 16.54	373.40± 117.62	10.52±2.57
11-11.11	B	54	1514.81±243.23	46.78±12.98	49.46±11.91	401.91±110.98	11.20±2.78
	G	41	1458.73±259.99	44.09±13.37	46.70±10.93	384.41±126.64	11.01±3.10
12-12.11	B	55	1651.32±307.93	47.21±9.6	53.48±19.02	458.59±96.29	12.23±2.28
	G	26	1529.11±309.87	43.36±9.79	49.48±12.67	447.57±148.79	10.40±1.73
13-13.11	B	42	1555.52±293.14	42.8±7.79	50.05±18.430	411.28±114.52	10.57±1.85
	G	32	1375.91±244.19	38.65±7.40	42.46±13.10	344.96±145.70	9.77±2.08
14-14.11	B	28	1570.78±219.06	46.78±12.30	50.29±11.44	439.23±89.12	10.89±1.93
	G	11	1333.05±254.53	38.12±6.44	40.95±10.82	353.55±125.24	10.25±1.69
15-15.11	B	2	1469.73±55.88	36.48±1.79	49.65±1.75	374.24±8.47	9.72±1.35
	G	3	1198.41±154.82	34.31±4.89	31.42±5.15	215.53±120.47	9.67±0.93
Total	B	300	1526.92 ±316.85	44.81±11.98	49.16±16.54	399.62±114.11	11.06±2.56
	G	178	1398.68±284.06	41.1±10.98	44.02±12.95	370.79±137.04	10.19±2.37
't' value Boys v/s Girls			**4.59*** **	3.57***	3.64***	2.43*	3.89***

*significant at p<0.05 ***significant at p<0.005

Table 4.1.15: Analysis of Variance of Sex and Age v/s Mean Nutrient Intakes

Parameter	ANOVA (F value)				
	Energy	**Protein**	**Fat**	**Calcium**	**Iron**
Sex	**22.96*** **	**10.03*** **	**0.83**	**7.06** **	**8.97*** **
Age	**5.3*** **	**2.85*** **	**0.22**	**5.66*** **	**2.85*** **
Sex& Age	**1.47**	**0.786**	**0.43**	**1.37**	**0.91**

*significant at p<0.05 ***significant at p<0.005

Factors significantly associated with Energy Intakes – Multiple Regression Analysis

On performing multiple regression analysis with energy intakes as the dependent variable, three factors were found to exert an independent effect on it (Table 4.1.16). Sex was the first factor to to enter the equation and explained 3.7% of the variation seen in the energy intakes. The second factor was per capita income, which accounted for 2.9% of the variation and lastly, the third factor was age to enter the equation. Age accounted for 1.4% of the variation in energy intakes. All the three factors together accounted for 8% of the variation seen in energy intakes.

Factors significantly associated with Protein Intakes – Multiple Regression Analysis

Age was the only factor found to exert an independent effect on protein intakes of the subjects. It accounted for 2.1% of the variation seen in the intakes of protein amongst the subjects (Table 4.1.17).

Factors significantly associated with Calcium Intakes – Multiple Regression Analysis

Four factors entered the equation for multiple regressions on taking calcium intakes as a dependent variable. The first factor to enter the equation was age and accounted for 2.3% of the variation. Sex explained for 1.1% of the variation observed in protein intake and entered on the second step in regression analysis. Dietary habit of the subjects was the third factor and explained for 0.9% of the variation seen in calcium intakes. Last factor to enter the equation was family size, which accounted for 0.7% of the variation. On the whole, the four factors explained 5% of variation seen, amongst the subjects, in calcium intakes (Table 4.1.18).

Factors significantly associated with Iron Intakes – Multiple Regression Analysis

On carrying out multiple regression analysis, taking iron intakes as the dependent variable it was observed that only sex had a significant and independent effect on it. It explained for 2.5% of the variation seen in the intakes of iron by the subjects (Table 4.1.19).

Thus, sex has an independent effect on intakes of energy, protein, calcium and iron. Univariate analysis revealed a significant effect of sex and age on the intakes of energy, protein, calcium and iron.

Table 4.1. 16: Factors significantly associated with Energy Intakes – Multiple Regression Analysis

Variable	Adjusted R^2	SE	Variation Explained	'F' Value
Sex	0.037	305.66	3.7	18.91***
Per Capita Income	0.66	300.91	2.9	9.7***
Age	0.080	298.74	1.4	15.22***

***significant at p<0.005

Table 4.1. 17: Factors significantly associated with Protein Intakes – Multiple Regression Analysis

Variable	Adjusted R^2	SE	Variation Explained	'F' Value
Sex	0.021	11.73	2.1	11.01***

***significant at p<0.005

Table 4.1. 18: Factors significantly associated with Calcium Intakes – Multiple Regression Analysis

Variable	Adjusted R^2	SE	Variation Explained	'F' Value
Age	0.023	122.07	2.3	12.27***
Sex	0.034	121.43	1.1	9.18***
Dietary Habits	0.043	120.82	0.9	8.10***
Family Size	0.050	120.43	0.7	7.11***

***significant at p<0.005

Table 4.1. 19: Factors significantly associated with Iron Intakes – Multiple Regression Analysis

Variable	Adjusted R^2	SE	Variation Explained	'F' Value
Sex	0.025	2.49	2.5	13.27***

***significant at p<0.005

Mean Intakes of Nutrients as % RDA

Mean nutrient intake for all the nutrients except fat was found to be lower than the recommended amounts suggesting inadequate food consumption.

As shown in Figure 4.1.36 overall intakes of fat and protein were higher than the recommended dietary allowances (RDA). Intakes for the rest of the nutrients were less than 70% including iron which was less than 50% of the RDA. Although the overall energy intakes were low, the mean fat intake was quite high the reason being consumption of foods like vegetable puffs, chips and ‘tasty’ (fried munchies prepared from rice). High protein intakes can be explained by regular consumption of dals (64%) and milk (84%) by majority of the subjects on a daily basis as shown in the food frequency section explained later in the chapter.

Apart from protein and fat, the consumption of other nutrients was lower than 84% of the RDA. The highest intakes for energy, protein, fat and calcium as % RDA for boys were observed at <9 years of age while for iron it was highest at 9 years. Boys at 15 years had the lowest % RDA consumption for all the nutrients. Except for fat, consumption of all the other nutrients was less than 67% with iron being the lowest (30%) (Table 4.1.20).

Girls had highest % RDA consumption for energy and calcium at age<9 years, for protein and iron at 9 years and for fat at 10 years of age. The lowest consumption as % RDA for all the nutrients was observed at 15 years for girls. At this age the highest consumption as % RDA was for fat(79%) followed by protein (66%), energy (51%), iron (36%) and calcium (27%).This explains the reason for higher prevalence of underweight and stunting in this age.

Nutrient Intake at various levels of Recommended Dietary Allowances

As can be observed from Figure 4.1.37 majority (67.8%) of the subjects had energy intakes between 26-75% of RDA while majority subjects had intakes above 75% of protein (84%) and fat (93.5%). Nearly half (46.2%) and one third (62%) subjects had intakes below 50% of the RDA of calcium and iron respectively. Merely 5% and 6% subjects consumed >75% of the RDA for calcium and iron respectively (Figure 4.1.37).

Figure 4.1.36: Mean Nutrient Intakes as % RDA (N=478)

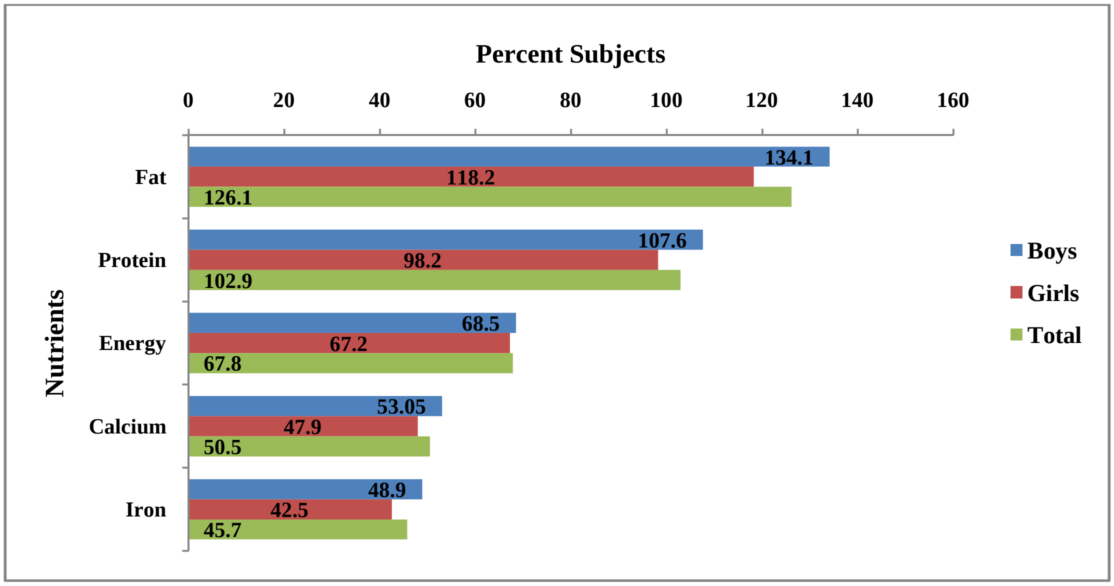


Figure 4.1.37: Nutrient intakes at various levels of RDA

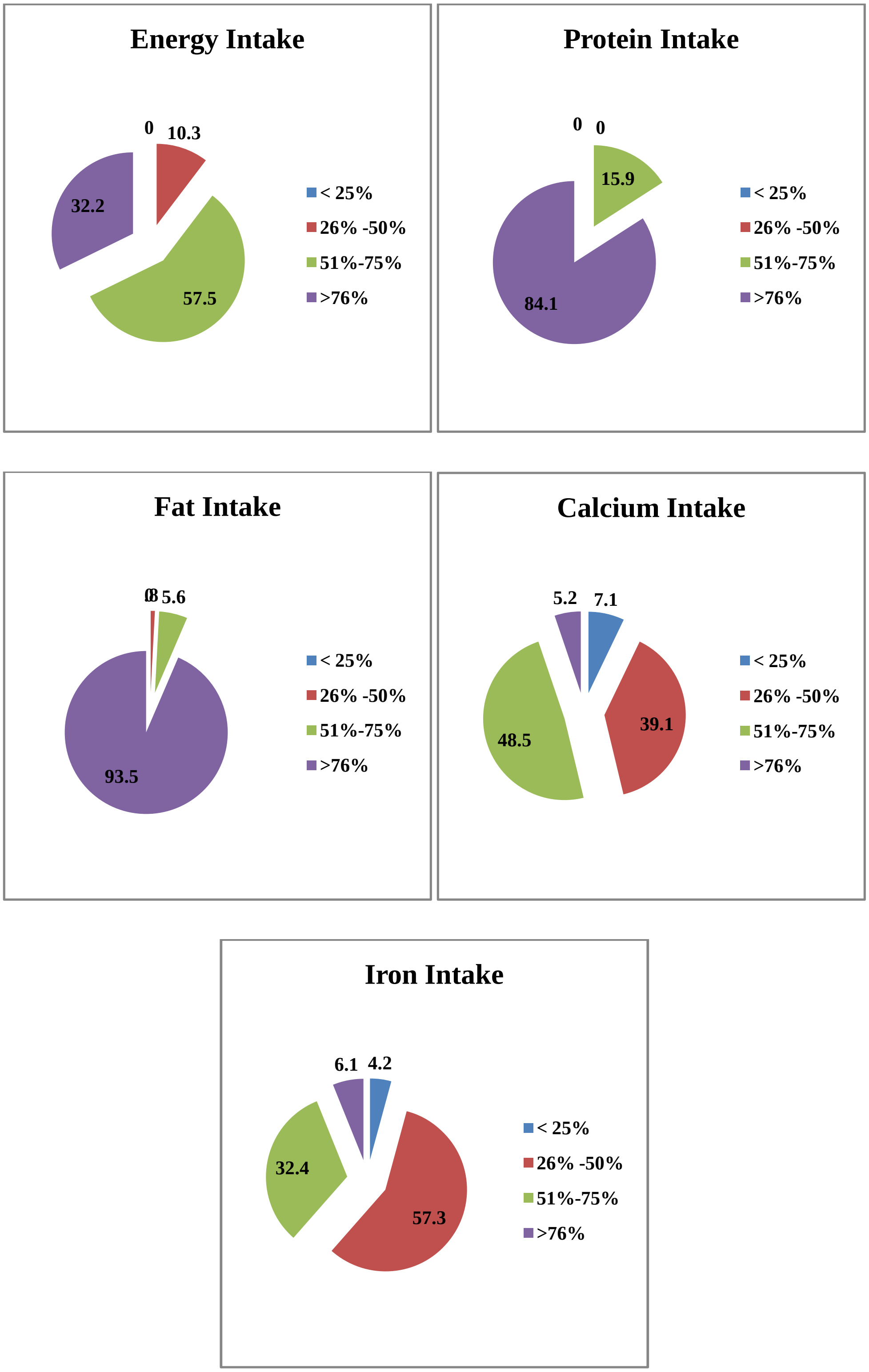


Table 4.1.20: Nutrient Intakes as % RDA- Agewise (N=478)

Age	Sex	N	Nutrient Intake as % RDA				
			Energy	Protein	Fat	Calcium	Iron
<9	B	19	84.3	140.7	163.5	60.7	63.4
	G	9	76.3	115.7	125.1	65.1	53.2
9-9.11	B	45	82.2	136	144.2	56.6	66.7
	G	25	73.3	133.4	122.7	52.9	58.8
10-10.11	B	55	69.4	116.6	137.4	46.5	52
	G	31	71.5	106.2	135.7	46.7	39
11-11.11	B	54	69.2	117.2	141.3	50.2	53.3
	G	41	72.6	109.1	133.4	48.1	40.8
12-12.11	B	55	75.4	118.3	152.8	57.3	58.2
	G	26	76.1	107.3	141.4	55.9	38.5
13-13.11	B	42	56.6	78.8	111.4	51.4	33
	G	32	59.1	74.5	106.2	43.1	36.2
14-14.11	B	28	57.1	86.2	111.8	54.9	34
	G	11	57.2	73.4	102.4	44.2	38
15-15.11	B	2	53.4	67.2	110.3	46.8	30.4
	G	3	51.4	66.1	78.6	26.9	35.8

Mean Nutrient Intakes according to the Nutritional Status

Table 4.1.21 shows the mean nutrient intakes of the subjects according to the nutritional status. Analysis was done to assess the relationship between nutrient intake and the nutritional status of the subjects. Energy and fat intakes were found to be significantly correlated to HAZ, WAZ and BAZ scores ($p<0.001$). However, protein intakes were significantly correlated to HAZ and WAZ scores ($p<0.001$).

Subjects with WAZ scores <-3 had the lowest intakes for all the nutrients while the subjects with WAZ scores between 2-2.99 had the highest intakes for energy.

Mean intakes for all the nutrients were lowest for the subjects having HAZ scores between-2.99 to <-2 SD. The mean energy, fat and iron intakes were highest for the subjects with HAZ scores between 2 to 2.99 SD.

In case of BAZ scores, subjects with scores between -2.99 to <-2 had the lowest mean intakes for all the nutrients while the subjects with BAZ scores > 3SD had the highest mean intakes for all the nutrients.

Analysis of variance (ANOVA) revealed that WAZ scores were significantly associated with the mean intakes for energy and fat. HAZ scores showed a positive significant association with the intake of all the nutrient viz. energy, protein, fat, calcium and iron. However, BAZ scores were significantly associated with the mean intakes for energy. It was interesting to note that all three anthropometric inidcators were significantly associated with energy intakes. Thus, as the mean nutrient intakes increased a similar trend in the nutritional status was also observed (Table 4.1.21).

Frequency of Consumption of Various Foods

The staple cereals of the subjects were rice and wheat. Majority of the subjects consumed chapatti (85%) daily followed by rice (67%). Pulses were consumed by 63.7% subjects daily whereas another 20% consumed pulses on alternate days. Legume consumption was seen in majority as bi weekly (23.6%) followed by weekly (20.1%) (Table 4.1.22).

Nearly 84% subjects consumed milk daily. Almost half of the subjects reported consumption of green leafy vegetables or roots and tubers or other vegetables daily. Most of the subjects consumed yellow and orange vegetables on alternate days (21%) or twice weekly (19%) or once weekly (19%) basis (Figure 4.1.38).

Majority subjects consuming non-vegetarian foods consumed them on a once weekly basis. Daily fruit consumption was reported by 54% subjects. Seasonal fruits were consumed by about half of the subjects whereas only 22% subjects reported consumption of yellow or orange fruits on a daily basis.

Subjects consuming aerated and non-aerated soft drinks reported consumption mostly on a biweekly or weekly. About 20% subjects did not consume any packaged drink whereas almost the same number of subjects reported daily consumption of fresh fruit juice. Bakery food items consumption was very high (42.5%) on a daily basis. These foods mainly consisted of vegetable puffs and biscuits. Similarly 42.3% subjects reported a daily consumption of various accessories like jams, jellies, murabbas, pickles, papads and chutneys along with their meals (Table 4.1.23). Data on consumption of processed foods was mainly obtained for checking the dietary quality of the subjects through the Healthy Eating Index for Adolescents developed in the present study.

Table 4.1.21: Mean Nutrient Intakes According to the Nutritional Status
(*significant at p<0.05 ** significant at p< 0.01 ***significant at p<0.005)

	Mean Nutrient intake (N=631)					
	N	**Energy (Kcal.)**	**Protein (g)**	**Fat (g)**	**Calcium (mg)**	**Iron (mg)**
WAZ scores						
≤ -3	5	1108.44 ±202.1	32.07 ±5.94	28.4 7±11.7	204.32 ±170.73	9.35 ±2.52
-2.99 to -2	19	1393.68 ±449.72	40.95 ±13.91	41.17 ±19.24	314.07 ±160.64	10.47 ±2.79
-1.99 to < -1	75	1374.27 ±264.93	40.87 ±10.3	42.52 ±13	374.72 ±117.08	10.18 ±2.25
-1 to +1	308	1472.18 ±270.05	43.82 ±11.9	46.94 ±13.1	392.82 ±116.91	10.86 ±2.54
1 to 1.99	61	1661.03 ±389.83	46.08 ±10.88	56.93 ±21.74	426.11 ±127.08	11.07 ±2.61
2 to 2.99	10	1719.42 ±390.42	44.49 ±14.92	54.09 ±19.11	381.13 ±136.42	10.32 ±2.36
‘t’ value <- 2 SD v/s ≥- 2 SD		0.71	0.84	0.27	1.91	1.18
F value		**5.02*** **	**1.11**	**3.62*** **	**2.46***	**1.38**
HAZ scores						
≤ -3	2	1378.63 ±430.42	47.25 ±19.49	43.25 ±24.83	302.72 ±155.53	9.35 ±0.54
-2.99 to -2	10	1234.07 ±379.92	36.73 ±11.41	39.60 ±17.41	287.13 ±163.35	9.8 ±2.71
-1.99 to < -1	39	1423.84 ±336.24	39.65 ±9.88	43.0 ±17.17	340.18 ±154.3	10.32 ±2.15
-1 to +1	314	1452.0 ±276.67	42.92 ±11.32	46.29 ±13.85	389.7 ±121.3	10.6 ±2.39
1 to 1.99	74	1575.83 ±374.68	47.64 ±15.42	51.95 ±18.41	418.03 ±110.96	11.26 ±2.95
2 to 2.99	31	1648.56 ±324.69	45.97 ±8.62	53.23 ±17.95	393.49 ±97.95	12.08 ±2.85
>3	8	1595.98 ±215.29	40.11 ±4.6	49.5 ±12.05	455.38 ±74.41	9.62 ±1.17
‘t’ value <- 2 SD v/s ≥- 2 SD		1.66	0.30	0.38	1.83	0.31
F value		**4.26*** **	**2.7*** *	**1.10*** **	**2.98***	**2.49*** *
BAZ scores						
≤ -3	7	1553.53 ±312.16	48.3 ±9.86	47.65 ±14.2	393.99 ±128.47	12.22 ±2.64
-2.99 to -2	40	1364.61±313.66	41.07 ±10.75	40.69 ±14.09	329.83 ±136.94	10.81 ±2.5
-1.99to < -1	105	1474.36±308.83	44.28 ±13.26	46.49 ±15.61	399.17 ±132.26	10.82 ±2.73
-1 to +1	239	1467.76±270.58	43.08 ±11.21	46.38 ±12.91	391.11 ±112.16	10.68 ±2.44
1 to 1.99	66	1542.21±375.73	43.71 ±10.78	54.10 ±20.75	404.41 ±136.22	10.72 ±2.4
2 to 2.99	19	1569.77±386.22	43.03 ±12.59	49.73 ±16.19	366.42 ±123.83	10.2 ±2.83
>3	2	2184 ±708.52	64.0 ±26.87	71.5 ±37.48	447.0 ±9.9	12.5 ±2.12
‘t’ value <- 2 SD v/s ≥- 2 SD		1.62	0.15	0.48	2.04	0.71
F value		**3.45*** **	**1.01**	**1.9**	**1.23**	**0.88**

Table 4.1.22: Frequency of Consumption of Various Foods (N=631)

Food Item	Daily	Alternate Days	Twice/ Week	Weekly	Twice Monthly	Monthly	Rarely	Never
Cereals								
Chapati	85.1	5.9	3.0	1.1	0.2	0.8	1.6	2.4
Phulka	16.6	12.5	6.0	7.9	1.7	3.6	13.6	37.9
Paratha/ Bhakri	28.8	20.6	22.2	7.4	2.9	3.3	6.3	8.4
Puri	3.2	9.0	20.8	21.9	17.1	13.7	12.9	1.4
Rice	67.2	14.7	7.0	5.5	1.9	1.4	1.9	0.3
Khichdi	12.2	17.6	21.7	23	6.0	7.0	8.7	3.8
Pulao/ Fried Rice	5.5	13.6	18.2	22	9.5	13.2	9.2	8.7
Bread	12.8	18.5	20.3	17.2	9.3	7.5	8.0	3.3
Pulses and Legumes								
Pulses	63.7	20.3	7.8	2.9	1.0	0.5	1.9	2.1
Legumes	8.1	13.0	23.6	20.1	7.1	6.5	7.3	14.3
Milk and Milk Products								
Milk	83.7	4.8	2.5	2.1	0.6	0.6	1.3	4.4
Curd / Buttermilk	33.0	20.4	13.3	10.5	3.8	2.5	4.8	11.7
Cheese	6.8	9.5	9.8	16.0	9.2	7.1	15.8	25.7
Butter	17.3	17.7	18.5	10.1	4.4	4.8	11.4	15.7
Ghee	55.9	13.3	65.0	4.8	1.9	3.0	6.7	7.9
Poultry, Meat and Fish								
Eggs	3.2	5.5	10.5	14.1	5.5	3.5	1.0	56.7
Chicken	0.2	2.2	4.0	12.5	7.0	4.6	1.6	68.0
Meat	0.3	1.3	3.8	6.5	7.3	2.2	7.6	71
Fish	0.2	2.1	2.5	5.9	4.4	3.8	11.9	69.3
Vegetables								
Green Leafy Vegetables	47.5	22.7	15.5	6.5	2.5	0.8	2.9	1.6
Yellow and Orange Vegetables	13.2	21.2	18.9	19.3	4.0	5.7	9.2	8.6
Roots and Tubers	46.6	24.2	12.7	5.5	2.5	2.2	4.4	1.7
Others	50.2	24.6	13.0	5.2	2.4	1.6	1.9	1.1
Fruits								
Overall Fruit consumption	54.0	22.3	10.3	7.0	2.7	0.8	1.9	1.1
Seasonal Fruits	47.5	23.5	11.3	9.7	3.3	1.4	2.4	1.0
Yellow and Orange Fruits	22.0	26.1	20.0	11.3	5.7	2.9	8.4	3.6

Figure 4.1.38: Frequency of Vegetable Consumption Among the Study Subjects

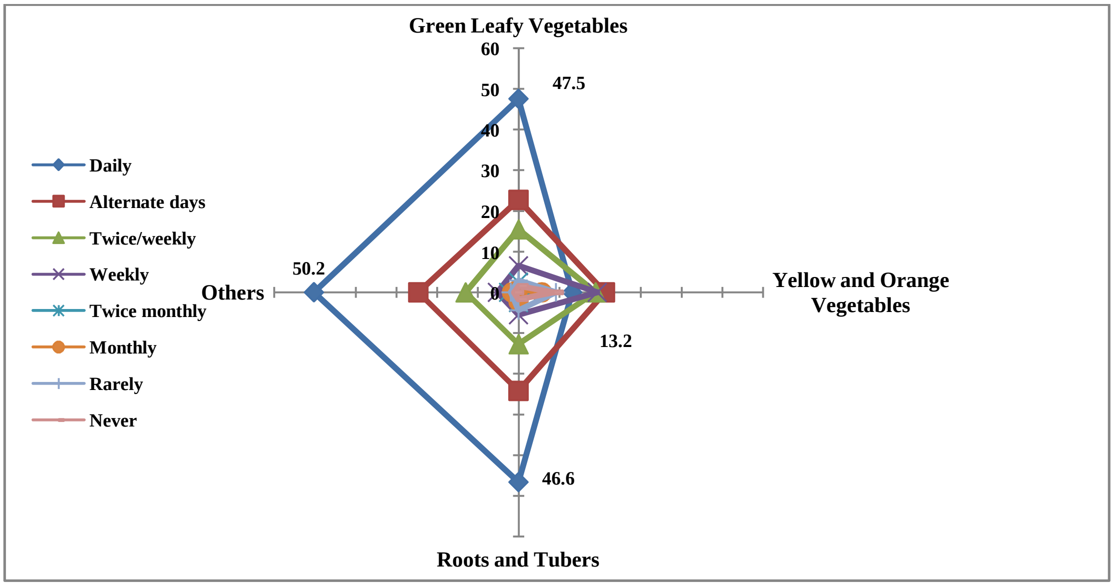


Table 4.1.23: Frequency of Consumption of Processed / Fast Foods (N=631)

Food Item	Daily	Alternate Days	Twice/ Weekly	Weekly	Twice Monthly	Monthly	Rarely	Never
Beverages								
Fresh Fruit Juice	21.0	14.4	14.1	10.6	9.5	8.7	14.1	7.6
Tinned Fruit Juice	7.4	12.5	13.5	13.8	7.9	7.9	19.5	17.4
Aerated Soft Drinks	5.1	7.6	12.4	12.8	10.5	10	23.1	18.5
Non Aerated Soft Drinks	4.1	10	13.8	11.3	10	9.7	21.1	20.1
Processed Foods								
Fried Foods	15.1	16.3	18.7	14.4	9.8	8.4	12.2	5.1
Baked Foods	42.5	26.3	11.6	9.7	3.8	1.9	4.0	0.3
Fast Foods	10	17.1	23.0	21.6	9.5	10.1	7.9	0.8
Sweets, Chocolates and Candies	33.6	31.4	15.2	7.8	5.1	2.9	4.0	0.2
Accessories	42.3	27.3	11.3	5.7	3.5	2.1	6.7	1.3

Key Findings

- Mean intakes of all the food groups except grains and edible oils were lower than the recommended amounts.
- Mean intakes of all the nutrients were lower than the recommended amounts except for fat.
- Age and sex significantly affected mean nutrient intakes of the subjects.
- WAZ scores showed a significant positive association with the energy and fat intake
- HAZ score was positively and significantly associated with the mean intake of all the nutrients namely, energy, protein, fat, calcium and iron.
- BAZ scores were positively associated with the mean energy intakes and the association was found to be significant.
- Frequency of consumption of various foods revealed a low consumption of fruits and vegetables especially the yellow and orange ones.
- Consumption of baked foods like cream biscuits, salted biscuits, plain biscuits, pastries, cakes; accessories like jams, murabbas, pickles, papad, chutneys and sweet foods like chocolates, candies, mithai and ice creams was high amongst the subjects.

Discussion

Mean food intakes for grains and fat were above the recommended allowances for both boys and girls. A study on dietary intakes of girls in urban Jaipur (2009) also revealed similar intakes for grains, milk and fruits. Present study subjects had two third intakes for grains as compared to the NNMB survey (2002). Very high fat intakes as compared to the present study have been observed by Gupta et al (2010) in urban adolescents and young adults whereas the NNMB survey (2002) showed intakes equivalent to half of the present study. Pulses and milk intakes in the NNMB survey were lower than the present study. Fruit intakes were almost same for the present study and the NNMB survey (2002).

Mean energy intake of the subjects was 68% which was quite low as reported by other studies (Saibaba et al, 2002;Yearul k, 2010; Choudhary S, 2010 and Iyer U, 2011) but was higher than those reported by Goyle (2009). Protein intakes were very high (103%) as compared to the above stated studies except the Bangladesh study reporting mean intake as high as 154% of RDA (the main reason being high consumption of non- vegetarian foods).Protein intakes were similar to those reported by Saibaba et al(2002). Fat intake was high as compared to other studies but was comparatively lower than the intakes reported by Iyer (2009) amongst adolescents in urban Vadodara and Gupta (2010) in New Delhi mainly because the subjects in the present study were from middle income group households while the subjects in the studies by Iyer et al (2009) and Gupta (2010) were from high income group families.

Mean iron intakes of the subjects were higher as compared to Iyer et al (2009), but were quite low as compared to values reported by Choudhary (2010), Yearul (2010); Goyle (2009) and Saibaba et al (2002). Mean calcium intakes were recoreded to be around 45% of the RDA. These intakes were lower than those reported by Choudhary 2010 but were in line with the intakes reported for urban adolescent girls in Jaipur (Goyle, 2009) and Saibaba et al (2002). A comparison with the intakes of the subjects as reported by NHANES III shows a high deficit amongst the mean intake of nutrients in the diets of the subjects from the present study (Table 4.1.24). This explains the higher growth rates in NHANES subjects in comparison to Indian adolescents.

Data shows that there was a frequent consumption of cereals (85%), milk (83%0 and pulses (64%) on a daily basis unlike the Varanasi study where only cereals consumption was very high (92%). Consumption of meat, fish and poultry was infrequent in the present study, which corroborates the findings of many studies (Alam N,2010; Venkaiah 2002).

Frequency of consumption of baked foods and accessories with meals were highest on a daily basis which was higher than that reported by Choudhary et al (2010), indicating a high sodium consumption in these children. This could be attributed to the fact that typical Gujarati foods consists of lots of accessories like chutneys, papad, pickles etc.. Consumption of fast foods and aerated soft drinks on a regular basis was quite low in the present study as compared to studies on Australian adolescents (Gayle S 2007) or in North India (Vaida N, 2013).

Table 4.1.24: Mean Nutrient intakes of the subjects (NHANESIII v/s Present Study)

Nutrients	Boys		Girls	
	NHANES III (12-19 years)	Present Study (7.5-18y)	NHANES III (12-19 years)	Present Study (7.5-18y)
Energy (Kcal)	2652	1527	2007	1399
Protein (g)	94	45	67.8	41
Fat (g)	97.5	49.2	76.1	44
Calcium (mg)	1175	400	874	371
Iron (mg)	18.9	11.1	14.5	10.2

Biochemical estimations

The complete blood count is one of the most prescribed laboratory tests and the most useful in medical practice. The complete blood count has two types of analysis: a quantitative analysis to measure the absolute number of cells per unit of volume of blood and a qualitative analysis that reveals the different forms of blood cells. The complete blood count allows affirming the existence of anemia on hemoglobin levels below the normal range (UNICEF/UNU/WHO, 2001).Biochemical estimations were carried out only on the subjects who got a written consent from their parents (N=61). Total blood count with Hemoglobin, Total proteins, albumen and red cell morphology was carried out on these subjects.

Hemoglobin levels of the study subjects

Mean hemoglobin level of the subjects in the present study was 11.92± 1.34 g/dl. Mean hemoglobin level of girls was above the cut off value (11.5 g/dl at age 11 years and 12 g/dl above 12 years) at all ages whereas for boys it was lower than the cut off (11.5 g/dl at age 11 years and 12 g/dl between 12-14 years) between 11- 13 years of age. However, gender did not affect hemoglobin levels significantly at any age. On comparing the mean hemoglobin levels with the WHO cut offs (WHO, 2001) (Figure4.1.39) it was observed that boys had mean Hemoglobin levels below the cut-off point i.e. 12g/dl at the age of 12 to 14 years. Irrespective of the sex, subjects between 7-11 years and >14 years had normal hemoglobin levels. Boys had lower hemoglobin levels than girls between 7-14 years of age (Figure 4.1.39).

Frequency distribution of the hemoglobin levels of all the subjects

Figure 4.1.40 shows the frequency distribution of hemoglobin levels of the subjects sex wise. As evident from the figure, the hemoglobin levels of the subjects were normally distributed. Majority of the girls (41%) had hemoglobin levels between 11-11.9 g/dl while most of the boys (47%) had hemoglobin levels between 12-12.9 g/dl (Table 4.1.25).Another 45% of the girls had hemoglobin levels above 12g / dl whereas only 9% boys had hemoglobin levels above 13g/dl. Six percent boys and 4% girls had hemoglobin levels <10g/dl. The lowest hemoglobin levels noted in girls and boys were 8.6g/dl and 7.4g/dl respectively. However, the highest hemoglobin levels were found to be 15g/dl and 15.1 g/dl for girls and boys respectively.

Table 4.1.25: Mean Hemoglobin Levels of the Subjects Cross Tabulated by Age and Sex

AGE (yrs.)	Hemoglobin Levels of the subjects (g/dl) Mean ± S.D		
	Boys (N=32)	**Girls (N=29)**	**Total (N= 61)**
< 9	12.07 ± 0.76 N= 3	11.85 ± 2.19 N= 2	11.98 ± 1.23 N=5
9 - 9.11	12.39 ± 0.74 N=7	11.65± 0.47 N=6	12.05 ± 0.72 N=13
10-10.11	11.74 ± 1.18 N=10	11.7 ± 0.40 N=6	11.73 ± 0.94 N=16
11-11.11	11.15 ±0.87 N=6	12.37± 2.15 N=9	11.85 ± 1.81 N=15
12 – 12.11	11.08 ± 2.49 N=4	12.57 ± 0.46 N=3	11.71 ± 1.95 N=7
13 – 13.11	11.7 ± 0 N=1	12.17 ± 0.83 N=3	12.05 ± 0.72 N=4
14-14.11	15.1 ± 0 N=1	--	15.1 ± 0 N=1

Figure 4.1.39: Mean Hemoglobin Levels of the Study Subjects (N=61)

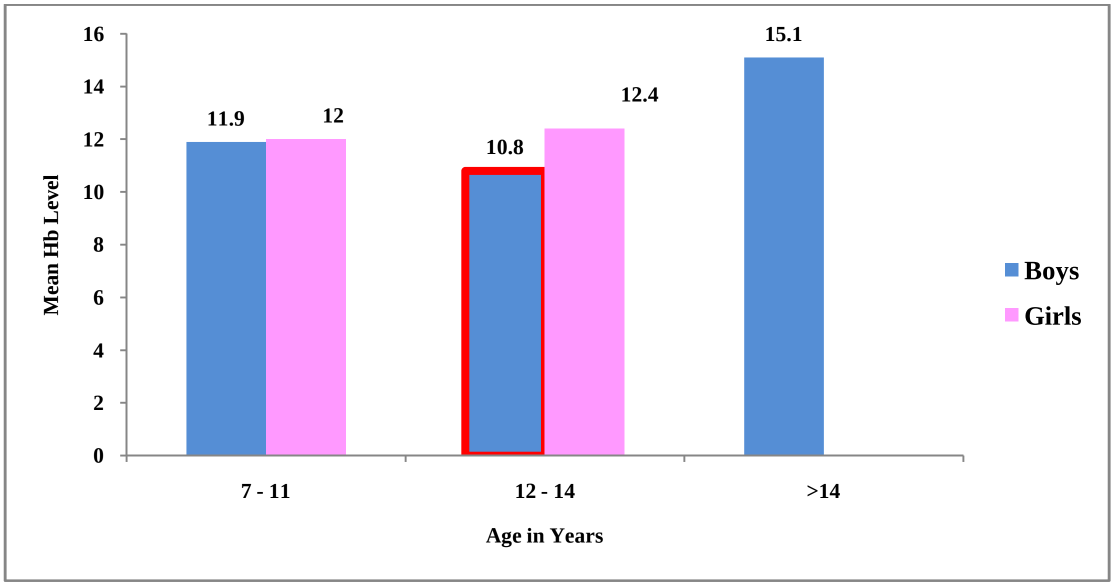
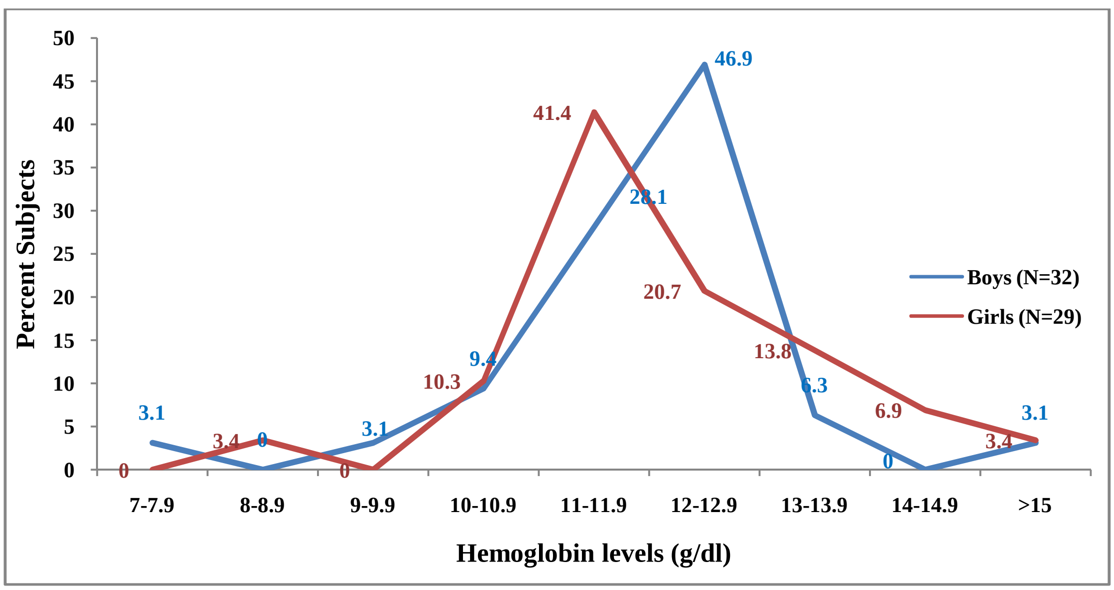


Figure 4.1.40: Frequency Distribution of the Hemoglobin Levels of the Study Subjects (N=61)



Prevalence of Anemia

Percent prevalence of anemia was 42.6% with mild, moderate and severe forms being 27.9%, 13.1% and 1.6% respectively. Figure 4.1.41 shows prevalence of anemia age wise, and it can be observed that the prevalence was highest in children between 11 to 13 years of age.

Prevalence of anemia was highest (29.5%) during early-adolescence followed by pre-adolescence (8%) and mid-adolescence (5%).

This establishes the need to focus on the pre and early stages of adolescence in order to improve the nutritional status of adolescents.

Red Cell Morphology in Anemic and Non Anemic subjects

In all 73.8% subjects showed normocytic and normochromic red cell morphology (Table 4.1.26). Further analysis using data obtained on the red cell morphology revealed that almost 58% of the anemic subjects showed normocytic red cell morphology whereas for non anemic subjects it was 86%.

Among the anemic subjects 23.1% had microcytic hypochromic anemia and 15.4% had microcytic mild and moderate hypochromic anemia.

Anemia Vs nutritional status

On comparing with the nutritional status there was no significant association found between the WAZ and HAZ scores with anemia. It was observed that 70% of the overweight girls were anemic. There was no significant difference found between normal and anemic subjects in regards to WAZ scores (Table 4.1.27).

Table (4.1.27) shows that on comparing the HAZ scores with anemia no significant difference was observed. Around 8% subjects with HAZ >2 were found to be anemic.

There was a significant difference found between the subjects of the two groups with regards to BAZ scores. Majority of the anemic subjects had BAZ scores between -1 to 1 and 1 to 1.99.

Figure 4.1.41: Prevalence of Anemia among the subjects in the present study according to the Stage of Adolescence (N=61)

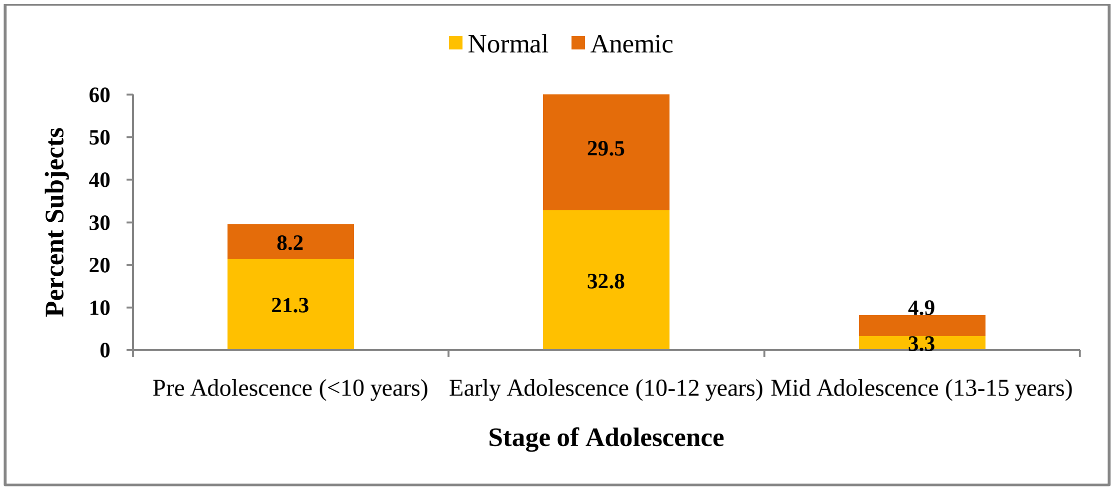


Table 4.1.26: Red Cell Morphology in Anemic and Non Anemic Subjects

Red Cell Morphology	Anemic (N=26)			Non – Anemic (N= 35)			Total (N= 61)		
	B	G	T	B	G	T	B	G	T
Normocytic Normochromic	62.5 (10)	50 (5)	57.7 (15)	75 (12)	94.7 (18)	85.7 (30)	68.8 (22)	79.3 (23)	73.8 (45)
Microcytic Hypochromic	25 (4)	20 (2)	23.1 (6)	6.2 (1)	0 (0)	2.9 (1)	15.6 (5)	6.9 (2)	11.5 (7)
Microcytic Mild and Moderate Hypochromic	12.5 (2)	20 (2)	15.4 (4)	18.8 (3)	5.3 (1)	11.4 (4)	15.6 (5)	10.4(3)	13.1 (8)
Macrocytic	0 (0)	10 (1)	3.8 (1)	0(0)	0(0)	0(0)	0(0)	3.4 (1)	1.6 (1)
Total	100 (16)	100 (10)	100(26)	100 (16)	100(19)	100 (35)	100 (32)	100 (29)	100 (61)

Table 4.1.27: Anemia v/s Nutritional Status

Nutritional status(Z scores)	Percent subjects				Mean Hemoglobin level (g/dl)
Weight for age- Z scores					
	Normal (N=35)	**Anemic (N=26)**	**Total (N=61)**	**Chi Square**	**Total (N=61)**
< -2	0 (0)	3.9 (1)	1.6 (1)	7.12^{NS}	12.7
-1.99 to < -1	14.3 (5)	7.7 (2)	11.5 (7)		12.7
-1 to +1	62.9 (22)	69.2 (18)	65.6 (40)		11.8
1 to 1.99	17.1 (6)	19.2 (5)	18 (11)		12.0
>2	5.7 (2)	0 (0)	3.3 (2)		12.2
Height for age- Z scores					
	Normal (N=35)	**Anemic (N=26)**	**Total (N=61)**	**Chi Square**	**Total (N=61)**
<-2	0 (0)	1.6 (1)	1.6 (1)	7.65^{NS}	12.7
-1 to +1	37.7 (23)	19.7 (12)	57.4 (35)		12.0
1 to 1.99	11.5 (7)	13.1 (8)	24.6 (15)		12.0
>2	8.2 (5)	8.2 (5)	16.4 (10)		11.6
BMI for age- Z scores					
	Normal (N=35)	**Anemic (N=26)**	**Total (N=61)**	**Chi Square**	**Total (N=61)**
< -2	6.6 (4)	0 (0)	6.6 (4)	13.37**	12.3
-1.99 to < -1	14.8 (9)	6.6 (4)	21.3 (13)		11.7
-1 to +1	27.9 (17)	18 (11)	45.9 (28)		12.1
1 to 1.99	6.6 (4)	16.4 (10)	23 (14)		11.6
>2	3.3 (2)	0 (0)	3.3 (2)		12.2

****significant at p<0.01**

Analysis of nutritional status and hemoglobin levels revealed that the mean hemoglobin levels of the subjects belonging to HAZ >2SD were also found to be the lowest amongst all other groups.

The lowest hemoglobin levels were reported in the subjects having BAZ scores between 1 to 1.99. Unlike HAZ, subjects with WAZ or BAZ score >2 had better hemoglobin levels than the previous group.

Hematological Indices of the Subjects

Red blood corpuscles (RBC) count, Mean Corpuscular Volume (MCV), Mean corpuscular Hemoglobin (MCH) and Mean corpuscular Hemoglobin Concentration (MCHC) were studied in relation to anemia. Figure 4.1.42 shows that mean hematological indices in boys had lower mean values than females except for same MCHC% and a higher RBC count in boys. However, this difference was not significant. Mean values for all the hematological indices were less than the international references (UNICEF/UNU/WHO 2001) (Table 4.1.28). Hemoglobin was positively correlated with all the hematological indices ($p< 0.01$).

Serum total proteins and albumin

Serum total proteins and albumin were well within the normal range. There were a very small percentage of subjects (6.6% boys and 3.3% girls) who had total serum protein levels above the normal range. None of the subjects fell below the cut offs. The mean serum total protein level of the subjects was found to be 7.5 ± 0.6 g/dl and 7.69 ± 0.45 g/dl for boys and girls respectively. Table (4.1.29) shows mean Serum total protein levels of the subjects at various ages. Girls had higher mean total protein levels at all stages of adolescence. Mean total protein levels showed a gradual increase with age. However, both boys and girls had lower mean total protein levels at 11-<12 years of age. Boys also had lower values at 13 to <14 years of age. According to stage of adolescence mean total protein levels showed a rise with each advancement in the stage. This trend was similar for both boys and girls (Figure 4.1.43.)
Although serum protein levels did not show any significant association with the Z scores yet mean total serum protein levels were found to quite low in subjects with BAZ scores less than -2 SD(7.21±0.35g/dl)as compared to those with scores >-2 SD(7.63±0.54 g/dl).

Figure 4.1.42: Mean Hemtological Indices – Sexwise (N=61)

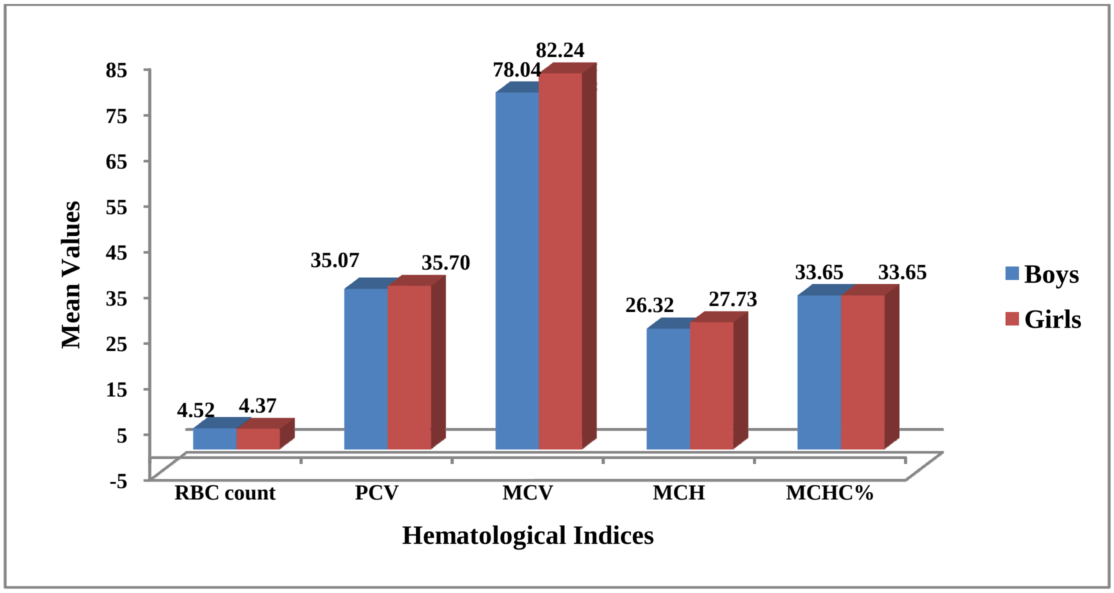


Figure 4.1.43: Mean Serum Total Protein Levels According to the Stage of Adolescence

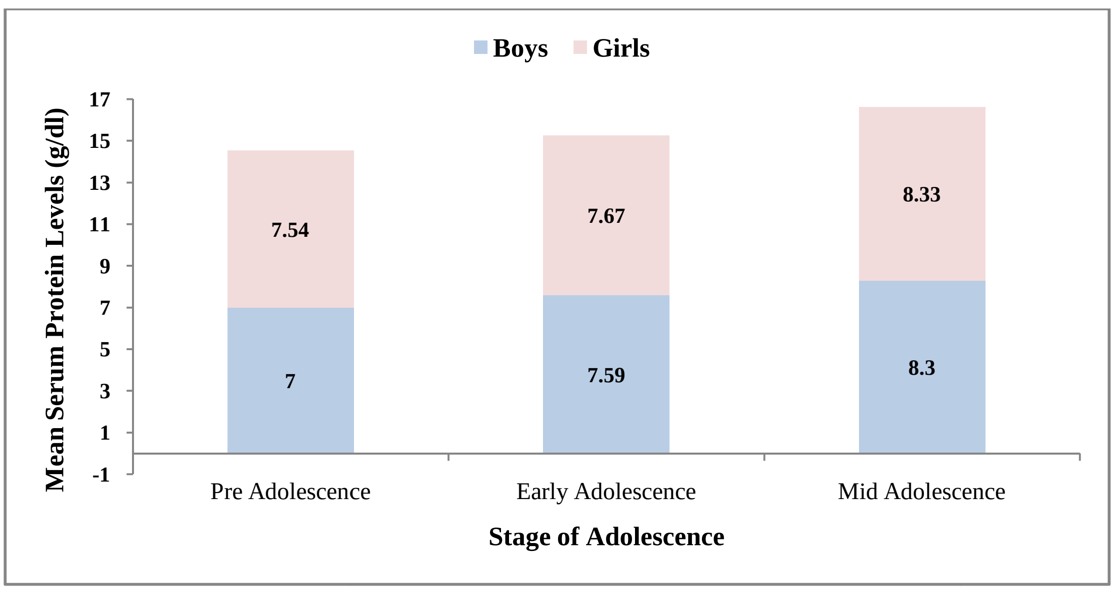


Table 4.1.28: Mean Hematological Indices Age and Sexwise

Indices	Female & male (5-7.9 y)	Female & male (8-11.9 y)	Female (12-14.9 y)	Male (12-14.9 y)
RBC Count (10^{12} /l)	4.09$\pm$ 0	4.45$\pm$ 0.48	4.31$\pm$ 0.18	4.69$\pm$ 0.66
MCV (fl)	81.7$\pm$0	79.68$\pm$8.61	85.88$\pm$3.23	81.46$\pm$9
MCH (pg)	27.4$\pm$0	26.99$\pm$3.36	28.71$\pm$1.39	26.97$\pm$3.74
MCHC (g/l)	33.5$\pm$0	33.8$\pm$1.08	33.45$\pm$0.58	32.98$\pm$1.33

Table 4.1.29: Mean Serum Protein Levels of the Study Subjects

AGE (yrs.)	Serum Total Protein Levels of the subjects (g/dl) Mean $\pm$ S.D			't' value
	Boys (N=32)	Girls (N=29)	Total (N= 61)	
< 9	6.93 $\pm$ 0.20 N= 3	7.45 $\pm$ 0.23 N= 2	7.14 $\pm$ 0.33 N=5	3.18^{NS}
9 - 9.11	7.27 $\pm$ 0.56 N=7	7.58$\pm$ 0.27 N=6	7.41 $\pm$ 0.46 N=13	2.2^{NS}
10-10.11	7.54 $\pm$ 0.44 N=10	7.79 $\pm$ 0.29 N=6	7.63 $\pm$ 0.40 N=16	2.14^{NS}
11-11.11	7.3 $\pm$0.59 N=6	7.52 $\pm$ 0.56 N=9	7.48 $\pm$ 0.55 N=15	2.16^{NS}
12 – 12.11	7.95 $\pm$ 0.53 N=4	7.77 $\pm$ 0.42 N=3	7.87 $\pm$ 0.45 N=7	2.57^{NS}
13 – 13.11	7.5 $\pm$ 0 N=1	8.33 $\pm$ 0.31 N=3	8.13 $\pm$ 0.49 N=4	4.3^{NS}
14-14.11	9.1 $\pm$ 0 N=1	--	9.1 $\pm$ 0 N=1	--

Morbidity profile of the Study Subjects

Morbidity data was collected on 478 subjects comprising 300 boys and 178 girls. Adolescence is generally considered as a time of being relatively free of health problems. However, 61%subjects reported to have experienced some or the other form of morbidity (ies) (Figure 4.1.44). Table 4.1.30 shows the common morbidities experienced by the subjects. The most common morbidity was cold (31%) followed by headache (30%), stomachache (28%), cough (27%), fever (21%) etc. Incidence of vomiting was significantly higher ($p<0.01$) in girls as compared to boys. Compared to boys, the girls had a significantly higher ($p<0.001$) percentage of subjects suffering from headache and stomachache. Majority girls reported to have been experiencing stomachache due to their menstrual cycle. Except for diarrhea, the percent subjects experiencing various morbidities in the 15 days preceding the survey, was higher amongst girls as compared to boys. Figure 4.1.45 shows the morbidities experienced by both the sexes at different ages.

Further age wise analysis revealed that the morbidities were highest during early-adolescent years followed by pre-adolescence. None of the boys experienced any form of morbidity at the age of 15 years and above.

Figure 4.1.46 shows morbidities experienced according to the stage of adolescence. As can be clearly seen subjects in the early-adolescence were the ones who experienced most of the morbidities. Pre-adolescents were the next to follow. This can be attributed to the high incidence of undernutrition amongst these subjects during pre and early-adolescence. Thus, it can be concluded that pre and early-adolescence are the stages which need to be targeted for a desirable positive health scenario in adolescents as well as adults.

As consumption of confectionery was high in the subjects thus, the oral health of the subjects was also assessed. One third of them reported of brushing their teeth once a day and one fifth of them had caries. However, 14% of the subject brushing their teeth twice also reported of having caries. Overall 17% of the subjects reported of having dental caries. Number of caries was found to be 1, 2 and 3 in 57%, 32% and 11% subjects respectively.

Figure 4.1.44: Morbidity Profile of the Study Subjects (N=478)

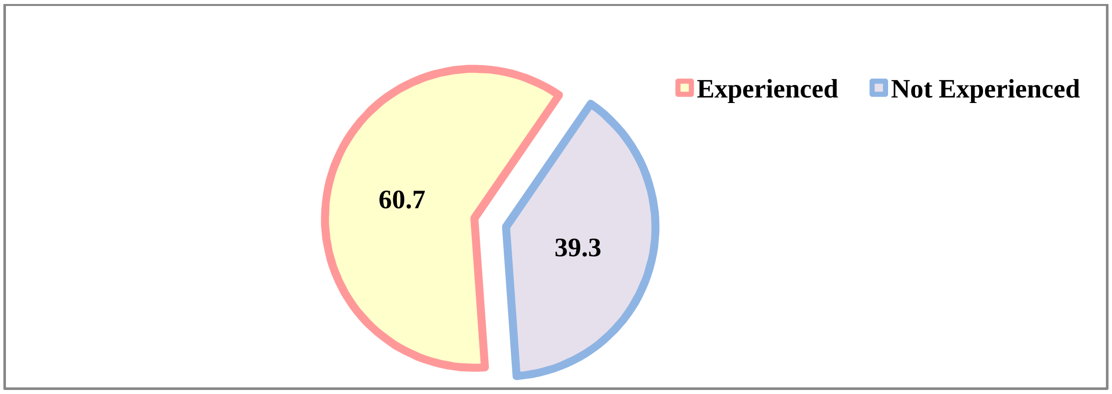


Figure 4.1.45: Morbidity (ies) Experienced - Agewise (N=478)

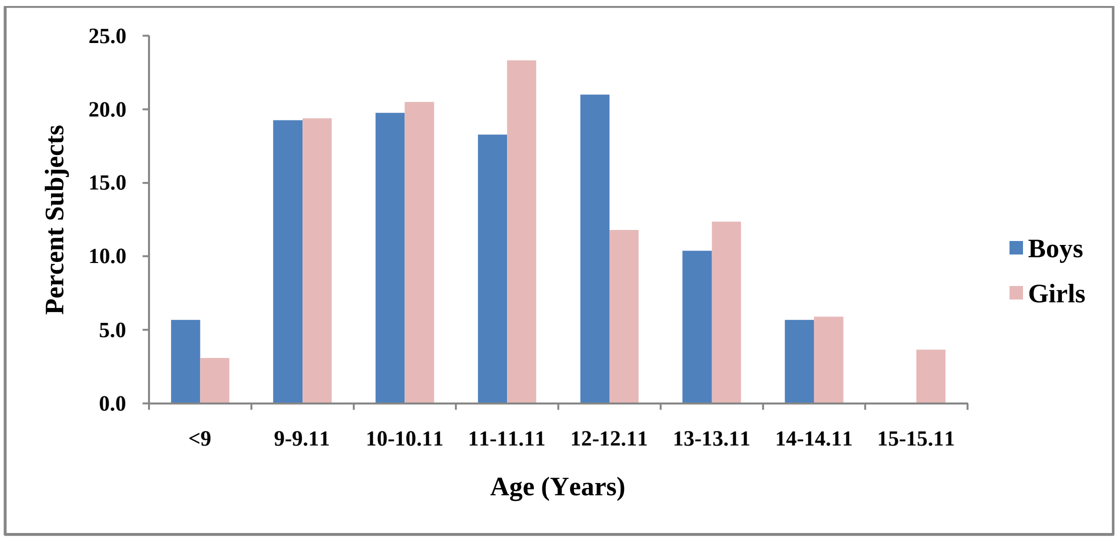


Figure 4.1.46: Morbidities Experienced According to the Stage of Adolescence(N=478)

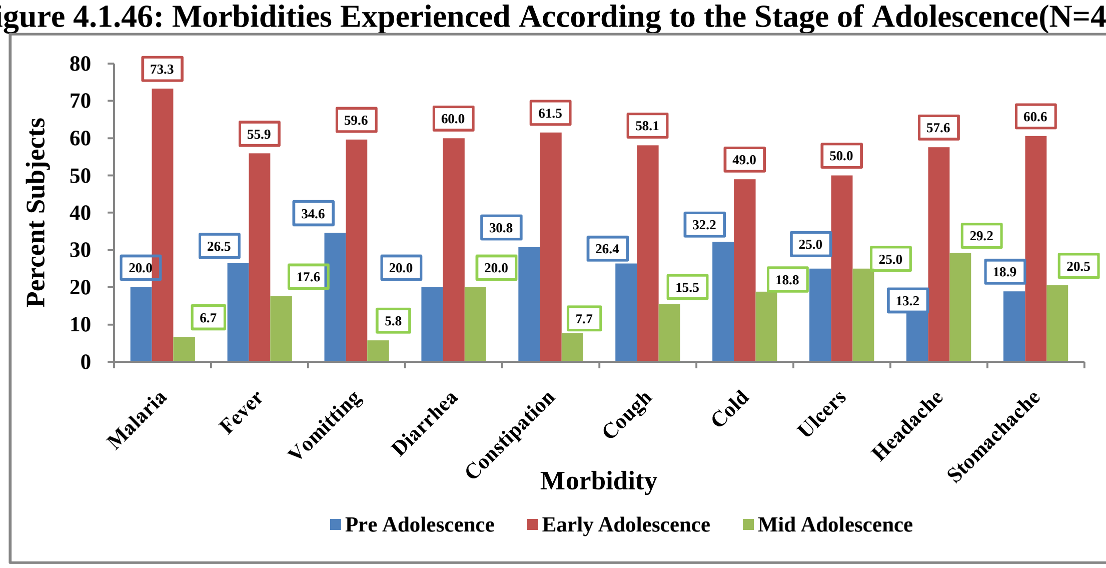


Table 4.1.30: Morbidities Experienced – Sexwise (N=478)

Morbidity	Boys (N= 300) % (n)	Girls (N= 178 % (n)	Total (N= 478) % (n)
Malaria	2.7 (8)	3.8 (7)	3.1 (15)
Fever	19 (57)	25.3 (45)	21.3 (102)
Vomitting	8 (24)	15.7 (28)**	10.9 (52)
Diarrhea	3 (9)	1.3 (6)	3.1 (15)
Constipation	2.7 (8)	2.8 (5)	2.7 (13)
Cough	24 (72)	32 (57)	27 (129)
Cold	31.7 (95)	30.3 (54)	31.2 (149)
Headache	23 (69)	42.1 (75)***	30.1 (144)
Stomachache	17.7 (53)	44.4 (79)***	27.6 (132)

****significant at p<0.01 ***significant at p<0.001**

Key findings

- Mean hemoglobin level of all the subjects was 11.92 $\pm$ 1.34 g/dl.
- Girls had mean hemoglobin (Hb) levels above the cut offs at all ages while boys had Hb levels lower than the cut offs between the age of 11- 13 years.
- Prevalence of anemia was 42.6% amongst the subjects. Subjects in their mid and early adolescents showed the highest prevalence of anemia.
- Around 74% of the subjects showed normocytic normochromic anemia. Almost all (86%) of the non anemic subjects and 58% of the anemic subjects showed normocytic and normochromic anemia.
- About 61% subjects experience some or the other form of morbidity (ies). The most common morbidities experienced by them were cough, cold, headache and stomachache.

Discussion

Mean hemoglobin level was found to be 11.92 g/dl, which was similar to that reported by Agarwal KN (2003), but lower than that reported by other studies (Basu S, 2004;Yearul 2010; Ramzi 2011; Atto et al, 2012). This value was higher than the values reported for urban Vadodara girls by Kotecha PV et al (2009). Prevalence of anemia among the subjects in the present study was found to be 42.6% which is corroborated with the findings of Jain et al (2012) and is close to the prevalence reported by Sudhagandhi et al (2011) and Agarwal KN (2003). Several studies have reported prevalence of anemia between 5.6 to 75.8% in different parts of the world (Ahmed, 2000;Basu S, 2004; Choudhary, 2006; Baral, 2009; Kotecha, 2009;Dutt R 2009; Yearul 2010; Ramzi 2011;Balci, 2012; Atto et al, 2012).

The present study showed different types of anemias-normocytic and normochromic predominantly (57.7%), microcytic hypochromic (23.1%), microcytic mild and moderate anemia (15.4%) and macrocytic anemia (3.8%).The high prevalence of microcytic hypochromic anemia in adolescents, confirms the frequency of nutritional deficiencies including iron and vitamins as shown by other studies. (Abu-Samak et al 2008; Chaudhary S, 2008).

Serum total protein levels were within normal range. Goyle A () also observed that mean serum protein levels were adequate in 90% of the subjects. This could be attributed to the ‘Indian diet’ which comprises of cereals and pulses mainly.

Girls reported a higher incidence of morbidities as compared to boys corroborating with previous studies (Kaur, 2011; Dambhare, 2010). Most common morbidities were stomachache, headache, cough, cold and fever. Girls reported a significantly higher incidence of stomachache as was shown by Tiwari K (2000). Around 42% of the girls reported headache similar to the Patiala girls (44%) (Kaur, 2011).Incidence of dental caries was found to be 17% which was very less as compared to Wardha adolescents () but was quite close to the values reported by Sachan et al (2012). This can be attributed to the fact that nearly two third of the subjects brushed their teeth twice daily. However other studies reported incidence of dental caries amongst adolescence to be between 2.2 to 28% (Susmitha, 2012; Panda 2000; Kumar R, 2008). Overall, there was no significant association between anemia and morbidities experienced by the subjects in the present study, which could be mainly due to the presence of mild and moderate anemia in most of the subjects. Prema et al (1982) has reported that morbidities may increase only in the case of severe anemia.

Physical Activity Profile of the Study Subjects

Physical activity is termed as “any bodily movement produced by skeletal muscle that results in a substantial increase over the resting energy expenditure” (Casperson et al, 1985). This section provides an insight into the physical activity, leisure time, sleep time and study time of 478 subjects comprising of 300boys and 178 girls between 8 to 14 years of age.

Physical activity levels of the subjects

On being asked about the physical activity (in minutes) done on the previous day majority of the girls (67%) reported a physical activity level of <30 minutes. For boys almost an equal percentage (around 45%) had physical activity levels of <30 minutes or>45 minutes in the past 24 hours respectively (Figure 4.1.47).

Between 12-14 years most of the children played for <30 minutes on the previous day. As age advanced, physical activity of 45-60 minutes reduced from 32% to 0% at age <9 years and 15 years respectively. Around half of the subjects played for <30 minutes between 9-11 years.

However, 60% of the subjects reported physical activity of<30 minutes above 11 years (Figure 4.1.48). Thus, indicating decline in playtime as age advanced which is mainly due the increase in workload of studies and tuitions.

Playtime at Home and School

Playtime at home and school included the physical education classes, free time during lunch and also playtime after school and at home. Irrespective of the age and sex most of the subjects either played for <30 minutes or >120 minutes in school and home daily (Figure 4.1.49). As majority of the subjects went for tuitions in the evenings duration of play did change according to the age. Number of subjects reporting playtime of< 60 minutes daily increased as compared to playtime of>120 minutes from the age of 12 years and onwards (Figure 4.1.50).

Sleep time

Many subjects (48% boys and 41% girls) reportedly slept for 7.5 to 8.5 hours followed by 8.5 to 9 hours and <7.5 hours daily (Figure 4.1.51). On analyzing age wise it was observed that the number of subjects with reported sleep time of 7.5 to 8 hours increased till the age of 14 years. Subjects reported to have been sleeping for more than 9 hours decreased from the age 11 years and finally there was no subject with sleep time of 9 hours or more at the age of 15 years (Figure 4.1.52).

Figure 4.1.47: Physical Activity Performed by the Subjects on the Previous Day –Sexwise (N=478)

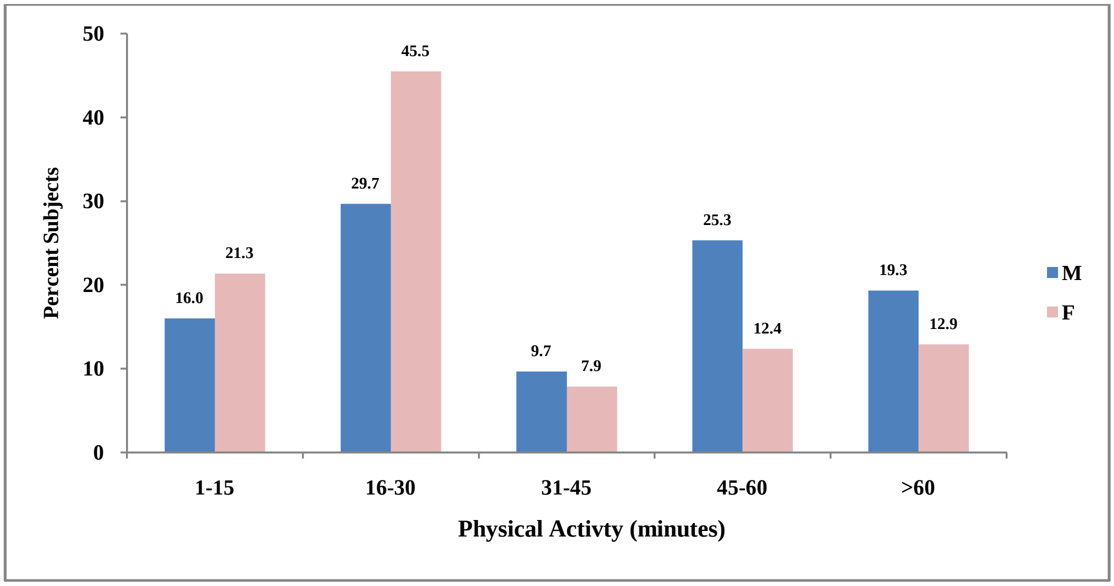


Figure 4.1.48: Physical Activity Performed by the Subjects on the Previous Day –Agewise (N= 478)

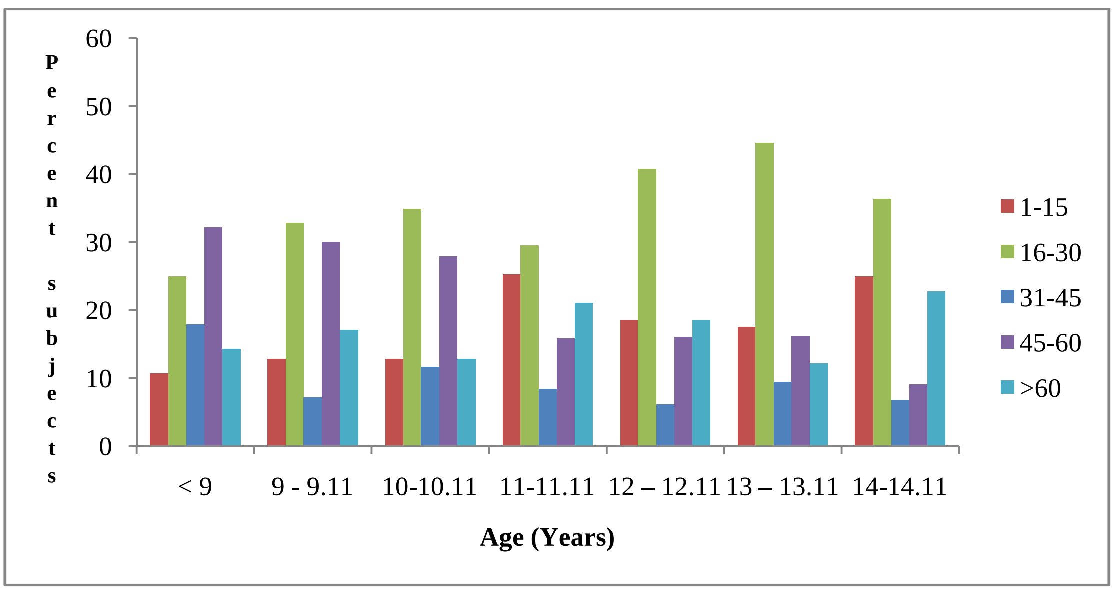


Figure 4.1.49: Reported Playtime at Home and at School –Sexwise (N=478)

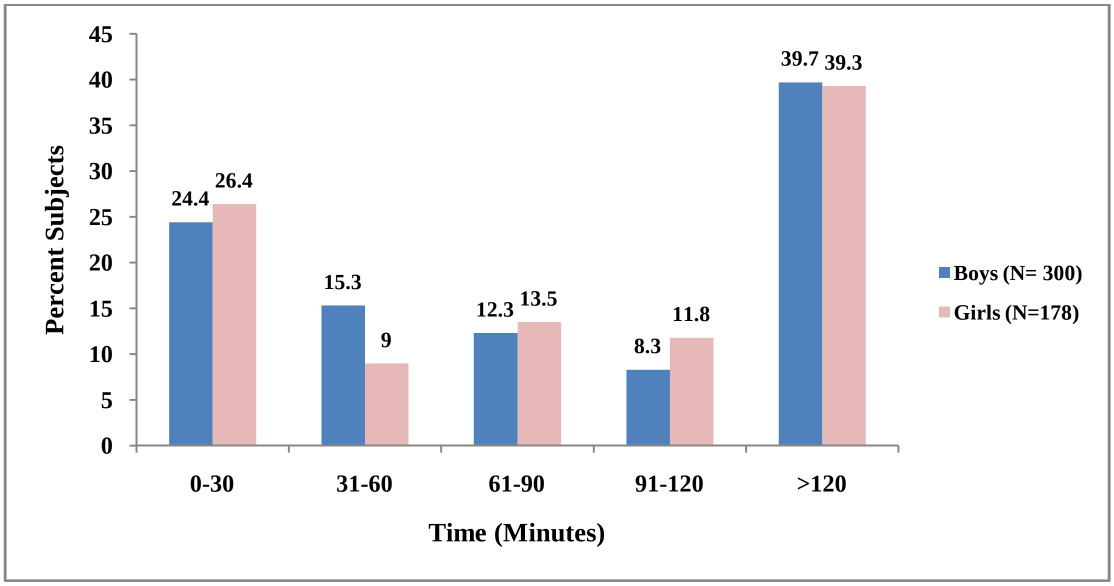


Figure 4.1.50: Reported Playtime at Home and at School –Agewise (N=478)

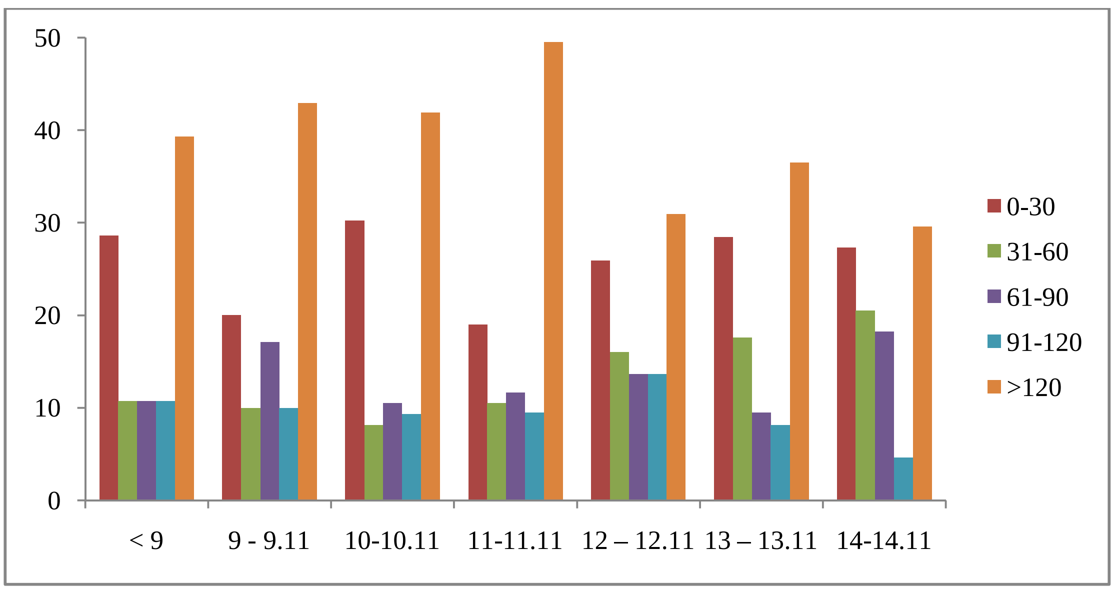


Figure 4.1.51: Reported Sleeptime of the Study Subjects – Sexwise (N=478)

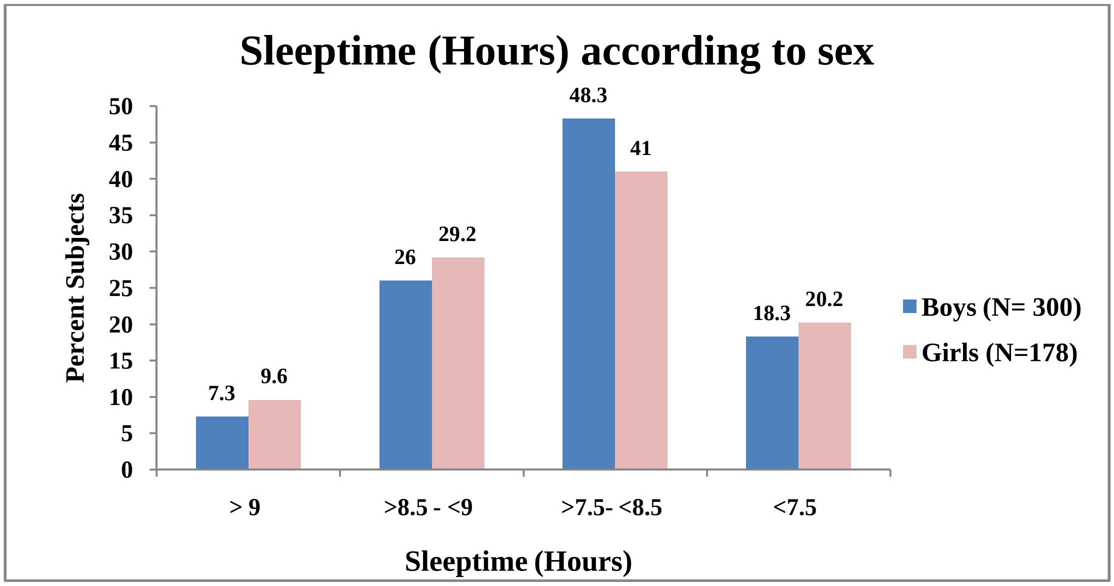
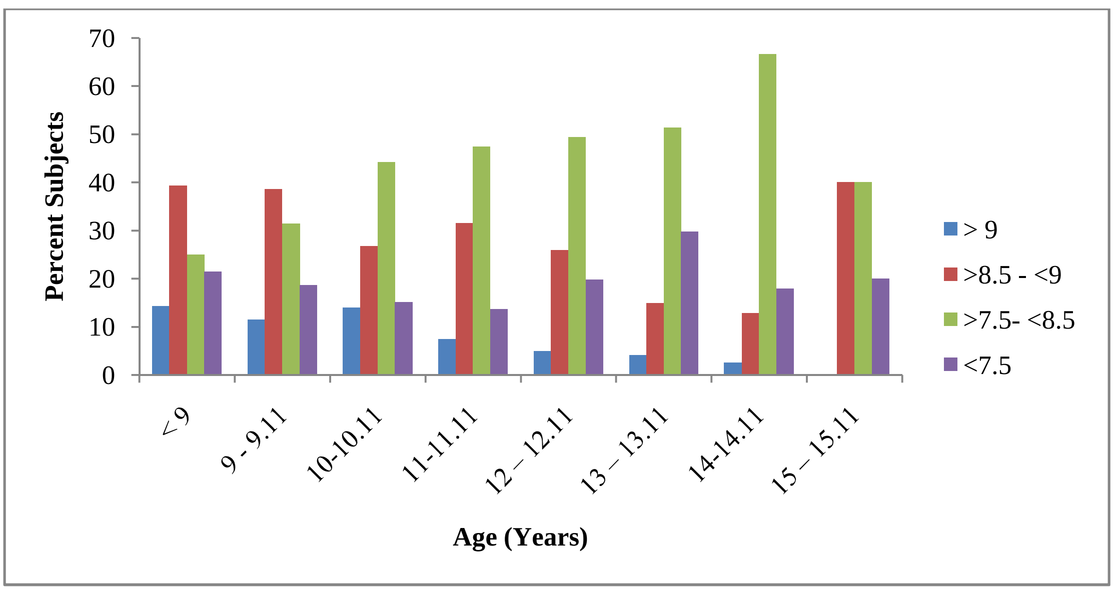


Figure 4.1.52:Reported Sleeptime of the Study Subjects – Agewise (N=478)



Leisure time

As far as leisure time was concerned boys spent less time on leisure than girls but the difference was not significant. Nearly 21% girls spent more than 2 hours on leisure (Figure 4.1.53). Maximum children reported 60 minutes or lesser as total leisure time. As the age advanced children spent lesser time on leisurely activities and at the age of 15 none of the subjects spent more than an hour on leisure (Figure 4.1.54).

Study time

More than 30% of the boys and girls studied for > 5 hours daily apart from their school studies. Thus these children spent about 10-11 hours daily on studies (Figure 4.1.55).

From 10 years onwards subjects who reported study time of more than 5 hours daily increased up to the age of 15 years where 60% of the subjects reported study time of> 5 hours daily (Figure 4.1.56).There was no significant difference in the time spent for studies amongst the sexes.

Cognitive Abilities of the Study Subjects

Apart from rapid physical growth adolescents also experience improvements in cognitive functions. The cognitive abilities can be studied by using a variety of tests. Cognitive abilities of the study subjects based on the cognitive function tests and their examination marks are presented in this section. Tests used to measure the various aspects of cognitive abilities were Digit Span (DS), Visual Memory Test (VMT), Maze test (MT) and Class Performance (CP) (WISC IV, 2004; Bhardwaj and Gopaldas, 1986; Bhatt 1973).
Mean Scores as shown in Table 4.1.31 depict a better performance by girls in DS, MT and overall class percentage than boys. However, the difference in the cognitive scores was not found to be significant between the sexes. Age wise analysis further shows (Table 4.1.32) the lowest scores were for children between 15-16 years of age except for the MT. All the cognitive function scores showed a significant positive correlation with age ($p<0.01$). CP showed a significant negative correlation to age ($p<0.05$).

Figure 4.1.53: Reported Leisure Time - Sexwise (N=478)

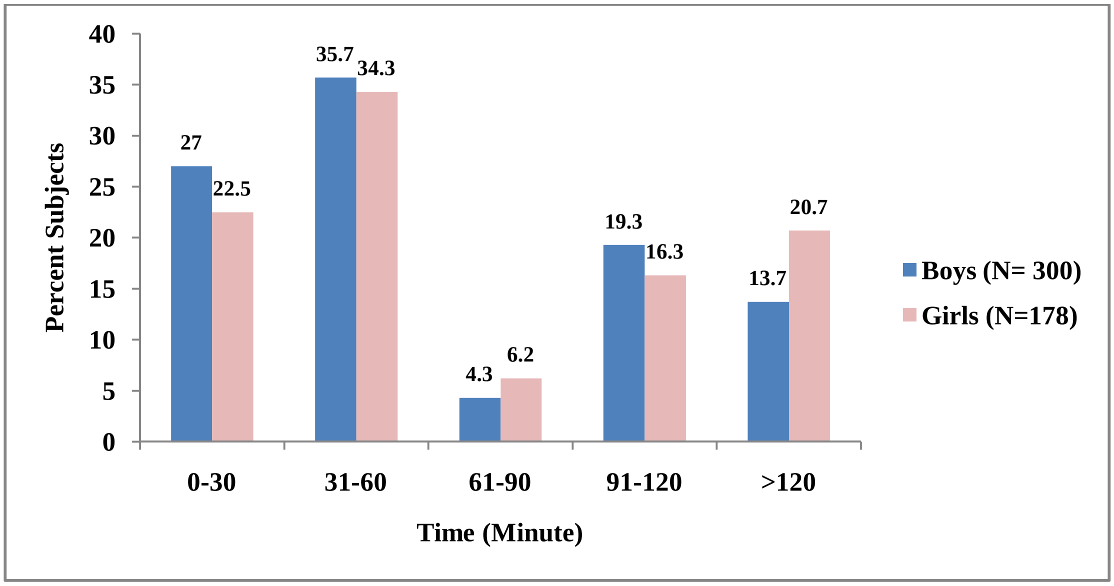


Figure 4.1.54: Reported Leisure Time - Sexwise (N=478)

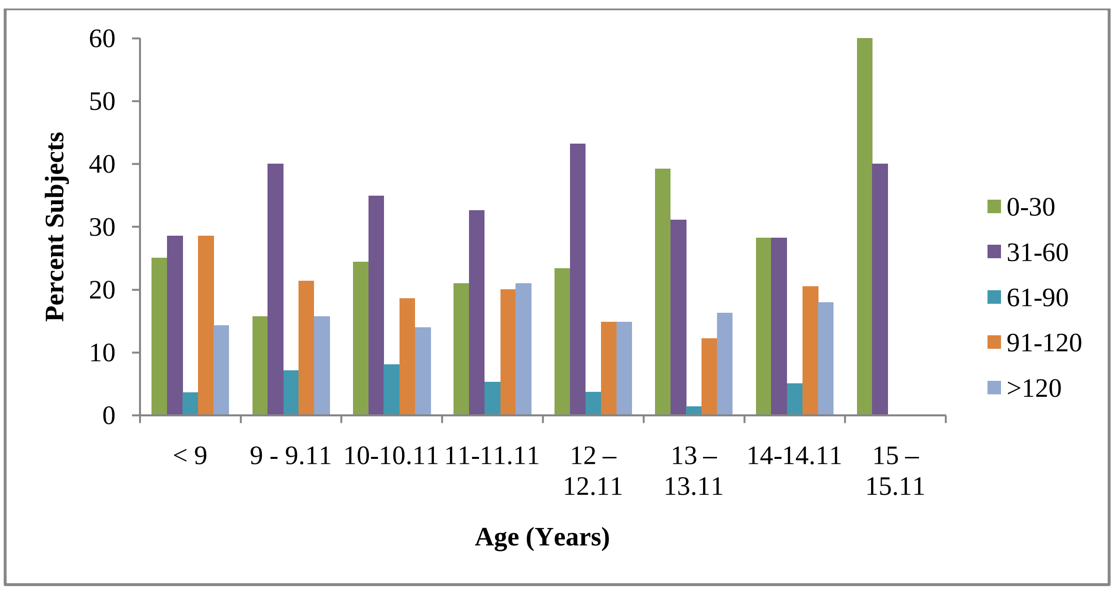


Figure 4.1.55: Reported Studytime of the Study Subjects – Sexwise (N=478)

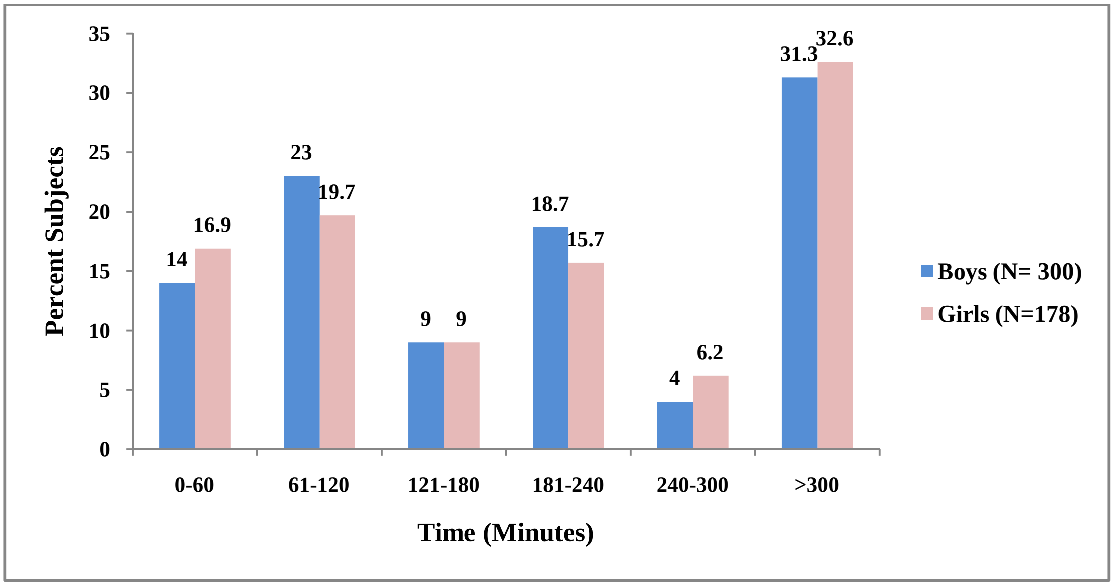


Figure 4.1.56: Reported Studytime of the Study Subjects – Sexwise (N=478)

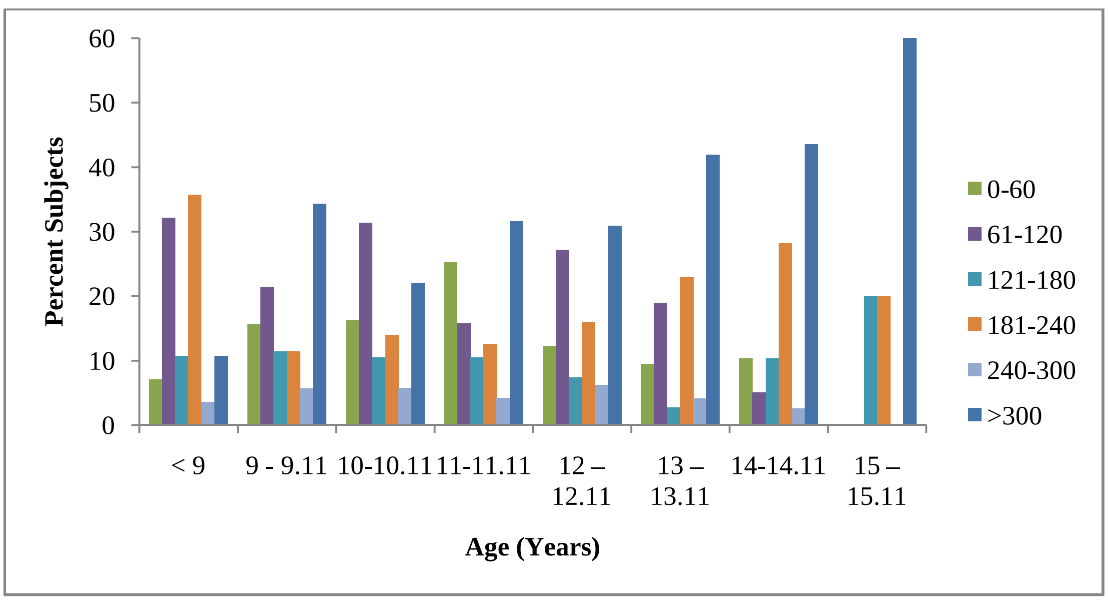


Table 4.1.31: Mean Cognitive Test Scores Sex wise (N=478)

Sex	DS	VMT	MT	CP
Boys (n=300)	12.55±2.7	0.52± 0.15	13.41± 3.22	65.24± 16.08
Girls(n=178)	12.58± 2.35	0.52± 0.16	13.72± 3.69	69.66± 15.09
Total (N=478)	12.56± 2.58	0.52± 0.16	13.53± 3.41	66.88± 15.85

Table 4.1.32: Mean Cognitive Test Scores age wise (N=478)

Age	N	DS	VMT	MT	CP
<9	28	11.82± 2.92	0.47± 0.17	12.82± 4.52	63.60±18.31
9-9.11	70	12.24±3.1	0.51±0.16	13.07±2.99	69.50± 13.93
10-10.11	86	12.10±2.40	0.51± 0.13	13±3.9	70.11± 14.67
11-11.11	95	12.02±2.34	0.49± 0.16	13.35± 3.5	67.33±15.83
12-12.11	81	13.02±2.28	0.53± 0.14	14.05±3.37	64.94±16.74
13-13.11	74	13.46±2.08	0.56±0.16	14.43±2.63	66.85±15.57
14-14.11	39	13.59± 2.78	0.59± 0.19	13.64±2.94	62.66±16.93
15-15.11	5	10.8±3.49	0.38± 0.84	13.6±2.88	49.32±8.74

Stage wise analysis shows that mean VMT and MT scores were lowest during the early-adolescence while DS scores showed an improvement from pre-adolescence to mid-adolescence whereas VMT and MT scores showed a decline during early-adolescence (Figure 4.1.57). These results can be attributed to the highest prevalence of anemia and higher prevalence of undernutrition during early-adolescence.

Cognitive development is affected by nutritional anemia as well as by the nutritional status. Overall cognitive scores for anemics as compared to normal subjects were low. On comparison between anemic and non anemic according to WAZ scores it was observed that underweight anemic subjects had lower total cognitive scores (Table 4.1.33). Anemic subjects with WAZ between -1.99 to -1 had lower overall scores as compared to their non anemic counterparts (Table 4.1.33). Although the association found was not significant. Analysis revealed that anemic subjects who were underweight (WAZ <-3SD) had the lowest scores for these tests (Figure 4.1.58).

According to Table 4.1.26comparison of anemic and normal subjects on the basis of HAZ scores shows no significant difference in overall cognitive scores. However subjects with HAZ scores between -2.99 to <-2 had lowest overall cognitive scores whereas those between 1 to 1.99 SD had highest overall cognitive scores. Another key finding was that subjects with HAZ score >2 to 2.99 had lowest scores for VMT and lower scores for MT than the subjects having HAZ scores between 1-1.99. Anemic Subjects with HAZ scores <-2 had lowest overall scores for the cognitive tests (Figure 4.1.59).

None of the anemic subject had BAZ score less than -2 SD. Anemic subjects with BAZ scores between 1 to <2 SD had the highest overall cognitive test scores whereas those with scores between <-1 to <-2 had least overall scores (Figure4.1.60).

Figure 4.1.57: Mean Cognitive Test Scores According to the Stage of Adolescence (N=478)

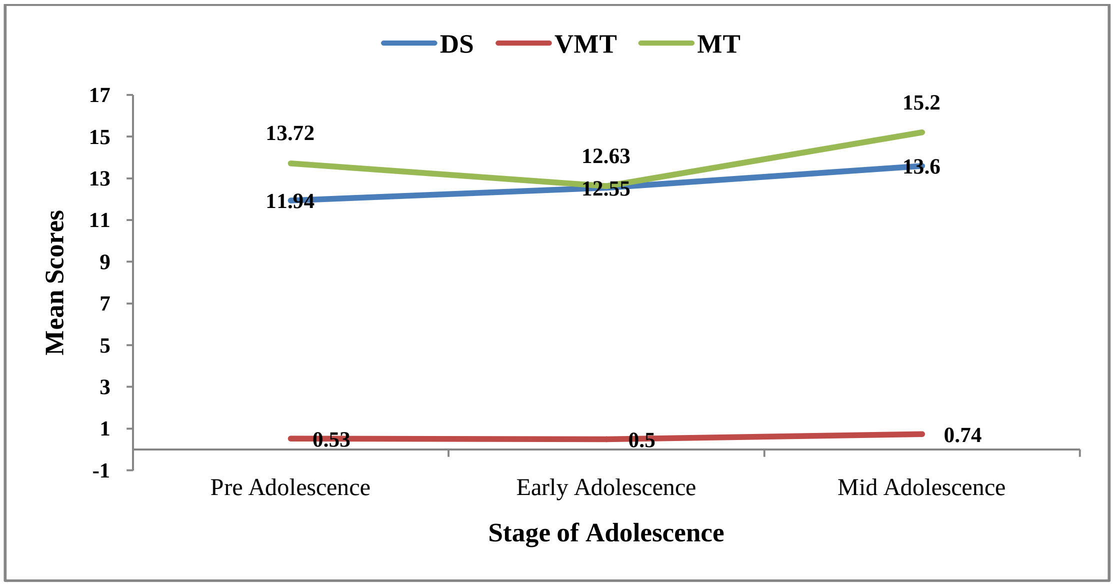


Table 4.1.33: Mean Cognitive Scores of the Subjects According to their Nutritional Status and Anemia

Z Scores	Cognitive test Scores (Mean + SD)					
	Normal (N=35)			Anemic (N=26)		
	Digit Span	Visual Memory Test	Maze Test	Digit Span	Visual Memory Test	Maze Test
Weight for age – Z scores						
< -2				11+0	0.5+0	13+0
-1.99 to < -1	13+ 3.6	0.37+0.25	14.5+1.5	13+0	0.5+0	14+0
-1 to +1	12.1+ 2	0.54+0.14	13.1+3.7	11.8+2.2	0.53+0.13	13.4+3.9
1 to 1.99	14.8+ 1.7	0.65+0.17	10+ 7.4	13.6+1.9	0.57+ 0.11	14.1+4.2
>2	12.5+0.7	0.55+ 0.07	10+1.4			
Height for age - Z scores						
<-2				11+0	0.5+0	13+0
-1 to +1	12.7+2.6	0.49+0.19	13.1+3.5	11.5+2.1	0.54+0.13	12.8+4
1 to 1.99	12.3+2.4	0.59+0.17	14+3.2	12.8+2.3	0.58+0.12	14.6+3.9
>2	12.5+2.1	0.55+0.07	15+4.2	13.6+1.7	0.48+0.08	14+3.7
>3	12.7+0.6	0.57+0.06	6.67+5.9			
BMI for age – Z scores						
< -2	12.5+4.7	0.35+0.17	15.25+2.1			
-1.99 to < -1	14.6+0.6	0.44+0.29	12+4.9	12.1+2.8	0.5+0.09	12.1+4.9
-1 to +1	11.8+2	0.57+0.15	12.95+4	11.5+1.7	0.49+0.11	13.8+2.6
1 to 1.99	14.25+1	0.53+0.05	12.25+5.6	13+1.9	0.61+0.11	14.7+3.4
>2	12.5+0.7	0.55+0.07	10+1.4			

Figure 4.1.58: Mean cognitive Test Scores of the Anemic Subjects According to WAZ Scores (N=61)

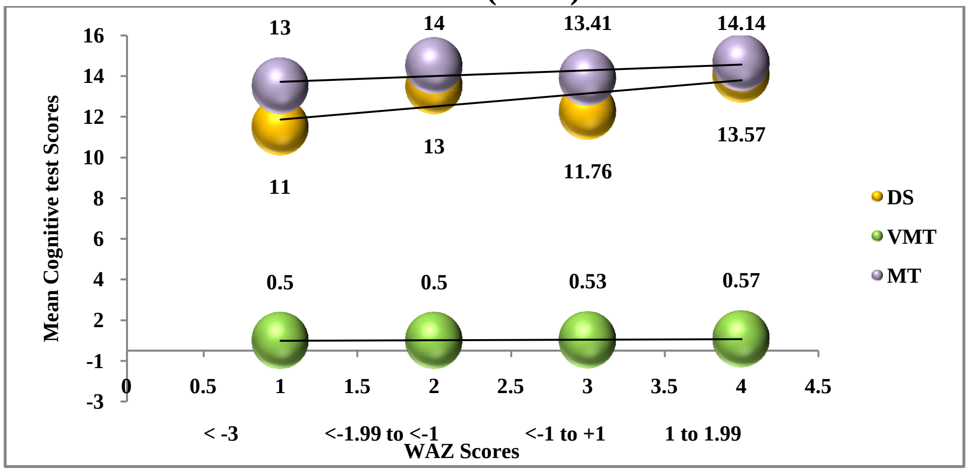


Figure 4.1.59: Mean cognitive Test Scores of the Anemic Subjects According to HAZ Scores (N=61)

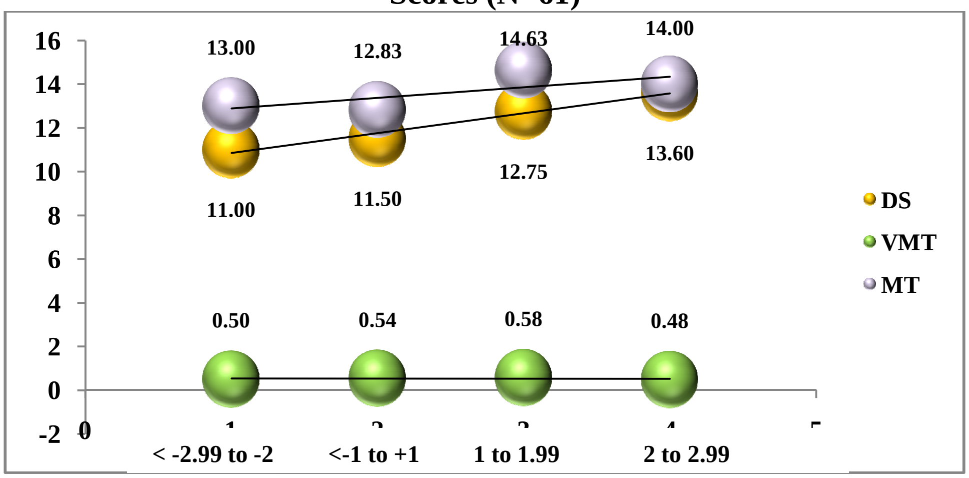
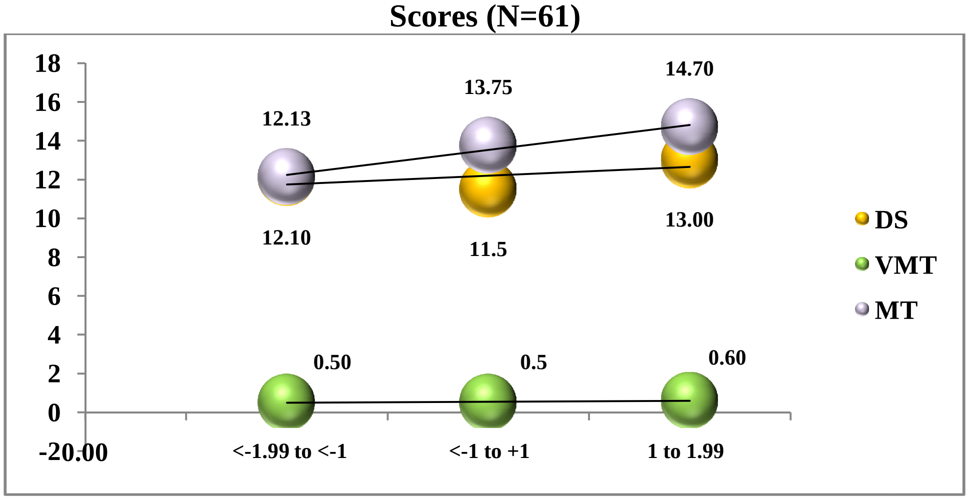


Figure 4.1.60: Mean cognitive Test Scores of the Anemic Subjects According to BAZ Scores (N=61)



Key findings

- Physical activity levels declined as age advanced. Physical activity came down to 0% at the age of 15 years from 32% at the age of <9 years.
- More subjects reported a playtime of a lesser duration at the age of 12 years and onwards as compared to children below 12 years.
- Percentage of subjects who slept for 9 hours or more was 14% at the age of <9 years while at the age of 15 years none of the subjects slept for 9 or more hours.
- As age advanced children spent lesser time on leisure activities.
- Study time of more than 5 hours apart from the school time was reported by 60% the subjects at the age of 15 years.
- Cognitive function test scores were significantly correlated with age.
- Girls had higher scores in digit span, maze test and a higher class performance than boys. However, there was no significant difference observed in terms of score between the sexes.
- Undernourished subjects had lowest overall score in the cognitive tests performed by them.

Discussion

Physical activity levels of the subjects revealed that higher percentage of the subjects between 9-11 years was involved in physical activity (in school & after school) for a longer duration. Decline in physical activity of children as they increase in age has been reported by many investigators (Strauss, 2001; Dovey, 1998; NM YRRS, 2005).Majority of the girls were involved in physical activities for a lesser time as compared to boys in the present study, trend similar to that observed in several studies (Ruiz, 2011; Wen LM 2009; Strauss, 2001; Dovey, 1998).

Sleep time patterns showed that 48% and 41% boys and girls slept for 7.5 to <8.5 hours/ day respectively. Sleep duration decreased as the age increased, a similar trend has been shown by various studies (Patil R, 2012; Rhie S, 2011; Swaminathan S, 2011; Gupta R, 2008).

More than half of the subjects spent less than an hour on leisure activities (computer, television, conversing on phone etc.). Swaminathan (2011) reported mean time for TV watching and video games was <1 hour/ day irrespective of the gender. With advancement in age there was decline in total leisure time observed which is supported by findings reported by Dovey et al (1998).

Extensive homework obligations and private lessons attendance take children away from physically active pursuits (Loucaides, 2003; Swaminathan S, 2011). In the current study also, it was observed that as age advanced study time increased due to increase in tuition timings and extra workload.

Cognitive development scores of the subjects in the present study revealed that undernourished subjects had lowest overall scores as compared to the well nourished ones. Malnourished group differed significantly from the adequately nourished group on tests of ponemic fluency, design fluency, selective attention, visuo-spatial working memory, visuo-spatial functions, verbal comprehension and verbal learning and memory showing poor performance (Kar B, 2008). Agarwal et al (1989) found that there was no significant difference between the IQ scores of anaemic and non-anaemic group. However, an effect of nutritional status was observed on the IQ scores. Also anaemics showed lower levels of attention and concentration. Another study by Agarwal et al (1995) revealed that undernourished boys demonstrated lower scores compared to normal nourished children for abilities related to mental control, logical memory, digit span, visual reproduction and associative learning. Significantly lower scores were seen in anemic than non anemic adolescent school girls in Vadodara (Sen A, 2005). The findings of the present study are in line with the above stated studies thus, reinforcing the effect of nutritional status and anemia on cognitive abilities of adolescents.

Knowledge, Attitude and Practices (KAP) of the Subjects regarding Healthy Eating, Dietary Habits and Physical Activity

Knowledge, attitudes and practices related to diet and lifestyle directly affect the nutritional status of adolescents. Creating awareness about the healthy eating and physical activity practices may help in promoting a healthy diet and increase physical activity levels. (Summerbell et al, 2006). The foremost requirement for this is to assess their knowledge and attitude regarding these factors as well as the practices followed by them. This section evaluates the knowledge, attitude and practices of the subjects (N=478) regarding healthy eating, meal patterns, healthy choices, food pyramid, dietary consumption pattern, physical activity etc.

Knowledge and Attitude regarding Healthy Eating, Meals and Meal Pattern

A mere 15.1% of the subjects felt that diet together with exercise was needed for a healthy growth and development. On the other hand 64% subjects thought either diet or some specific food item was required for the same. For 84 % of the subjects healthy food included some particular food item while only 7% could correctly say that healthy food is a balanced diet with all the nutrients. Most of the responses received on healthy eating behaviours were either hygiene related or eating related. The most common responses were 'Wash your hands before and after meals' and 'Eat with a spoon'. School staff reported of teaching the students about healthy eating behaviours, and 68 % of the children reported to have been taught this. From these nearly 44% subject either did not remember what had been taught or they gave a response which was irrelevant (Table 4.1.34).

According to the curriculum the children are taught about the functions of food and various food groups from the age of 7-8 years and the same concept is reinforced every year. However when questioned about the functions of food, only 7.3% and 29.3 % children either gave a correct answer or were partially correct (2 functions) respectively. Most (94%) of the subjects could not identify the different food groups.

On being asked to name any 3 foods which they believed helped them to grow, the foods that topped the list were vegetables followed by cereals and fruits. Thirty percent of the subjects listed milk as one of the three foods that helped them remain healthy (Figure 4.1.61).

Eighty three percent subjects stated the need to have three or more complete meals in a day. More than half (54%) of the subjects felt breakfast to be a very important meal. According to 41.2% subjects an ideal breakfast consisted of milk and cereals.

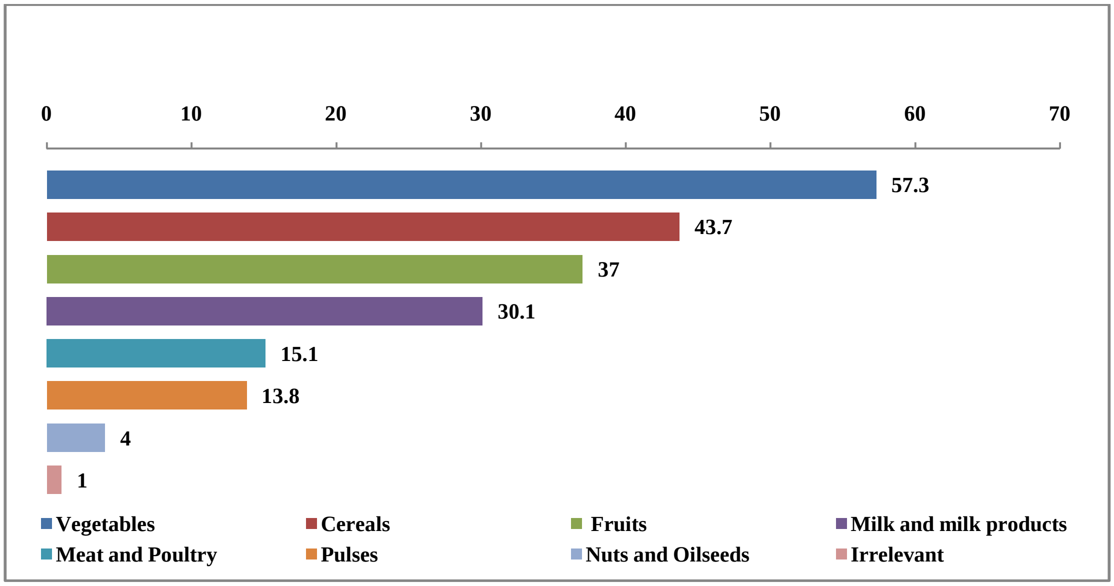
Table 4.1.34 : Knowledge and Attitude regarding Healthy Eating, Meals and Meal Pattern (N=478)

Awareness About	Percent Response % (N)
1. Requirement for healthy Growth and Development	
• Diet	32.6 (156)
• Exercise	2.9 (14)
• Diet and exercise	15.1 (72)
• Food items	31.6 (151)
• Others	17.8 (85)
2. Healthy Food means	
• Balanced diet with all nutrients	7.1(34)
• Food items	84.1 (402)
• Others	8.8 (42)
3. Healthy eating behaviours include	
• Hygiene related	28.5 (136)
• Eating related	25.9 (124)
• Environment related (while eating)	4.6 (22)
• Others	41 (196)
4. Were they taught about healthy eating in the school since last year?	
• Yes	67.6 (323)
• No	32.4 (155)
5. How many times were they taught	
• Never	32.4 (155)
• Once	24.7 (118)
• Twice	13.6 (65)
• Three or more lessons	26.2 (125)
• Any other	3.1 (15)
6. What was taught	
• Not taught	32.4 (155)
• Healthy eating behaviour related	3.6 (17)
• Eating related	16.3(78)
• Food items	2.7 (13)
• Do not remember	23 (110)
• Others	20.9 (100)
• Healthy diet	1.1 (5)
7. Functions of food	
• Correct	7.3 (35)
• Incorrect	63.4 (303)
• Partially correct (2 functions)	29.3 (140)

Awareness About	Percent Response % (N)
8. Names of different food groups	
• Correct	0.9 (4)
• Incorrect	94.1 (450)
• Partially correct	5 (24)
9. Number of complete meals to be taken in a day	
• One	3.3 (16)
• Two	14 (67)
• Three	50.4 (241)
• Four	23.7 (113)
• Five	4.2 (20)
• Six	4.4 (21)
10. Importance of having breakfast	
• Very important	53.8 (257)
• As important as other meals	29.1 (139)
• Not very important	13 (62)
• Not at all important	4.2 (20)
11. Constituents of a healthy breakfast	
• Only milk	8.4 (40)
• Milk and Cereal	41.2 (197)
• Milk, cereal and vegetables	8.6 (41)
• Milk, cereal and fruits	18 (86)
• Milk, cereal, fruits and nuts	10.9 (52)
• All of the above	11.7 (56)
• Any other	1.3 (6)

***(percentage may be more than 100 % due to multiple responses)**

Figure 4.1.61: Subjects Responses (%)Regarding Foods that Help them Grow(N=478)



Practices followed regarding Healthy Eating, Meals and Meal Pattern

Most of the subjects (92.3%) reported to be consuming breakfast, 71% of those consuming breakfast stated that they to consumed breakfast regularly. However, on being asked about breakfast consumption in the last 7 days only 56% of the children reported to have consumed breakfast on all the days. The main reason for skipping breakfast was 'I don't have time' and 'I cannot eat early in the morning'.

Figure 4.1.62 shows the most common breakfast items. Cereals were the most common foods consumed in the form of roti, paratha, pohe, upma, flakes, bread etc. followed by milk. Almost 12% children reported consuming only milk for breakfast and 79.7 % children consumed milk with some or the other form of cereal. Amongst children consuming processed foods 93.2% and 84.7% children reported to be having biscuits and maggi for breakfast respectively (Table 4.1.35). Nearly half of the subjects (50.2%) consumed bakery items in some or the other form on reaching home from school followed by lunch. Only 19.7% subjects had lunch straightaway on reaching home. The most commonly consumed baked items were biscuits and vegetable puffs.

Majority of the subjects (93%) consumed cereals in some or the other form followed by vegetables (46.7%) in lunch. Pulses and legumes consumption was reported to be very low (4%) whereas for meat, fish and poultry it was reported to be 9%. Sweets were consumed by almost $1/4^{th}$ of the subjects in lunch.

For evening snacks, maximum subjects (44%) reported to be eating either the leftovers from lunch or some freshly cooked snack like poha, upma etc. followed by consumption of bakery items mainly in the form of biscuits. Thirty three percent of these subjects had only biscuits as snacks. Nearly 20% subjects consumed fruits and almost the same number consumed processed foods for evening snacks which mostly consisted of maggi (noodles)/ pasta. Milk consumption in the evening was very low being 13% only (Figure 4.1.63).

Around 84% of the subjects had consumed three or more meals the previous day. This was almost the same as that stated in the knowledge section.

Figure 4.1.62: Commonly Consumed Food Items for Breakfast (N=478)

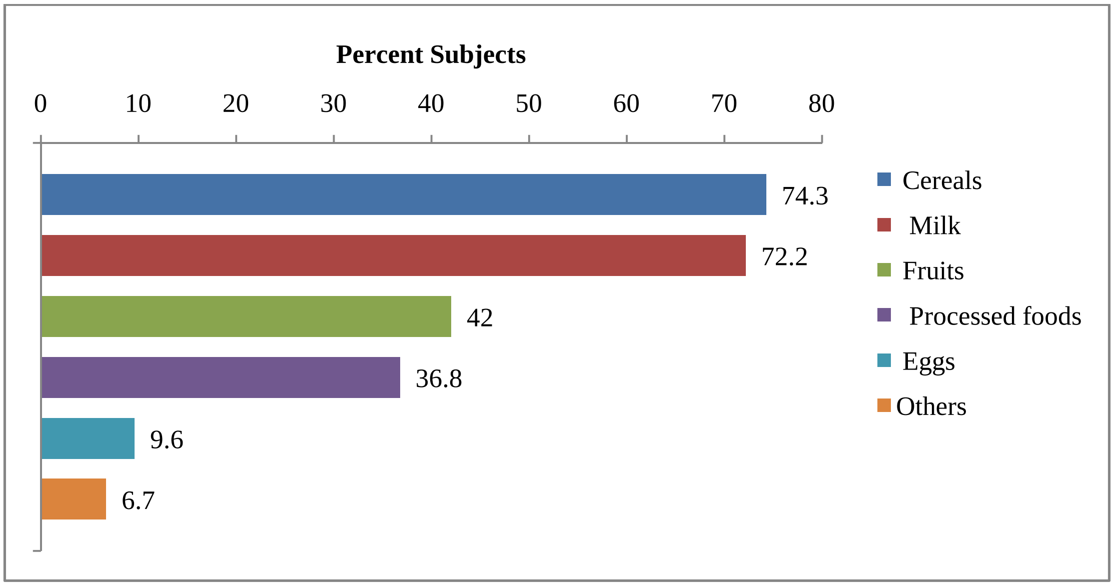


Figure 4.1.63: Commonly Consumed Food Items as Evening Snacks (N=478)

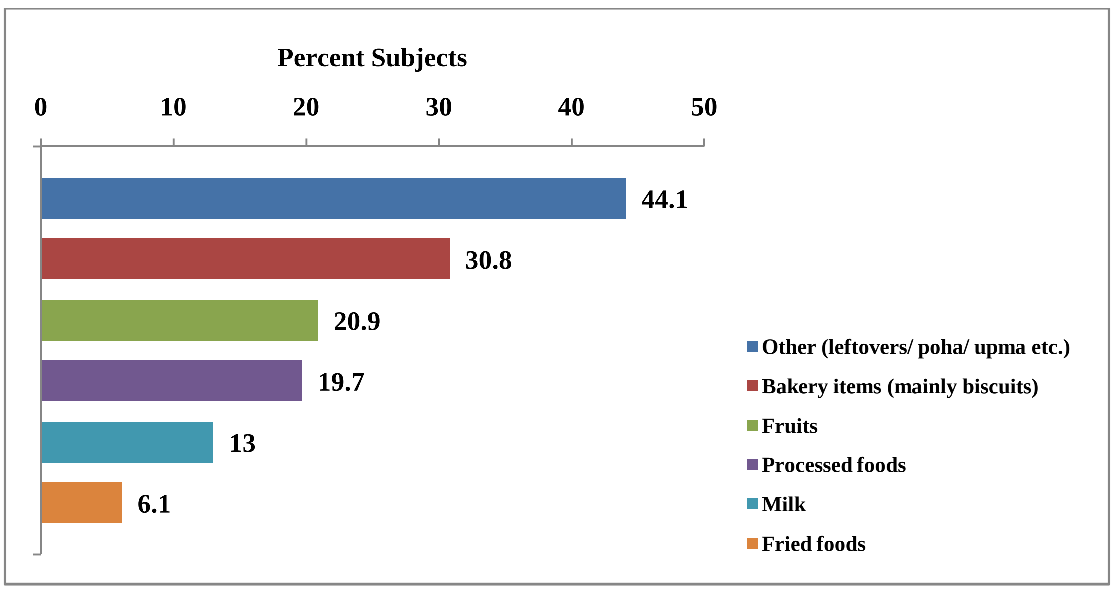


Table 4.1.35: Practices followed regarding Healthy Eating, Meals and Meal Pattern (N=478)

Practices	Percent subject % (n)
1. Breakfast consumption	
• Yes	92.3(441)
• No	7.7 (37)
2. Breakfast consumption regularly	
• Yes	71.1 (340)
• No	28.9 (138)
3. Breakfast consumption during past 7 days	
• Less than 2 days	15.7 (75)
• 2-4 days	17.6 (84)
• More than 4 days	10.9 (52)
• 7 days	55.9 (267)
4. Reason for skipping breakfast	
• I do not have time for breakfast	22.2 (106)
• I cannot eat early in the morning	14 (67)
• There is not always food in my home	2.7 (13)
• Some other reason	5.2 (25)
5. Breakfast food items*	
• Cereals	74.3 (355)
• Fruits	42(201)
• Milk	72.2 (345)
• Processed foods	36.8 (176)
• Eggs	9.6 (46)
• Others	6.7 (32)
6. Consumption pattern for foods after going home*	
• Lunch	19.7 (94)
• Processed foods	10.9 (52)
• Bakery items	50.2 (240)
• Fruits	17.4(83)
• Soft drinks	1.7 (38)
• Milk	18.6 (89)
• Others	13.4 (64)

Practices	Percent subject % (n)
7. Foods included in lunch*	
• Cereals	93.1 (445)
• Pulses and legumes	3.8 (18)
• Vegetables	46.7(223)
• Meat, fish and poultry	9 (43)
• Sweets	23.2(111)
• Others	3.1(15)
8. Foods consumed during evening when hungry*	
• Processed foods	19.7 (94)
• Milk	13 (62)
• Fruits	20.9 (100)
• Fried foods	6.1 (29)
• Bakery items (mainly biscuits)	30.8 (147)
• Other (leftovers/ poha/ upma etc.)	44.1 (211)
9. No. of meals consumed the previous day	
• Two	16.3 (78)
• Three	42.3 (202)
• Four	24.9 (119)
• Five	10.2 (49)
• Six	6.3 (30)

***(percentage may be more than 100 % due to multiple responses)**

Knowledge and attitude regarding Fruit Consumption, Healthy Choices and Food Pyramid

Seventy three percent children reported to have been taught about the benefits of eating fruits and vegetables. Barring a few subjects (2.5%) who stated that fruits and vegetables were needed to provide protection from diseases none of the subjects could give the correct response. According to 40% subjects fruits should be consumed twice daily while 26% subjects felt that it should be consumed once daily. For 44% subjects a serving of fruits should have one fruit and for 34% it should consist of two fruits (Table 4.1.36).

Three groups were given to the subjects to choose one food item from each group in order to see whether the choices made by them were healthy or not. Group A consisted of potato, cauliflower and green leafy vegetables. Group B included chips, pohe (a rice flakes preparation) and biscuit while group C had pastries, ladoos and fruit salad as options. Figure 4.1.64 shows the Food choices of the subjects. From group A although most subjects (49.4%) chose potato still there was a good 35.8% subjects who chose green leafy vegetables. From group B half of the subjects voted for chips followed by pohe (a rice flakes preparation). From group C majority of the subjects chose fruit salad (46%), which was the healthiest option, followed by pastries (38%).

To assess the knowledge regarding the food pyramid, subjects were asked to write the names of foods they should be eating most at the base of the pyramid followed by names of foods to be eaten in lesser quantities as they move upwards in the pyramid. Ninety three percent of the subjects did not know about the food pyramid which is a part of the curriculum since IV standard. Only 7% of the subjects were partially correct in filling the food pyramid details.

Practices regarding Fruit Consumption, Healthy Choices and Water Intake

Nearly 35% of the subjects reported to eat fruits like apple, chickoo (sapota) and pear either peeled or unpeeled. A mere 4.8% subjects reported non consumption of fruit the main reason for it being ‘I don’t have time for it’. Seventy six percent subjects did not add extra salt to their food. Nearly 25% of the subjects had a habit of eating curd, papad or pickles with their meals. (Table4.1.37).Water consumption in 36.4% subjects was less than 6 glasses per day including 14% subjects with a consumption as low as $\leq$ 3 glasses per day (Figure 4.1.65)

Table 4.1.36: Knowledge and Attitude regarding Fruit Consumption, Healthy Food Choices and Food Pyramid (N=478)

Awareness About	Percent Subjects % (N)
1. Were they taught about benefits of eating fruits and vegetables in the school since last year?	
• Yes	73 (349)
• No	27 (129)
2. How many times were they taught about benefits of eating fruits and vegetables?	
• Never	27 (129)
• Once	3.6 (17)
• Twice	23.8 (114)
• Three or more classes	20.9 (100)
• Other	24.7 (118)
3. What was taught about benefits of eating fruits and vegetables?	
• Not taught	27 (129)
• For good health / growth	20.3 (97)
• For protection from diseases	2.5 (12)
• For any other reason	34.3 (164)
• Do not remember	15.9 (76)
4. No. of servings to be consumed in a day	
• One	25.9 (124)
• Two	40 (191)
• Three	21.8 (104)
• Four or more	12.3 (59)
5. One serving of food consists of	
• 1 fruit	44.3 (212)
• 2 fruits	34.3 (164)
• 3 or more fruits	12.8 (61)
• 100-200 g of fruits	5.6 (27)
• 201- 500 g of fruits	1.7 (8)
• > 500 g of fruits	1.3 (6)

Awareness About	**Percent Subjects % (N)**
6. Food choices from given groups	
➢ **Group A**	
• Potato	49.4 (236)
• Green leafy vegetables	35.8 (171)
• Cauliflower	14.8 (71)
➢ **Group B**	
• Chips	50.6 (242)
• Pohe	28 (134)
• Biscuits	21.3 (102)
➢ **Group C**	
• Pastries	38.1 (182)
• Ladoos	16.1 (77)
• Fruit salad	45.8 (219)
7. Knowledge about Food pyramid	
• Correct	0.2 (1)
• Partially correct (Min. two correct responses)	7.1 (34)
• Incorrect	92.7 (443)

Figure 4.1.64: Attitudes based on Food Choices

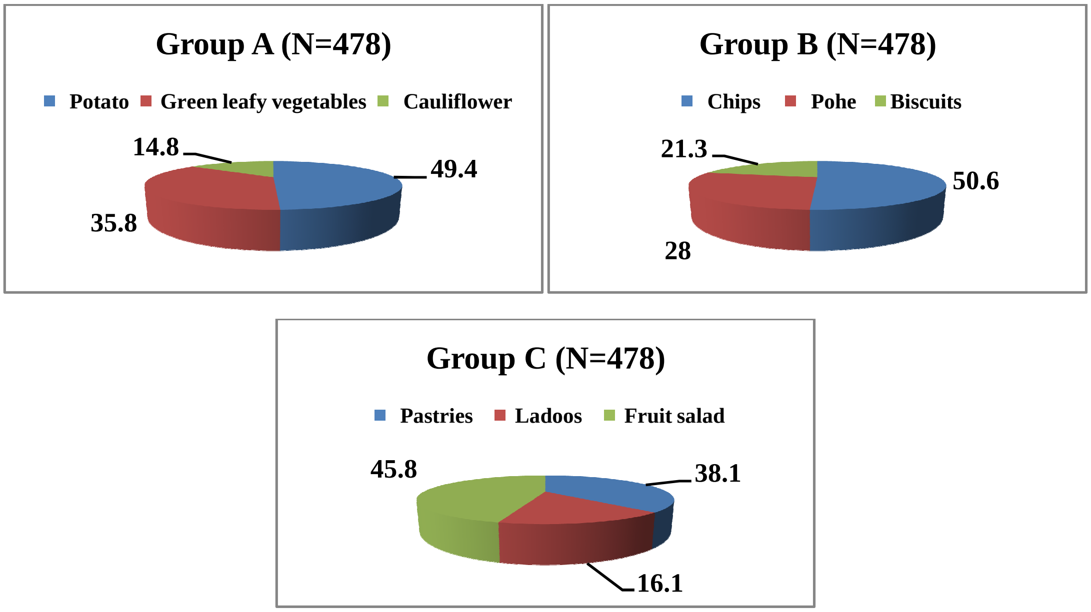


Figure 4.1.65: Reported Water Intake (Glasses/ Day) of the Subjects for the Past 24 Hours (N=478)

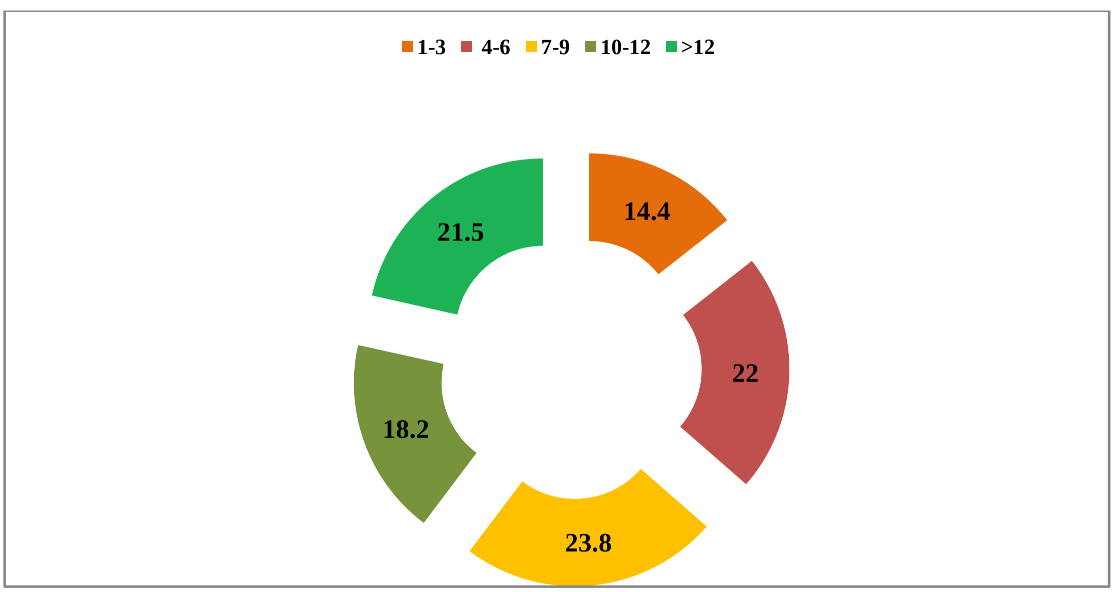


Table 4.1.37: Practices regarding Fruit Consumption, Healthy Food Choices and Water Intake (N=478)

Practices	Percent subject % (n)
1. Form in which they consume fruits like apple, chickoo, pear etc.	
• Whole fruits peeled	32.6 (156)
• Whole fruits unpeeled	35.1 (168)
• Fruit juice	27.4 (131)
• Do not consume fruits	4.8 (23)
2. Reason for not consuming fruits	
• I do not have time	1.7 (8)
• There is not always fruits at my home	0.4 (2)
• I don't like fruits	0.6 (3)
• Some other reason	2.1 (10)
3. Addition of extra salt	
• Yes	24.3 (116)
• No	75.7 (362)
4. Accessories consumed along with meals *	
• Curd	25.7 (123)
• Chutney	19.2 (92)
• Papad	28.5 (136)
• Pickles	25.5 (122)
• Jams/ Murabbas	8.8 (42)
• Other	2.1 (10)

***(percentage may be more than 100 % due to multiple responses)**

Knowledge and attitude regarding Soft Drinks, Fast Foods

According to 81% children soft drinks had no health benefits for them. Amongst these48% did not have an idea as to what effect it had on their health and another 36% could only say that it affected their health adversely (Table 4.1.38). Only 0.5 % children could correctly say that soft drinks led to weak bones. On the other hand nearly 30% subjects felt that soft drinks were good for their health and provided energy.

Regarding consumption of fast foods 79% felt that it did not have any health benefits but around 51% of them were not sure of the reason behind it. Another 30% could only say that it had adverse effects on health. Some 11% subjects stated that fast foods led to overweight and obesity due to high fat content and according to 8% subjects fast foods were unhygienic and thus had no health benefits.

Practices regarding fast foods, soft drinks and outside food intake

Subjects were asked regarding the frequency of eating out and to get an exact idea a recall of last 7 days was taken. Sixty six percent ate outside food once or more per week with family or friends including 20% subjects who ate out 2-3 times or more per week. For the past seven days 30% subjects did not eat out whereas nearly 50% ate out either once or twice. Twenty percent subjects had outside food for more than three days in the past week. Figure 4.1.66 shows the foods most liked by the subjects while eating out. As indicated the subjects had most of the unhealthy foods when they went to eat outside. South Indian food being comparatively healthier was liked by the least number of subjects.

Fifty eight percent of the subjects got pocket money from their parents including 20% subjects getting Rs. 75 or more per week. Fourteen percent subjects did not spend any of their pocket money on food whereas over one-fourth (27%) reported to spend half or more of their pocket money on food. On being asked about the foods purchased using their pocket money it was observed that most (56%) did not purchase any food item, (27%) spent it on confectionaries, followed by bakery items (9%), fried foods (7%) and processed foods (6%) (Table 4.1.39)

On further enquiry it was found that these children also bought food items using money apart from their pocket money and the details are shown in Figure 4.1.67. Around half of them (49%) purchased bakery items from shops near the school or tuition classes, followed by fruits (20%), cold drinks (19%), wafers (15%) etc.

Table 4.1.38: Knowledge and Attitude regarding Soft Drinks and Fast Foods (N=478)

Awareness About	**Percent Subjects % (N)**
1. Do soft drinks impart any health benefits	
➢ **Yes**	18.6 (89)
• Tasty	7.9 (7)
• Good for health/ Gives energy	29.2 (26)
• Relieves acidity / Gas	4.5 (4)
• Others	58.4 (52)
➢ **No**	81.4 (389)
• Contains harmful acids/ chemicals/ preservatives	12.6 (49)
• Affects our health adversely	36.2 (141)
• Bones become weak	0.5 (2)
• No nutrients	2.6 (10)
• Others	48.1 (187)
2. Do fast foods impart any health benefits	
➢ **Yes**	20.7 (99)
• Tasty	24.3 (24)
• Healthy / Good for growth	23.2 (23)
• Others	52.5 (52)
➢ **No**	79.3 (379)
• Unhygienic	8.2 (31)
• Affects health adversely	30.1 (114)
• Causes Overweight / Obesity due to high fat content	10.8 (41)
• Others	50.9 (193)

Table 4.1.39: Practices regarding Fast Foods, Soft Drinks and Outside Food Intake (N=478)

Practices	Percent subject % (n)
1. Frequency of eating out	
• Less than once a week	34.5 (165)
• Once a week	46 (220)
• 2-3 times a week or more	19.5 (93)
2. Outside food consumed during past 7 days with family or friends	
• 0 days	29.9 (143)
• 1- 2 days	49.6 (237)
• 3-5 days	17.3 (83)
• More than 5 days	3.1 (15)
3. Get pocket money	
• Yes	57.7 (276)
• No	42.3 (202)
4. Amount per week	
• No money	42.3 (202)
• Rupees 1-25	16.9 (81)
• Rupees 26-50	17.2 (82)
• Rupees 51- 75	3.3 (16)
• > Rupees 75	20.3 (97)
5. Amount spent on food	
• No pocket money	42.3 (202)
• Two thirds	1 (5)
• Half	21.3 (102)
• One third	5.9 (28)
• One fourth	6.9 (33)
• < one fourth	4 (19)
• Full	4.8 (23)
• None	13.8 (66)
6. Kind of foods purchased*	
• Fried foods	7.3 (35)
• Processed foods	5.9 (28)
• Bakery items	8.6 (41)
• Biscuits	3.6 (17)
• Cold drinks	3.8 (18)
• Others (chocolates, candies etc.)	27.2 (130)
• Do not purchase	56.1(268)

***(percentage may be more than 100 % due to multiple responses)**

Figure 4.1.66: Percent Subject Response Regarding Foods Most Liked While Eating Out

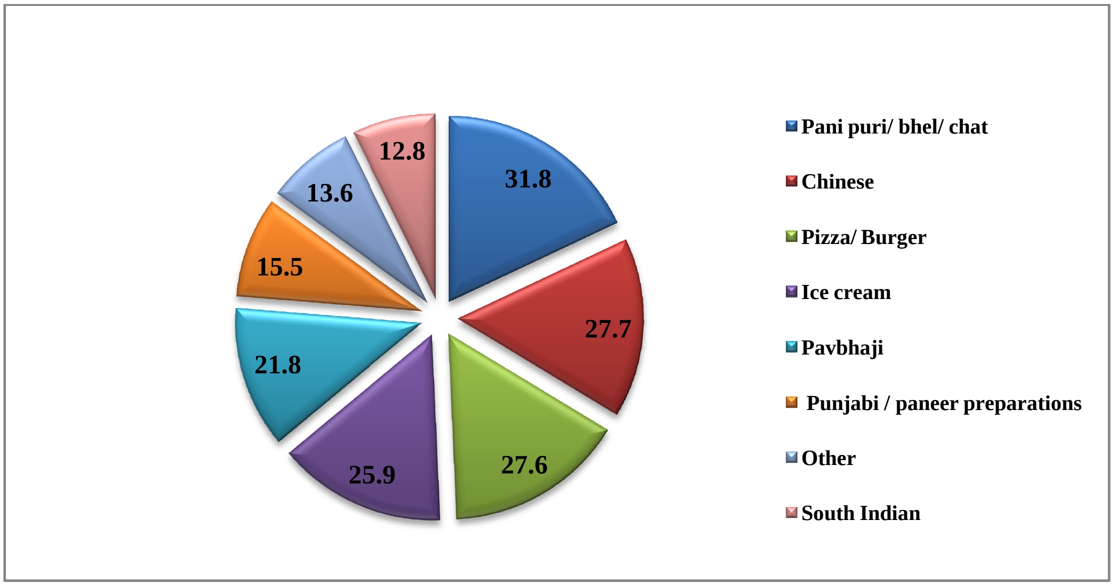
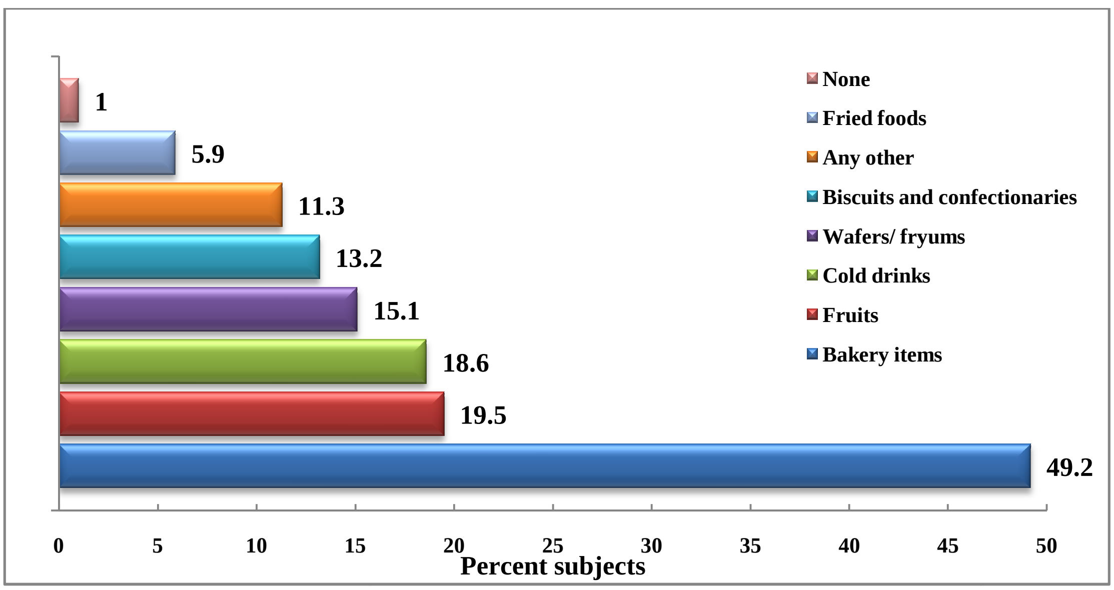


Figure 4.1.67: Foods Purchased from Street Vendor / Shops Apart from Pocket Money (N=478)



Practices related to Food Consumption in School

Majority (84%) of the subjects carried tiffin from home and only 7.5% subjects bought food from canteen or outside during recess hours. However on being asked about the past 7 days only 48% brought tiffin to school for 5 or more days. Sixty four percent subjects reportedly brought roti sabji in their tiffin most of the time including 49% subjects who brought only roti and sabji for tiffin. According to 85% subjects tiffins were not evaluated by the teachers (Table 4.1.40).

Knowledge and Attitude regarding Physical Activity and T.V. Viewing

Ninety three percent subjects felt that being physically active was important for them. Nearly 31% felt that they should undertake physical activity for more than one hour daily. Many (52.5%) subjects felt that viewing T.V. for long hours affects their growth and development of which majority (82%) stated that it affects their vision adversely. There was a high percentage (47%) of subjects stating that T.V. viewing did not affect their growth and development in any way. Barring 18% subjects rest all stated that they were told about physical activity at least once since past one year (Table 4.1.41).

Practice regarding Physical Activity

Around 47% of the subjects undertook some form of physical activity for more than 1 hour every day. Most common physical activity (75%) was playing outdoors. Majority (82%) were involved in physical activity during leisure/ free time in school. Although 47% subjects reported undertaking some physical activity daily, but on taking a recall for the past 24 hours only 17% subjects reported to have undertaken any form of physical activity for 1 hour or more (Table 4.1.42).

Seventy one percent subjects took less than 15 minutes to reach school. Around 56% subjects either went to school by walking or cycling, while the remaining used the public transport systems (31%) or own automated vehicles (12%).

On obtaining actual data for the past 7 days it was observed that only 47% subjects went to school walking or cycling for more than 5 days.

On being asked whether they felt tired after playing with friends for 5-10 minutes majority (71%) gave a negative reply. Around 80% subjects did not report any fatigue while playing or climbing stairs. Half of the subjects reported of falling ill ‘sometimes’ while 39% reported to be falling ill ‘rarely’.

Table 4.1.40: Practices related to Food Consumption Pattern in School (N=478)

Practices	Percent Subjects % (N)
1. Source of food during recess	
• Get packed tiffin from home	83.7 (400)
• Buy food from outside/ canteen	7.5 (36)
• Both of the above	1.7 (8)
• Go home for lunch	1.9 (9)
• None	5.2 (25)
2. Food items consumed during recess*	
• Roti sabji	64.4 (308)
• Dosa/ poha/ upma/idli	15.1 (72)
• Processed foods	11.7 (56)
• Dry snacks	2.5 (12)
• Others	16.3 (78)
3. Brought tiffin to school during past 7 days	
• 0 days	12.6 (60)
• 1- 2 days	7.3 (35)
• 3-5 days	13.2 (63)
• More than 5 days	47.7 (320)
4. Tiffin evaluation done by the teacher	
• Yes	15.5 (74)
• No	84.5 (404)

***(percentage may be more than 100 % due to multiple responses)**

Table 4.1.41: Knowledge and Attitude regarding Physical Activity and T.V. Viewing (N=478)

Awareness About	Percent Subjects % (N)
1. Being physically active is important	
• Yes	92.9 (444)
• No	7.1 (34)
2. **Minimum level of physical activity one should undertake daily**	
• Should not undertake at all	4.8 (23)
• ½ hour	27.2 (130)
• 1 hour	36.8 (176)
• 1-2 hours	22.4 (107)
• More than 2 hours	8.8 (42)
3. Prolonged T.V viewing affects growth and development	
➢ **Yes**	52.5 (251)
• Affects vision	81.7 (205)
• Leads to overweight and obesity	3.2 (8)
• Other	15.1 (38)
➢ **No**	47.5 (227)
4. How many times were you taught about Physical activity in the school/ home since last year?	
• Never	18 (86)
• Once	30.8 (147)
• Twice	21.5 (103)
• Thrice or more	29.7 (142)

Table 4.1.42: Practice regarding Physical Activity (N=478)

Practices	Percent Subjects % (N)
1. Average physical activity undertaken by you in a week	
• ≤½ hour	17.4 (83)
• 1 hour	35.6 (170)
• 1-2 hours	14.2 (68)
• More than 2 hours	32.8 (157)
2. Type of physical activity undertaken	
• Playing outdoors	75 (359)
• Cycling	3.8 (18)
• Sports	1.5 (7)
• Any other	11.3 (54)
• None	8.4 (40)
3. Physical activity undertaken during leisure or free time in school	
• Yes	82.2 (393)
• No	17.8 (85)
4. Physical activity performed since yesterday	
• 1-15 minutes	18 (86)
• 16-30 minutes	35.6 (170)
• 31-45 minutes	9 (43)
• 46-60 minutes	20.5 (98)
• >60 minutes	16.9 (81)
5. Time taken to reach school from your house	
• < 5 mins.	24.9 (119)
• 5-15 mins.	45.8 (219)
• 15-30 mins.	15.9 (76)
• 30 mins or more	13.4 (64)
6. Mode of transportation	
• Walking	12.8 (61)
• Bicycle	43.5(208)
• Public transport/ school transport	31.4 (150)
• Own automated vehicle	12.3 (59)

Practices	**Percent Subjects % (N)**
7. No. of days you walked or rode a bicycle to school during past 7 days	
• 0 days	31.8 (152)
• 1- 2 days	12.1 (58)
• 3-5 days	9 (43)
• More than 5 days	47.1 (225)
8. Feel tired after playing for 5-10 mins.	
• Yes	29.3 (140)
• No	70.7 (338)
9. **Avoid playing with friends because cannot keep up with them**	
• Yes	19.7 (94)
• No	80.3 (384)
10. Feel tired after walking up the stairs	
• Yes	18.6 (89)
• No	81.4 (389)
11. Fall ill	
• Often	11.5 (55)
• Sometimes	49.8 (238)
• Rarely	38.7 (185)

Knowledge and attitude regarding Physical Education and Appropriate Weight

On being asked about physical education 61% called it fitness or exercise as they had P.E. (physical education) classes in which they were shown how to exercise.

Almost all (97%) the subjects felt that physical education was important for them. Eighty six percent reported getting physical education classes. Three -fourth of the subjects reported of getting 2 classes / week for physical education. Excluding 5% of the subjects none of the subjects could correctly define appropriate weight. More than half of the subjects felt that having an appropriate weight was important for them (Table 4.1.43).

Self Perception and Nutritional Status

Self perception plays an important role in affecting the nutritional status of the adolescents as it influences their eating and physical activity patterns as well as habits (Yang et al, 2010). This section evaluates their self perception with regards to their actual BMI for age (BAZ) scores.

Subjects were shown three types of body figures and were asked to tick the one they felt they looked like, to get an idea of their self perception. The three body types shown were:

1) **Ectomorphic–** They are generally thin, flat chested, lean and small shouldered. They have a high metabolism rate to burn fat and tend to have long neck and phalanges.
2) **Mesomorphic–** They have a well built bone structure along with defined muscles. They have relatively broad shoulders and a narrow torso.
3) **Endomorphic –**They are typically large with round and soft bodies, their limbs are short in length, their hands and feet are fairly small and have a high waistline.

Of the subjects, 45% thought that they were ectomorphs or were underweight whereas another 48% believed that they were physically fit and had a mesomorphic structure. Twenty percent children who were overweight or obese felt that they were ectomorphic or underweight.

Similarly 36% of the thin subjects reported themselves as mesomorphs or as healthy person with a healthy muscle mass. On the same lines around 16% overweight or obese subjects too reported of themselves as mesomorphs (Table 4.1.44)

Twenty three percent subjects, who were actually having z-score less than -1 SD felt that they were having more fat in their body and considered themselves as endomorphs. Overall, 64% subjects had incorrect perceptions regarding their body image.

Table 4.1.43: Knowledge and Attitude regarding Physical Education and Appropriate Weight

Awareness About	Percent Subjects % (N)
1. Physical education means	
• Exercise/ fitness	60.7 (290)
• Games/ sports	16.3 (78)
• Any other	23 (110)
2. Physical education is important	
• Yes	96.9 (463)
• No	3.1 (15)
3. Are you given physical education	
• Yes	85.8 (410)
• No	14.2 (68)
4. No. of physical education classes per week	
• 0 days	14.9 (71)
• 1 day	37.7 (180)
• 2 days	21.3 (102)
• 3 days	5.4 (26)
• 4 days	5.2 (25)
• More than 5 days	15.5 (74)
12. Definition of appropriate weight	
• Correct	5.4 (26)
• Incorrect	93.9 (449)
• Partially correct	0.6 (3)
13. Importance of having appropriate weight	
• Not At All Important	9.2 (44)
• Slightly Important	22 (105)
• Moderately Important	14.9 (71)
• Very Important	51.7 (247)
• Extremely Important	2.3 (11)

Table 4.1.44: Self perception v/s nutritional status

Self Perception	BMI for age (WAZ) score							
	<-3	-3 to <-2	-2 to <-1	-1-<1	1-<2	2-<3	>3	Total
Ectomorphic	**2.8 (6)**	**6.9 (15)**	**18.1(39)**	**52.3(113)**	**14.8(32)**	**4.6(10)**	**0.5(1)**	**45.2 (216)**
Mesomorphic	**2.2(5)**	**7.4(17)**	**26.8(62)**	**48(111)**	**13(30)**	**2.6(6)**	**0(0)**	**48.3 (231)**
Endomorphic	**3.2(1)**	**3.2(1)**	**16.1(5)**	**67.7(21)**	**9.8(3)**	**0(0)**	**0(0)**	**6.5(31)**

Knowledge, Attitude and Practices of Teachers and Principals

Knowledge level of the teachers regarding healthy eating and physical activity practices for adolescents would affect the KAP of the children, therefore an analysis was done of the Principals, Teachers and Physical education (PE) instructors knowledge and attitudes regarding adolescence. Of all the subjects nearly 80% were females and the rest were males. Mean height. was 155.2 $\pm$ 5.1 cm, mean weight was 63.9 $\pm$ 9.8 Kg and mean BMI was found to be 26.6 $\pm$ 4.2 Kg/m^2. According to the IOTF cut offs for Asians, around 60 % of them were having Grade I obesity (BMI between 25 – 29.9 Kg / m^2) (Figure 4.1.68). When questioned about the definition of adolescence, although all of them answered the correct option as age of adolescence (10-19 years)out of the four options given. Yet they were unsure of the range of years for the same for eg. some of them stated 13-18 years, for some it was 12-16 years and so on. Half of them stated food to be most important for growth and development of adolescents whereas 29% stated both food and exercise to be important. Monitoring the dietary intake of the child at home was the best step for addressing the nutritional requirements of adolescents as answered by 71% of the teachers. While 57% of them were aware of the term 'malnutrition' the rest did not know about it. Further enquiry about the age groups most affected with malnutrition revealed that only 36% thought that adolescents can be affected by malnutrition. All of them (100%) stated that nutritional status assessment of adolescents from time to time was necessary but 64% did not have any knowledge about the method to be used. More than half (57%) were unaware about BMI and only 7% gave the correct formula for BMI.

Unhealthy dietary practices were considered to be the main cause of undernutrition in these children by 57% of their teachers. Others gave different reasons like 'economic status' (21%), 'lack of awareness amongst parents and children' (7%), 'working mother' (7%) and 'vegetarian diet' (7%) as the leading cause for under nutrition. According to 57% of the teachers healthy food for adolescents was a well balanced diet. Seventy one percent of them were not aware of healthy eating habits. As few as 7% stated the functions of food correctly whereas 36% were partially correct and 57% were incorrect in answering the same. Most of them (93%) could not mention the food groups correctly. As far as soft drinks were concerned all the teachers equivocally stated that it was harmful for kids. The main reasons given by the Teachers are shown in Figure 4.1.69.

Figure 4.1.68: Prevalence of Overweight / Obesity among the Teachers

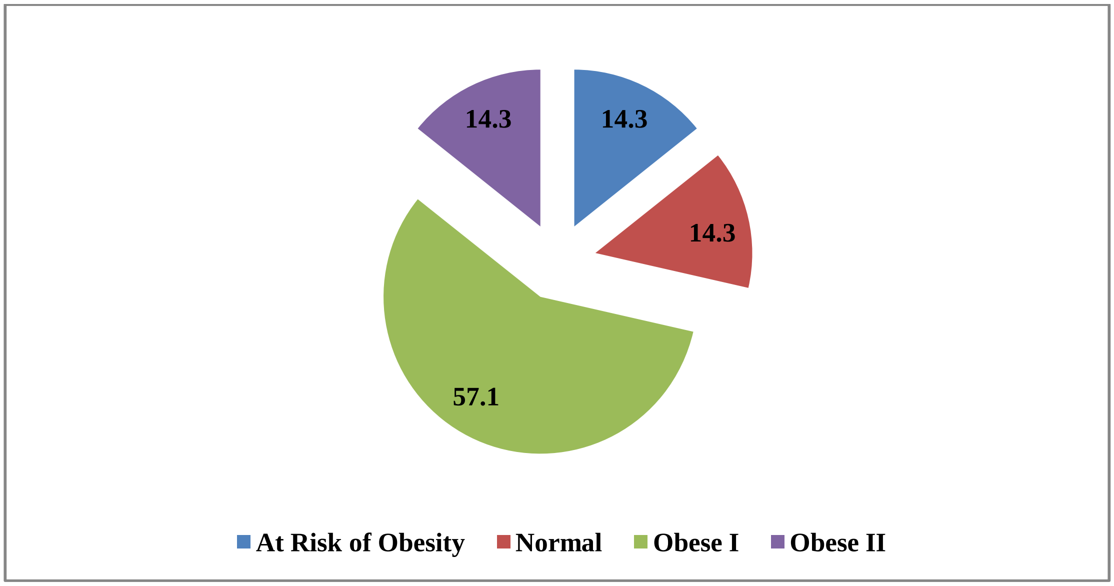
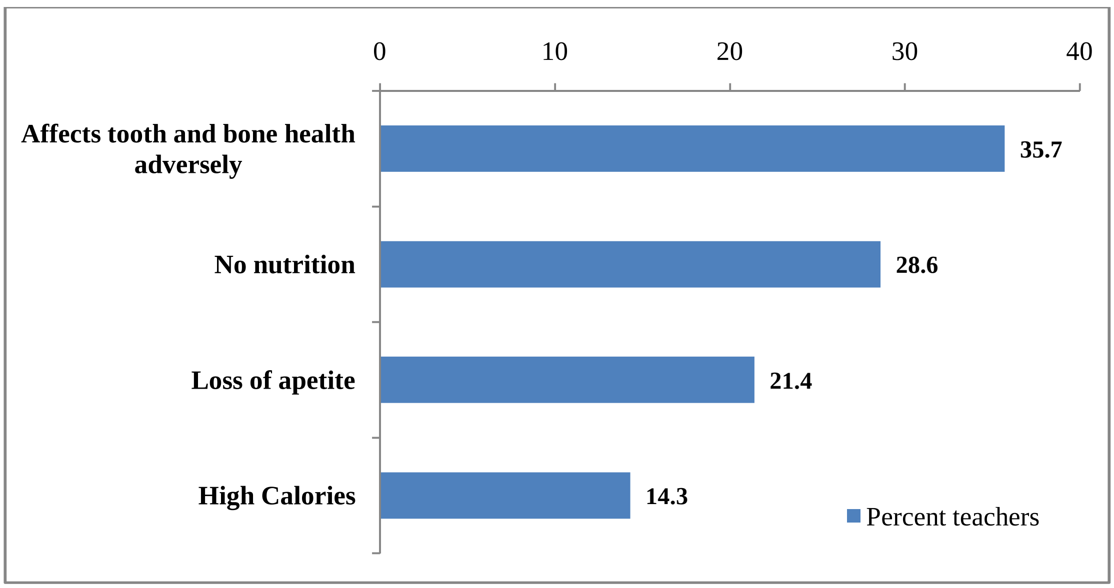


Figure 4.1.69: Response (%) of the Teachers Regarding the Harmful effects of Soft Drinks



According to them amongst the top 3 foods needed by adolescents, the first one was milk (93%) followed by pulses (as dals or sprouts) (50%) and fruits (42%). Teachers were of the opinion that adolescents should either have 4 meals (57%) or 3 meals (43%) in a day.

In case of fast food consumption 21% teachers were in favour of it, as they felt that it served as a source of vegetables to the children. All the teachers accepted that outdoor physical activity was a must for adolescents, both for boys and for girls. Daily physical activity was advised by 71% of the teachers while the rest were in favour of 3-4 days/ week of physical activity.

Nutritional needs of adolescents were most affected by their activities according to 64% of the teachers whereas only 14% thought that it was affected by age and only 7% believed that it was affected by sex. Only 28% teachers could correctly tell about the benefits of eating fruits and vegetables for adolescents. On being asked as to why these children should be given a variety of fruits and vegetables only 14% could give the correct answer. Twenty nine percent of the teachers felt that adolescents should be given a lot of fat and ghee as they are growing up. Although 93% teachers believed in the concept of hot and cold foods, only 29% favoured restriction of these foods for adolescents at any point of time.

As per 57% teachers these children should be given light foods like Khichdi, Dalia (Porridge) etc. during illness. The quantity should be restricted as they felt that digestion slowed down during illness. Figure 4.1.70 shows the responses of the Teachers regarding foods to be given to the adolescents during illness.

Most of them agreed that when the child came back from play he/ she should be given something to eat/drink. In this case 71% suggest that they should be given some drink such as fruit juice/ nimbupaani. Another 14% felt that the child should be given milk (Figure 4.1.71).

Figure 4.1.70: Response (%) Regarding Foods Required by Adolescents During Illness (N=14)

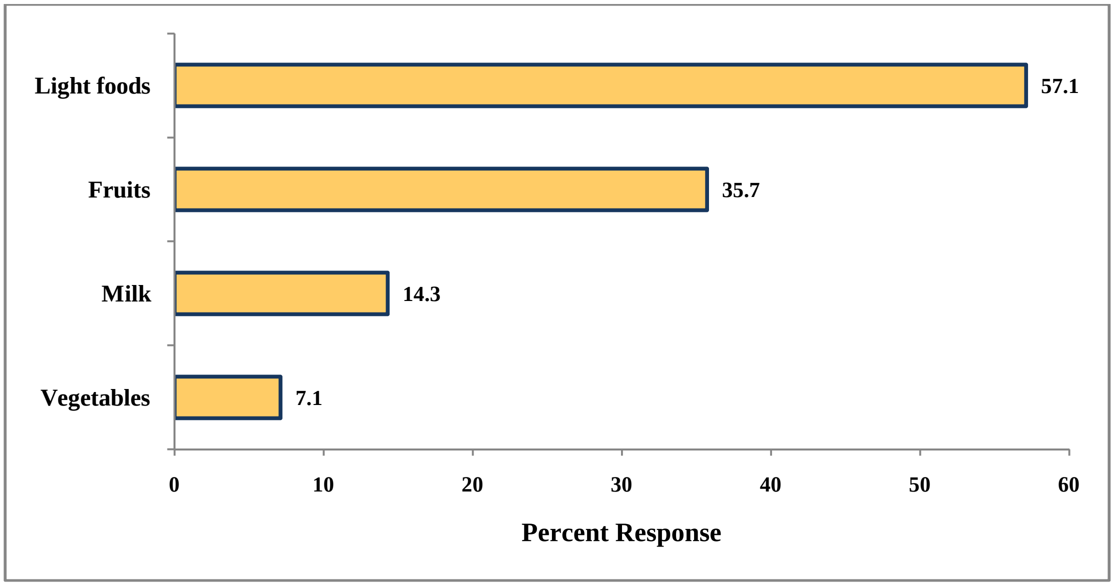
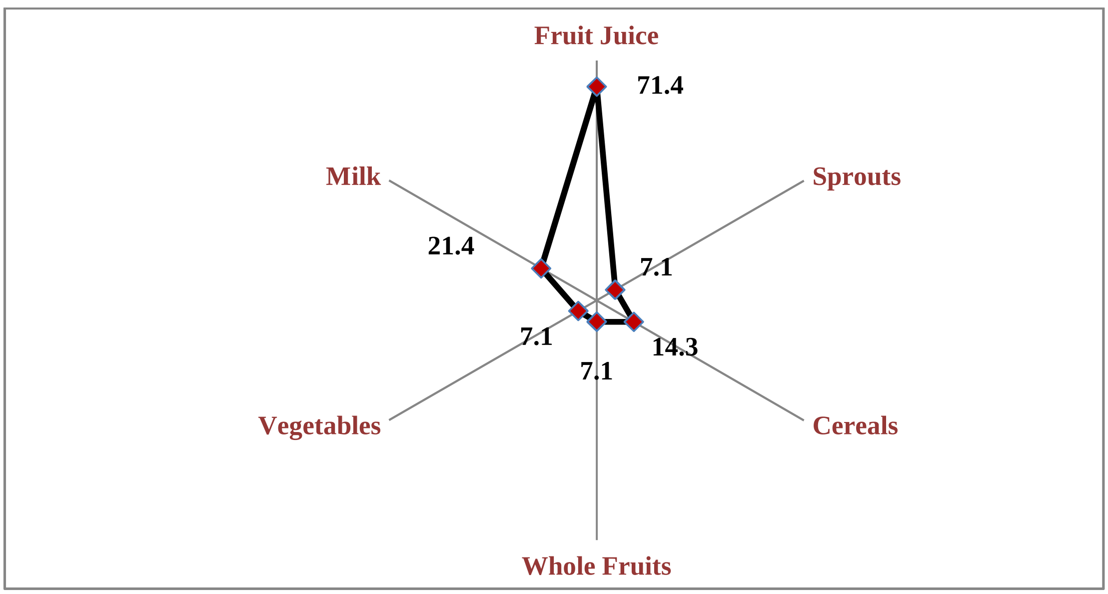


Figure 4.1.71: Response (%) Regarding Foods to be Served when the Child is Back from Play



On enquiring about the various foods that should be given for breakfast, 64% felt milk should be an integral part of breakfast followed by cereals (43%) and sprouts (29%). (Figure 4.1.72)

As evening snacks majority felt that biscuits (50%) and milk (43%) should be given to the children. Nearly 20% felt that these could either be given fruits, soup or processed foods like instant noodles, pasta etc (Figure 4.1.73). According to all the teachers (100%) the best food to be given in the tiffin was a cereal vegetable combination (Roti and Sabji).

Regarding their own practice, it was observed that 93% of them were aware of the amount of calories they consumed daily. Seventy nine percent reported that limiting the portion size of foods that they tend to overeat. Majority (86%) of them was using legumes over dals regularly and 79% of them consumed fruits like apple and cheeku along with the skin.

Decisions to purchase or consume certain foods based on information or advertisements from newspapers, magazines or television were affected as reported by 57% teachers whereas 43% reported to remain unaffected by these advertisements.

Figure 4.1.72: Response (%) Regarding Foods to be Served for Breakfast

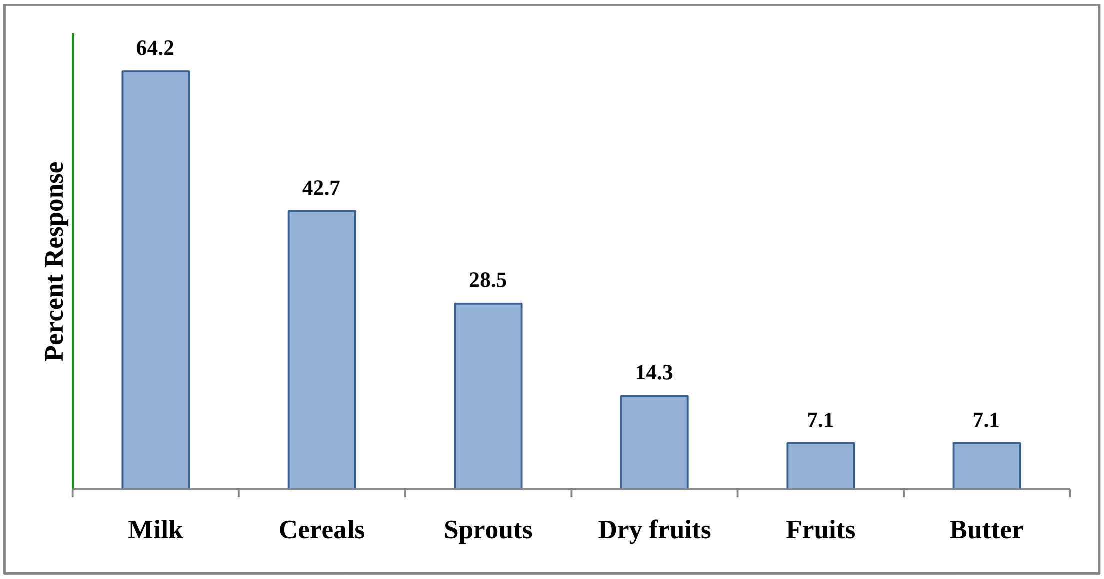
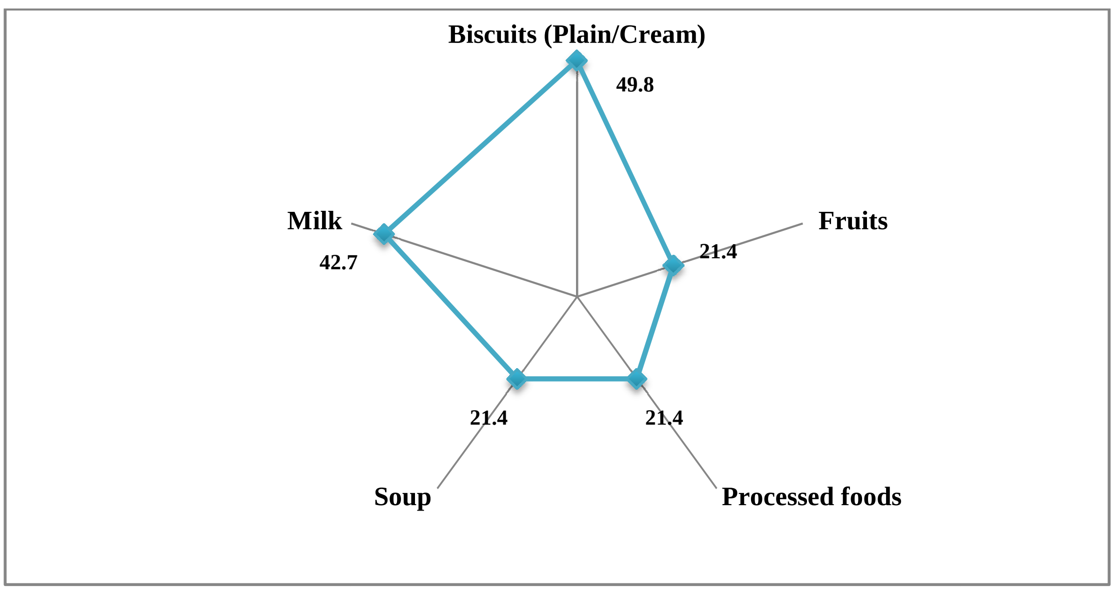


Figure 4.1.73: Response (%) Regarding Foods to be Served as Evening Snacks



Key Findings

- Data analysis revealed a lack of knowledge and awareness amongst the subjects regarding healthy foods, healthy eating, food groups, functions of foods, benefits of eating fruits and vegetables, food pyramid, physical activity etc.
- Fifty percent or more of the subjects were unable to make healthy food choices.
- Only 5% of the subjects could correctly define appropriate weight.
- Around two third of the subjects had incorrect perceptions regarding their body image.
- None of the teachers could correctly state the age group that adolescence covers. Although they could tell about the range of age covered by adolescence on giving options.
- More than half of the teachers were unaware of BMI and only 7% gave the correct formula for BMI.
- Lack of awareness and knowledge regarding various aspects of adolescence like health, foods to given under various conditions etc was observed amongst the teachers.

Discussion

This study clearly points to the lack of knowledge and awareness of nutritional needs and importance of healthy behaviors in adolescents as well as the teachers who guide their behaviors. These findings are supported by that reported by Mehan et al (2012) and Shah et al (2010) who observed that the knowledge of the students and the teachers pertaining to ‘healthy diet’ was found to be inapt. Nearly 20% subjects skipped breakfast due to lack of time in the present study which is lower than the 50% subjects reported by Singla et al (2012) in Ludhiana. Majority of the subjects in the present study were unaware of the food groups, functions of foods, food pyramid etc. thus indicating lack of knowledge in this front. There was a wide gap between the knowledge and practices regarding healthy foods, food choices, number of servings of fruits required, fast foods and soft drink consumption which has also been documented by various studies. Van Den Berg et al (2012) reported that half of the subjects did not know about the number of servings of fruits and vegetables needed in a day and also had inadequate knowledge regarding the foods to be eaten most.

Saha et al (2011) reported that most of the subjects spent extra money (apart from their pocket money) on buying high calorie foods like chocolates, candies and cold drinks etc., a finding similar to that observed in the present study (Table4.1.32). Almost all the subjects responded to physical activity being very important for them in the present study, yet data on the knowledge regarding the level of physical activity was not according to the recommended levels. Similar findings have been reported by Saha et al (2011) amongst adolescents in Bangladesh.

One third of the subjects could correctly answer about the duration of physical activity needed by them. About half of them reported to undertake moderate to vigorous activity for an hour daily but a separate recall of their previous day's physical activity showed that only 17% actually followed it. Lack of knowledge about the recommended physical activity level could be a possible reason. The findings are in line with other studies (Anand et al, 2012; Sagatun et al, 2008).

Self perception plays a very important role in determining the practices followed by adolescents. Present study revealed that a very high percentage of overweight subjects either perceived themselves as underweight or as normal. Also a very high percentage of thin subjects believed themselves to be normal or overweight. These findings have been supported by Saha et al (2011), Marsh et al(2004) and Hau et al (2002) that obesity has no effect on the dimension of self concept.

School is a child's second home and teachers have the ability to mold the minds of the students. Present study shows lack of nutrition knowledge on the part of the teachers concerning adolescents. This could be a reason why despite of food and nutrition topics being part of the curriculum the students were unable to answer simple questions like 'functions of food'. More than half of the teachers did not know about BMI and 93% could not give the formula for it. These findings are in line with other studies by Devgan S et al 2012, Mehan et al 2012and Shah P et al 2010.

Section II: Healthy Eating Index for Adolescents (HEIA) and Food Behaviour and Activity Checklist (FBACA) – Development, Assessment for Subjects and Validation

Dietary inadequacies have been highlighted by many investigators, but so far no attempt has been made to evolve a Healthy Eating Index scoring system or to develop a food behaviour checklist to assess the dietary inadequacies/practices of school children in India unlike western countries where people have developed and validated the HEI to assess the quality of diet in Americans age 2 and above.HEI provides a measure of overall dietary quality based on 10 dietary components. Healthy Eating Index (HEI) is being used by USDA since 1989 to assess the dietary quality of Americans. For the present study Healthy Eating Index for Adolescents (HEIA) was developed for adolescents in Indian context, details of which are shown in Chapter 3 (Methods and materials).

HEIA, in the present study, evaluated food consumption pattern against the recommendations made in *'Dietary Guidelines for Indians'* (ICMR, 2010). Each of the 7 components except total vegetables, Green/yellow/orange vegetables and Solid fat and added sugars (SOFAAS) had a scoring range of 0 to 10. Total vegetables and Green/yellow/orange vegetables had a maximum score of 5 each, while SOFAAS had a maximum score of 20. The most desirable intake of a component was given the maximum score. Minimum score was allotted to the most undesirable intakes.

The overall HEIA scores are the simple sum of the scores from the 10 components. Total HEIA scores over 80 implied a "Good" diet. Scores between 51 to 80 indicated a "need for improvement" and scores below 51 indicated a "poor diet".

A short food behavior checklist (FBC) was developed to evaluate the impact of nutrition education on fruit and vegetable intake among ethnically diverse women in the Food Stamp Nutrition Education Program (FSNEP) and the Expanded Food and Nutrition Education Program (EFNEP) (Blackburn et. al, 2006).This short, culturally neutral FBC is a valid and reliable indicator of fruit and vegetable consumption. Compared with the 24-hour dietary recall, it is also less time-consuming to administer code and analyze, with a reduced respondent burden.

On similar lines a Food Behaviour and Activity Checklist for Adolescents (FBACA) was developed in the present study. The maximum total FBACA score was 100. FBACA consisted of 20 practices related to diet and physical activity. Each FBACA component was allotted a maximum score of 5 and a minimum score of zero. Zero was given to the most undesirable action for any dietary component or activity pattern and a maximum score of 5 was given to the most desirable frequency of food item consumption or activity pattern (Appendix). If the total FBACA score was above 80 points then the practices were considered of a good quality. If the score ranged between 51 and 80 then the practices needed improvement and if the score was less than or equal to 50 then practices being followed were considered to be of a poor quality.

Phase II consisted of the development, assessment and validation of the HEIA and FBACA. As mentioned earlier, HEIA was developed to measure the overall dietary quality of adolescents while FBACA was developed to assess the overall quality of the dietary and physical activity practices being followed by the subjects.

Total HEIA Scores

For analysis data was obtained from 478 subjects. Dietary intakes in the form of 24 hour recall were obtained from each subject. HEIA scores were calculated for a period of three days, first day being Sunday and the other two were working days (Monday and Tuesday). Table 4.2.1 shows overall HEIA score for a period of 3 days. For the study subjects mean overall HEIA score was 63.34 $\pm$ 5.2. As can be observed there was no significant difference in the score for the three days. Mean score for boys was slightly higher than girls which can be explained by a higher overall intake of all the nutrients by boys (Phase I). However, this difference was not significant between the sexes.

An age and sexwise analysis shows that boys had overall higher scores than girls at all ages except between at 9, 11 and 13 years of age (Table 4.2.2). Total HEIA scores showed a gradual increase between 7 to 10 years followed by a drop in the total scores at 11 years of age. However, these scores again showed an increase at 12 years followed by a decline in total score a age advanced. Oldest age group had the lowest scores irrespective of the sex. However, these differences were not significant as shown by Analysis of Variance (ANOVA).

Mean HEIA scores were significantly correlated ($p<0.01$, 2 tailed) with mean energy, protein, calcium and iron intakes of the subjects.

HEIA scores and the Socioeconomic Status of the study subjects

An assessment was done to find out if there was any relationship between HEIA scores and the socioeconomic background of the subjects (Table 4.2.3). Mean HEIA scores were highest for 'Christians' followed by Hindus. Analysis of Variance (ANOVA) revealed that religion had a significant effect on the mean HEIA levels of the study subjects. There was no significant effect of the family type on the mean HEIA scores. A higher mean HEIA score was observed in the families with < 5 members as compared to those with more than 5 members. However, the difference was not significant.

Subjects with a per capita income of Rs. 5000 or more had higher mean HEIA scores. Children of better educated parents (Graduation or above) had higher mean HEIA scores as compared to others. Working status of mothers did not affect the mean HEIA scores as their children had higher scores compared to the children whose mothers were housewives. A possibility reflected in this case is that majority of the working mothers (66%) were taking tuitions at home and for this reason they could devote more time to their kids. However there was no significant effect of PCI, education of parents or working status of mother on the mean HEIA scores. Dietary habits (Vegetarian/ Non-vegetarian / Ovo-vegetarian) had a significant effect on the Mean HEIA scores. Mean HEIA scores were significantly higher in vegetarians ($p<0.001$) and non-vegetarians ($p<0.01$) as compared to ovo-vegetarians.

Table 4.2.1: Mean Total HEIA scores - Daywise

Total HEIA Scores	**Boys(N=300) (mean± SD)**	**Girls (N=178) (mean± SD)**	**Total(N=478) (mean± SD)**
Day1	63.83±6.87	63.81±7.42	62.83±7.08
Day2	63.63±7.05	63.57±6.42	63.6±6.81
Day3	62.87±6.81	62.16±6.31	62.61±6.63
Mean	63.44±5.18	63.18±5.25	63.34±5.2

Table 4.2.2:Mean Total HEIA score - Agewise

Age	**Boys**	**Girls**	**Total**
<9	63.2±5.37 (19)	62.98±2.65 (9)	63.13±4.62 (28)
9-9.11	63.23±4.95 (45)	63.42±5.22 (25)	63.3±5.01 (70)
10-10.11	64.91±5.21 (55)	62.82±4.87 (31)	64.15±5.16 (86)
11-11.11	62.77±5.75 (54)	63.47±5.21 (41)	63.07±5.51(95)
12-12.11	65.72±4.3 (55)	65.72±5.67 (26)	65.72±4.74 (81)
13-13.11	61.52±4.40 (42)	62.15±5.35 (32)	61.79±4.81 (74)
>**14**	60.95.0±4.74 (30)	60.45±5.30 (14)	60.79±4.86(44)

Figure in parentheses indicate number of subjects

Table 4.2.3: Socio Economic Status of the Subjects and Mean Overall HEIA scores

Socio Economic Parameter (N=478)	Mean HEIA Score
Religion	
Hindu	63.5± 5.11
Muslim	59.06± 6.54
Sikh	59.46± 5.96
Christian	66.5± 4.44
Others	59.04± 1.92
Type of Family	
Joint	63.49± 5.33
Nuclear	63.44± 5.16
Extended	62.91± 5.32
Family Size	
≥ 5 members	63.17± 5.31
< 5 members	63.47± 5.13
Per Capita Income	
≤ Rs. 5000	63.13± 5.3
> Rs. 5000	63.64± 5.06
Father's Education	
Graduate or above	63.55± 5.21
Intermediate/ Diploma or below	63.12± 5.2
Mother's Education	
Bachelor degree or above	63.68± 5.25
Intermediate/ Diploma or below	63.11± 5.17
Mother's Occupation	
Housewife	63.24± 5.28
Working	64.25±4.53
DietaryHabits	
Vegetarian	63.76±5.01
Non-Vegetarian	63.44±5.46
Ovo-Vegetarian	61.22± 5.01

Assessment of Dietary Quality based on HEIA Scores

Assessment of dietary quality was carried out as explained before. Subject with an overall score of 80 or more were considered as having a ‘good’ diet quality. An overall score between ‘51-80’ indicated a ‘need for improvement’ and a score of 50 or below indicated ‘poor’ diet’. Assessment of dietary quality based on mean HEIA scores is shown in Table 4.2.4. As can be seen, almost all the subjects (99%) needed improvement in their diets. None of the subjects were consuming diet of a good quality. There was no significant difference between the sexes in regard to diet quality.

HEIA v/s Nutritional status

Figure 4.2.1 shows a comparison of mean HEIA scores according to the nutritional status. It is clearly visible that as the nutritional status of these subjects improved there was an increase in their mean HEIA scores. Subjects having WAZ and HAZ scores <-2SD had almost similar HEIA scores which were also the lowest. A significant difference was seen between the mean HEIA scores of subjects according to their WAZ ($p<0.005$) and HAZ ($p<0.05$) scores (Table 4.2.5). BAZ scores did not have any significant effect on the mean HEIA scores.

HAZ scores were significantly correlated ($p<0.01$) to the mean HEIA scores while WAZ and BAZ scores had no significant correlation with the mean overall HEIA scores. However, analysis of Variance (ANOVA) showed a significant effect of WAZ ($p<0.05$) and HAZ ($p<0.005$) scores on the mean overall HEIA scores.

Table 4.2.4: Dietary Quality based on HEIA Scores

HEIA Scores	Percent Subjects(N=478)		
	Boys (N=300)	Girls (N =178)	Total(N=478)
Poor (<50)	0.67 (2)	0.56 (1)	0.63 (3)
Need Improvement (51- <80)	99.33 (298)	99.44 (177)	99.37 (475)
Good (80-100)	0 (0)	0 (0)	0 (0)

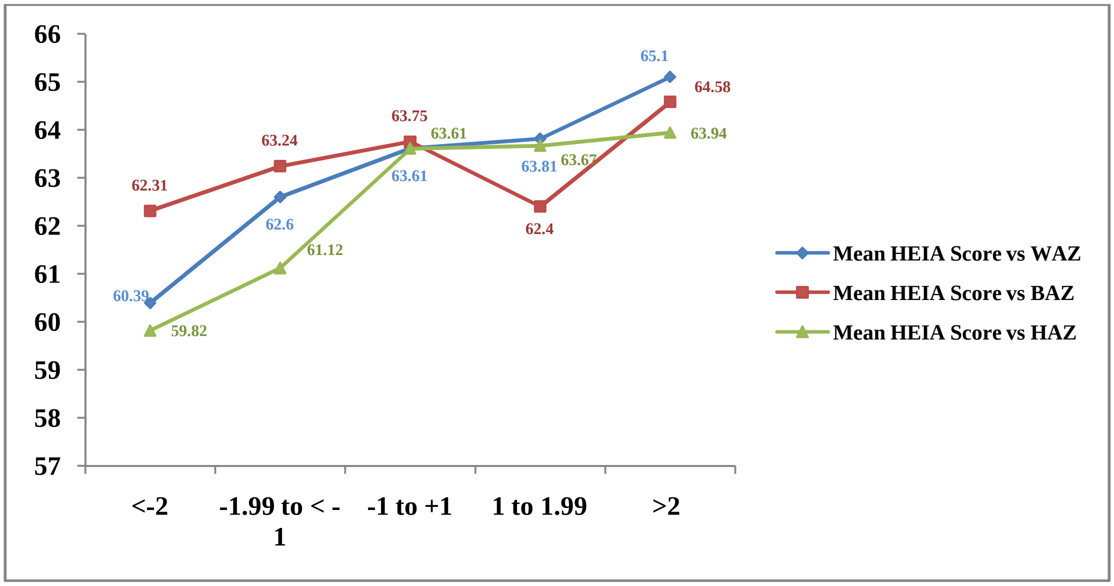
Table 4.2.5: Mean HEIA score according to the nutritional status

Nutritional Status (N=478)	Total HEI scores Mean±SD	't' value	'F' value
WAZ			
<-2 SD (n=24)	60.39 ±4.73	2.88***	2.30*
≥-2 SD (n=454)	63.50 ± 5.19		
HAZ			
<-2 SD (n=12)	59.82 ± 5.52	2.39*	2.88***
≥-2 SD (n=466)	63.44 ± 5.17		
BAZ			
<-2 SD (n=47)	62.31 ± 4.97	1.43	1.33
≥-2 SD (n=431)	63.46 ±5.22		

*significant at p<0.05

***significant at p<0.005

Figure 4.2.1: Mean HEIA Scores v/s Nutritional Status (N=478)



HEIA v/s Anemia

On comparing the diet quality of anemic and non anemic subjects (Table 4.2.6) it was found that the mean HEIA scores for non anemic subjects was higher than the anemic subjects. However, the difference in their mean HEIA scores was not found to be significant.

Factors affecting Mean HEIA score independently –Multiple Regression analysis

Mean HEIA scores were taken as a dependent variable and it was found that five factors exerted an independent effect on it (Table 4.2.7). The first factor to enter the equation was calcium intake of the subjects. Alone, it explained for 27.3% of the variation in HEIA score. The next factor was protein intake, which also exerted an independent effect on mean HEIA scores and accounted for 4.3% of the variation seen in HEIA scores. The third factor which had a significant and independent effect on HEIA scores was age. Age accounted for 3.3% of the variation in the scores. Iron intake and the dietary habits of the subjects were the fourth and the fifth factors to enter the equation, respectively. Both accounted for 1.5% of the total variation observed in the mean HEIA scores. The five factors together accounted for 36% of the total variation seen in the mean HEIA scores.

Individual Components Scores

HEIA consisted of 10 dietary components with a maximum score allotted to each component. Total vegetables and Green/yellow/orange vegetables had a maximum score of 5 each, while SOFAAS had a maximum score of 20. Rest of the components had a maximum score of 10. The minimum score was zero and was given to the most undesirable intakes. An in depth analysis for individual HEIA components were carried out. The maximum score achieved were for Solid fats and added sugar (SOFAAS) (19.82 for girls and 19.77 for boys out of 20) followed by total sugar (9.86 for girls and 9.77 for boys out of 10) and total oil (9.55 for girls and 9.44 for boys out of 10). On the other hand the lowest score for green, yellow and orange vegetables (0.4 for girls and 0.56for boys out of 5) and fruits (0.9 for girls and 1.08 for boys out of 10) indicate lack of variety in the diets of these subjects and low intake of protective foods (Table 4.2.8).

Table 4.2.6: Mean HEIA score based on Anemic status

Anemia	HEIA Scores Mean + SD	't' value
Non Anemic	**63.15+ 5.18**	**2.00**[NS]
Anemic	**62.71+5.98**	

Table 4.2. 7 : Factors significantly associated with Mean HEIA Scores – Multiple Regression Analysis

Variable	Adjusted R^2	Standard error of the estimate	Variation Explained	'F' Value
Calcium Intake	0.273	4.46	27.3	175.59***
Protein Intake	0.313	4.34	4.3	106.32***
Age	0.346	4.24	3.3	82.17***
Iron Intake	0.353	4.22	0.7	63.56***
Dietary Habits	0.361	4.20	0.8	52.36***

Table 4.2.8: Mean HEIA component scores

Components	Mean HEIA Scores			Maximum Score	't Value
	Boys	Girls	Total		
Total Grains	6.42+1.88	6.97+ 1.67	6.63+1.82	10	3.22***
Total pulses/Meat , Fish & Poultry	5.82+2.72	6.01+2.68	5.89+2.7	10	0.77
Total Vegetables	2.7+1.22	2.49+1.26	2.62+1.24	5	1.74
Total Green, Yellow & Orange vegetables	0.56+0.98	0.4+0.8	0.50+0.92	5	1.79
Total Fruits	1.08+2.31	0.9+2.23	1.01+2.28	10	0.83
Total Milk	3.73+1.91	3.49+2.24	3.64+2.04	10	1.25
Total Oil	9.44+1.02	9.55+0.80	9.48+0.94	10	1.21
Total Sugar	9.77+0.68	9.86+0.56	9.8+0.64	10	1.51
Variety	4.17+1.68	3.69+0.67	3.99+1.68	10	3.05***
SOFAAS	19.77+1.1	19.82+0.81	19.79+1.0	20	0.54
Total Score	63.44+5.18	63.18+5.25	63.34+5.2	100	0.53

Females had a significantly higher scores for total grains than males ($p<0.005$). On the other side, males had significantly higher scores for variety than females.

Overall HEIA scores showed a significant positive correlation ($p<0.01$, 2 tailed) with all the components (except Total oil, Total sugar and SOFAAS).

Socio Economic Status of the subjects and Mean Individual HEIA Component Scores

Various Socio Economic parameters affected the overall scores of the subject (As shown in this section earlier). Thus, the effect of these parameters on the individual component scores was also analyzed.

Christians had a significantly higher overall score as well as highest individual scores for all the components except Total Green/yellow/orange vegetable, Total oil and SOFAAS (Figure 4.2.2).Total pulse / Meat, Fish and poultry scores were highest for Christians and Muslims which can be attributed to a non-vegetarian diet and a higher consumption of poultry foods amongst them.

Milk consumption was lowest amongst Muslims. No consumption of Green, Yellow or orange vegetables was observed in Muslims. Score for SOFAAS was lowest amongst Sikhs.

Analysis of Variance (ANOVA) showed a significant effect of religion on the scores for Total Grains and Total Pulses/ Meat, Fish and Poultry.

Figure 4.2.3 shows, the individual component scores according to the type of family. Highest mean overall scores were observed in the subjects lining in joint families. Nuclear families showed significantly higher scores for Total Milk as compared to joint families ($p<0.005$). Nuclear families also had significantly higher scores for Total fruits as compared to the extended families ($p<0.05$).Analysis of variance also suggests that type of family had a significant effect on the Total Milk scores of the subjects.

Size of family had a significant effect ($p<0.05$) on Total Milk scores with subjects having less than 5 member (3.8) getting a higher score as compared to others with bigger families (3.4).However, size of the family did not affect other component scores significantly. Correlation between the family size and component scores revealed a negative correlation between family

Figure 4.2.2: Mean HEIA Component Scores according to Religion

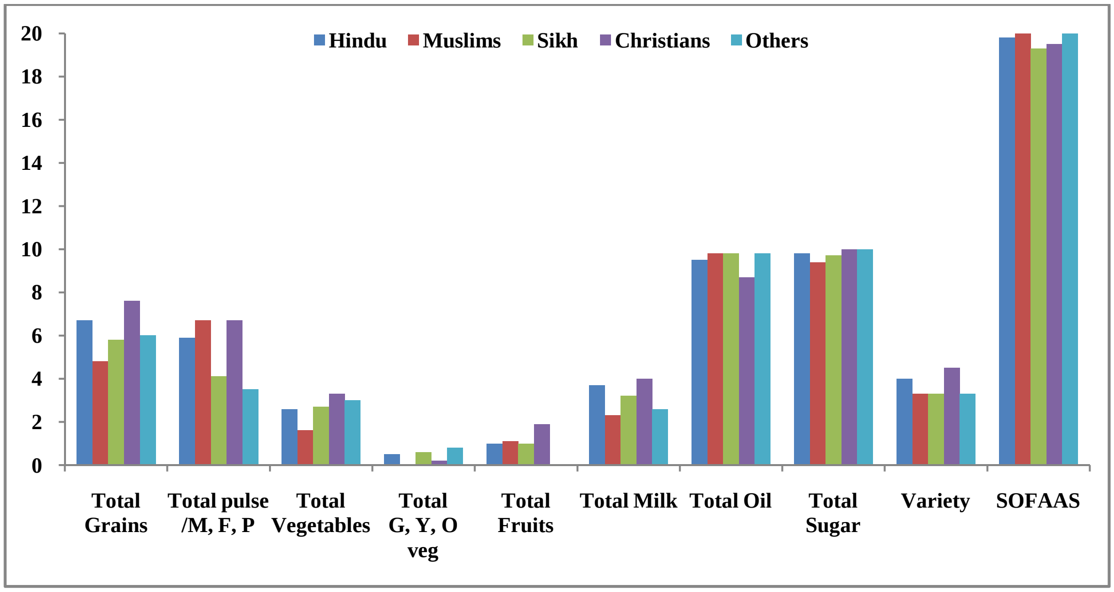
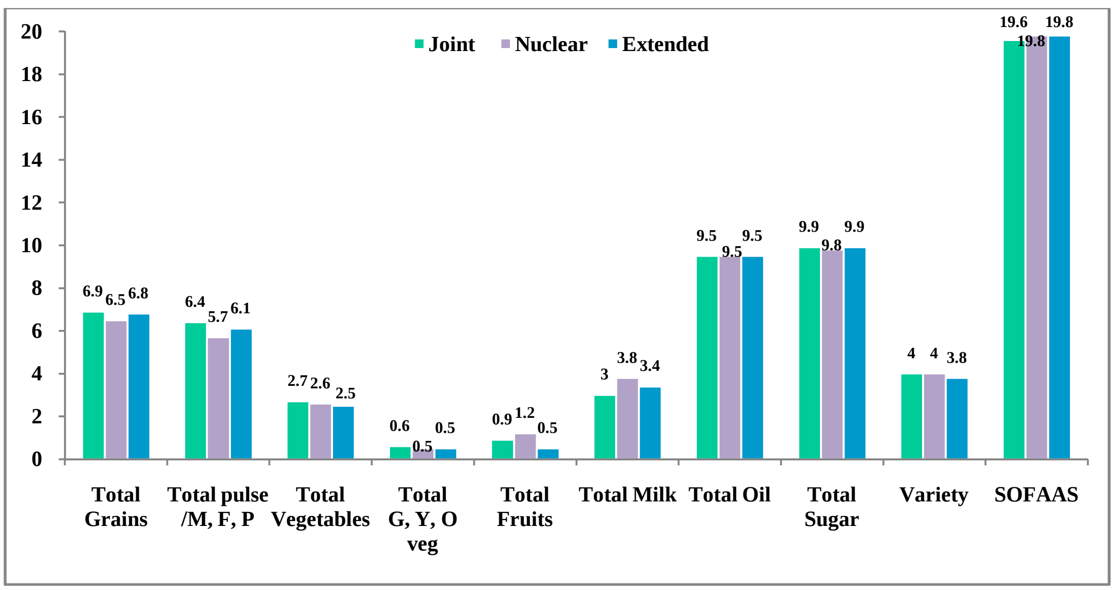


Figure 4.2.3:Mean HEIA Component Scores according to the Type of Family



size and Total fruit, Total milk and Total SOFAAS scores (Figure 4.2.4). However, this correlation was significant for milk only.

Income levels of the families of the study subjects had no significant effect on the individual component score (Figure 4.2.5). Total Milk and variety scores were higher in the subjects with a per capita income of 5000 or more, however this difference was not significant among the groups. A significant negative correlation was observed between per capita income and Total SOFAAS score which indicates that as income increased the dietary practice with regards to solid fats and added sugar consumption also increased, thus leading to a low Total SOFAAS score.

Education levels of the parents did not affect the individual component scores significantly (Figure 4.2.6). However, subjects whose fathers were graduate or above had significantly higher ($p<0.05$) scores for Variety while whose mothers were graduate or above had significantly higher ($p<0.05$) scores for SOFAAS. Thus, it can be stated that education level of parents plays an important role in improving the diet quality.

Mother's education did not have any significant effect on the individual component scores (Figure 4.2.7). However, the scores for Total Grains, Total Pulses/ meat/ fish/ poultry, Total vegetables, total milk and Total sugar were higher in the subjects whose mothers were working. No difference in the two groups can be attributed to the fact that most of the working mothers were taking tuitions at home (Figure 4.2.8).

Individual HEIA components scores were not significantly different between the groups based on dietary habits of the subjects (Figure 4.2.9). On comparing scores of vegetarians and non-vegetarians, no significant difference was observed. However, a comparison of vegetarian and ovo-vegetarian subjects revealed significantly higher scores for Total grains (6.81 and 6.11) and Total Milk (3.72 and 3.08) in the vegetarian subjects. Similarly, score for Total Green /yellow/ orange vegetables and Total milk was found to be significantly higher in Non-vegetarians when compared to Ovo-vegetarians.

Figure 4.2.4: Relationship between Mean HEIA Component Score and Family Size

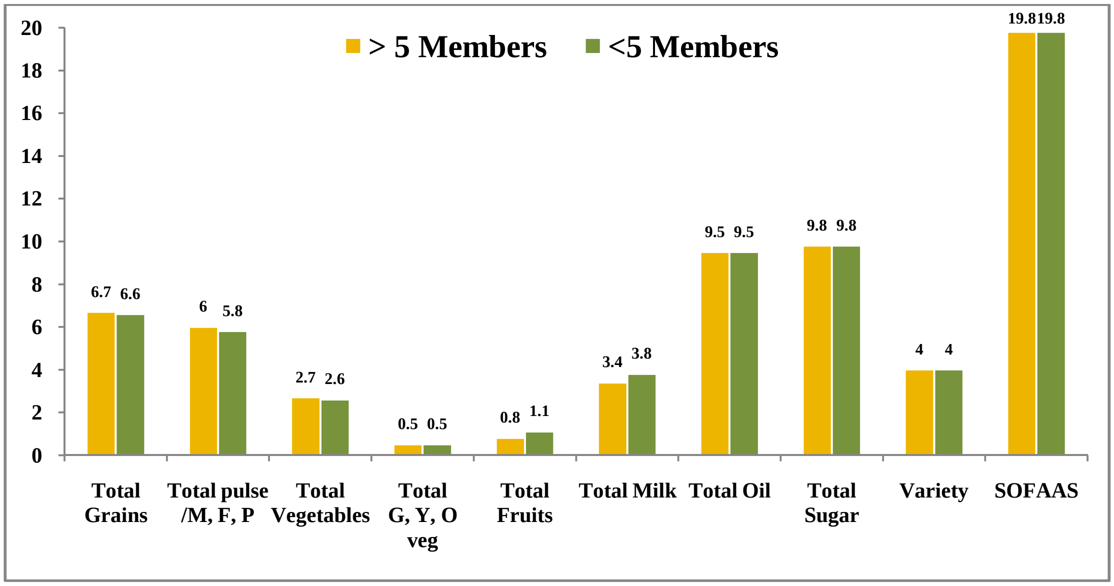


Figure 4.2.5: Relationship between Mean HEIA Component Scores and Per Capita Income

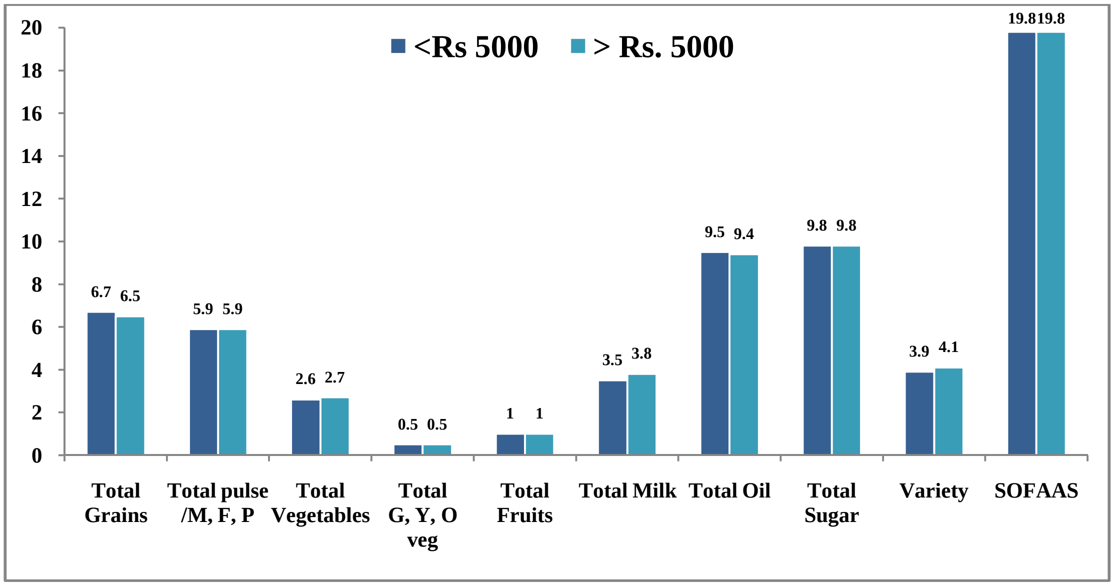


Figure 4.2.6: Relationship between Mean HEIA Component Score and Father's Education

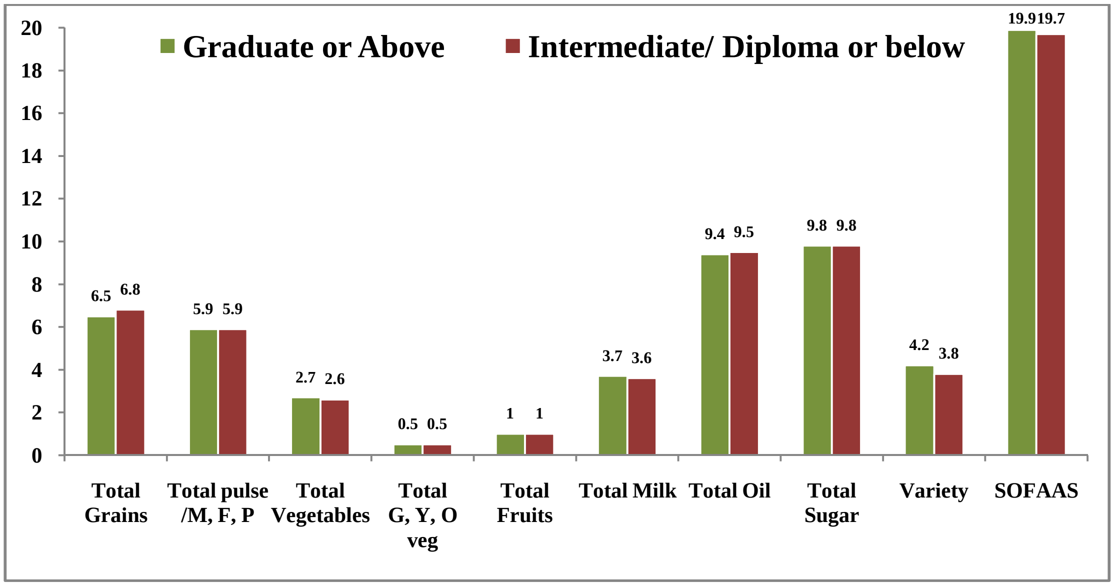


Figure 4.2.7:Relationship between Mean HEIA Component Scores and Mother's Education

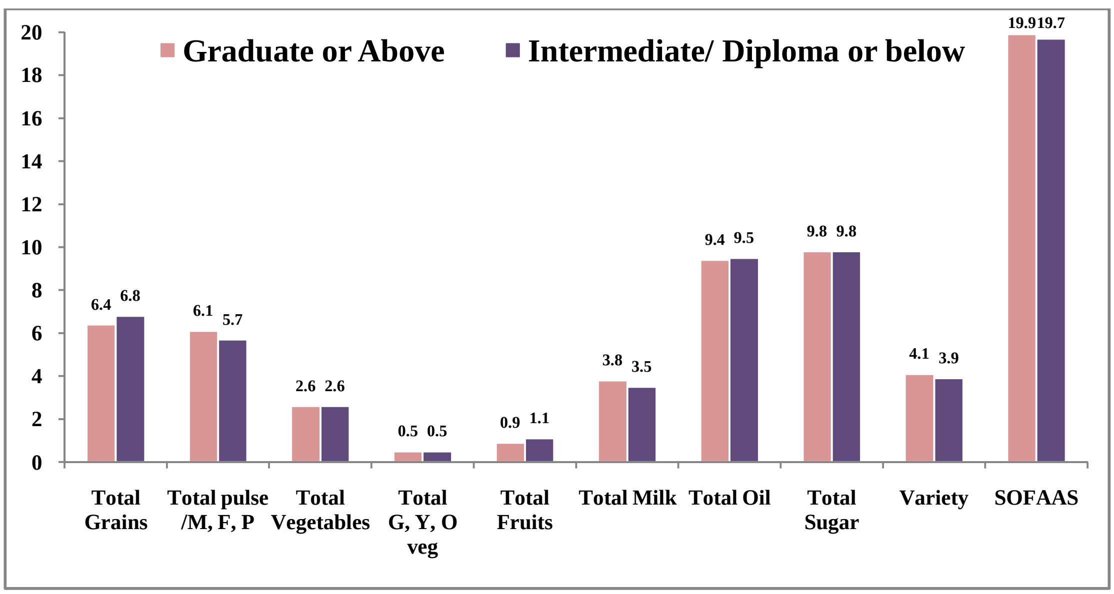


Figure 4.2.8: Relationship between Mean HEIA Component Scores and Mother's Occupation

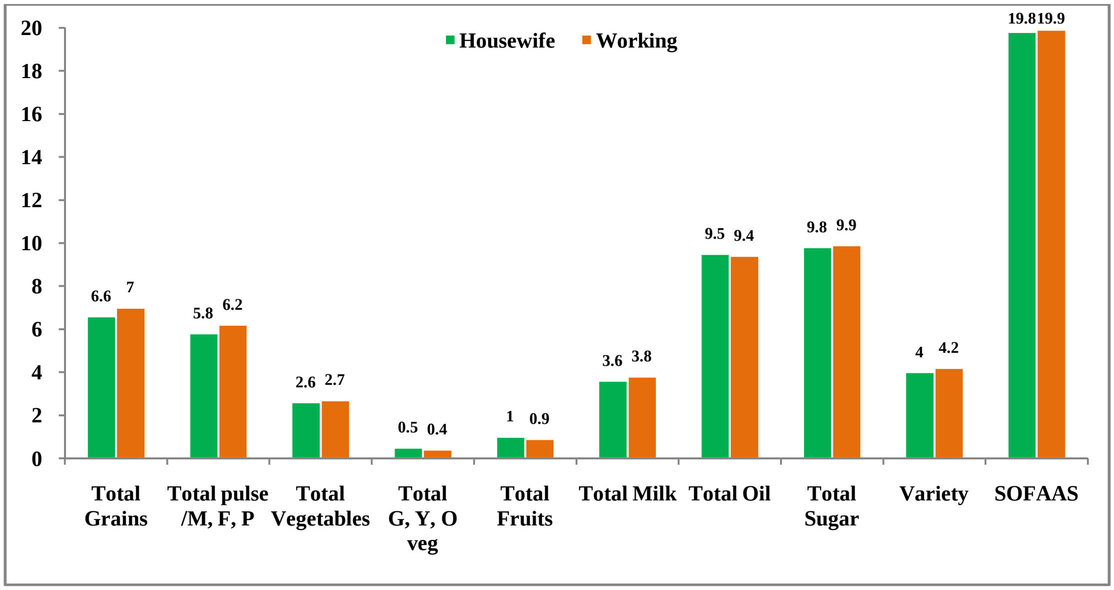
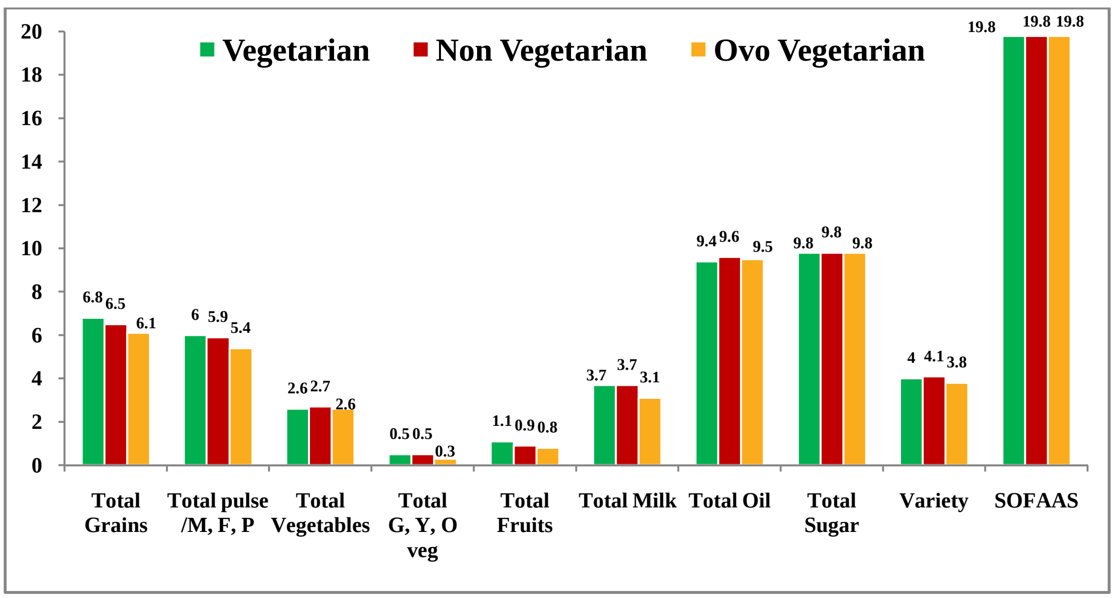


Figure 4.2.9: Relationship between Mean HEIA Component Scores and Dietary Habits



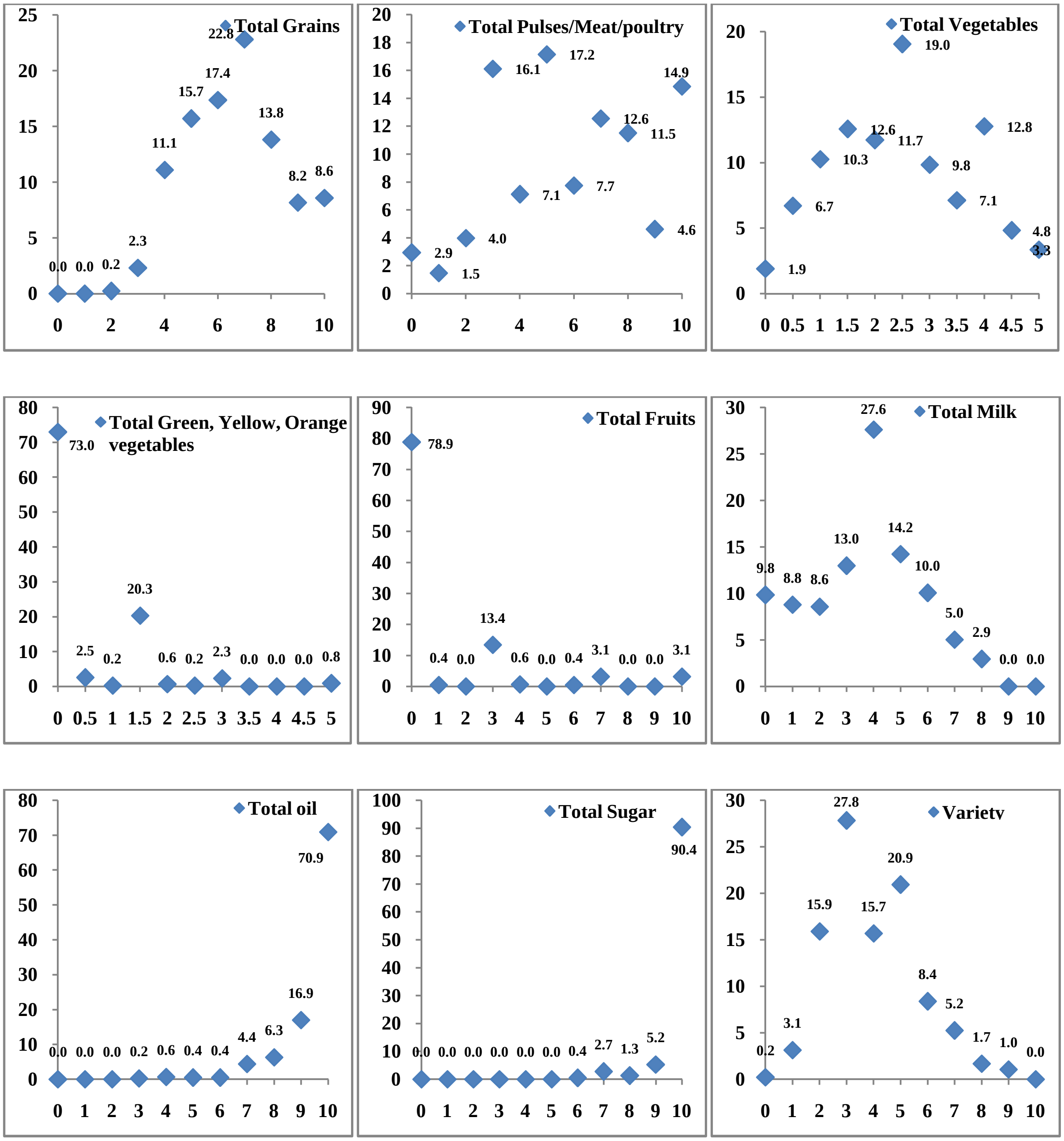
Frequency of HEIA scores for individual components

Figure 4.2.10 shows the scatter plot for various components and their HEIA scores. Majority (53%) subjects got a score of 7 or more for total grains which meant they were consuming around 70% or more of the RDA for total grains. Similarly for pulses/ meat/ poultry/ fish and also for total vegetables, about69% subjects got half of the maximum score or more. However, 43% and 28% of the subjects were consuming more than 70% of total pulses / meat/ poultry/ fish and total vegetables respectively. Seventy three percent subjects did not consume green, yellow or orange vegetables in the past three days. As many as 80% subjects did not consume fruits at all and a mere 7% consumed 50% or more of the RDA for fruits.

Majority of the subjects had total milk score of 4 or less indicating a milk consumption of 40% or less of the RDA for milk. Total oil intake by most of the subjects (88%) was less than the recommended amounts for edible oils. This explains the reason for a high total oil score of these subjects. For total sugar, a score of 10 for 90% of the subjects indicates that their diets fulfilled the RDA for sugar.

A score of 4 or less by 63% of the subjects for variety indicates 5 or <5 items per day. Ninety three percent subjects had a score of 20 for SOFAAS indicating < 20 % of the total energy intake by high calorie foods (containing solid fats and added sugars) in their diets.

Table 4.2.9 compares the mean HEIA component scores, amount consumed and the percent RDA for the common foods. As evident from the table overall intake for almost all the foods was low. Seventy five percent of RDA was met only for total oil (by both boys and girls) and total grains (by girls only). The lowest intake was for total fruits which also got the lowest HEIA score. Total milk intake was found to be 39% and 35% for boys and girls respectively which was also shown by the scatter plot in the previous Figure 4.2.10.



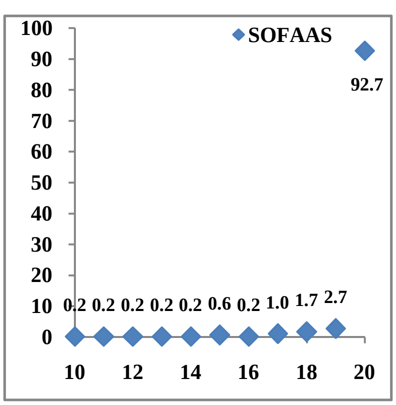


Figure 4.2.10: Scatter plot showing HEIA scores for Individual Components

X-Axis: HEIA Scores

Y Axis: Percent Subjects

Table 4.2.9: Individual component scores v/s RDA

<table>
<tr><th rowspan="2">Food Group</th><th colspan="3">Boys</th><th colspan="3">Girls</th></tr>
<tr><th>Mean Scores</th><th>Total Amount</th><th>RDA %</th><th>Mean Scores</th><th>Total Amount</th><th>RDA %</th></tr>
<tr><td>Total Grains</td><td>6.42±1.88</td><td>201.42±40.32</td><td>73.6</td><td>6.97± 1.67</td><td>189.96±43.48</td><td>76.2</td></tr>
<tr><td>Total pulse</td><td rowspan="2">5.82±2.72</td><td>38.98±19.65</td><td>56.1</td><td rowspan="2">6.01±2.68</td><td>37.98±17.73</td><td>61.4</td></tr>
<tr><td>Meat , Fish & Poultry</td><td>4.41±15.0</td><td>3.3</td><td>2.85±10.43</td><td>1.9</td></tr>
<tr><td>Total Vegetables</td><td>2.7±1.22</td><td>185.79±82.31</td><td>58.8</td><td>2.49±1.26</td><td>170.16±100.37</td><td>55</td></tr>
<tr><td>Total Fruits</td><td>1.08±2.31</td><td>15.67±35.57</td><td>14.2</td><td>0.9±2.23</td><td>15.79±51.23</td><td>13</td></tr>
<tr><td>Total Milk</td><td>3.73±1.91</td><td>194.08±95.67</td><td>38.7</td><td>3.49±2.24</td><td>181.98±113.21</td><td>34.7</td></tr>
<tr><td>Total Oil</td><td>9.44±1.02</td><td>22.89±6.34</td><td>78.9</td><td>9.55±0.80</td><td>181.98±5.56</td><td>75</td></tr>
<tr><td>Total Sugar</td><td>9.77±0.68</td><td>12.08±5.46</td><td>53.1</td><td>9.86±0.56</td><td>11.44±5.82</td><td>47.4</td></tr>
</table>

FBACA-Food Behaviour and Activity Checklist for Adolescents

A Food Behaviour and Activity Checklist for Adolescents was prepared in the present study. The FBACA checklist was administered for 7 days to ascertain the trend. The frequencies of 20 dietary and physical activity practices were scored for the past week, based on the semi structured questionnaire which was filled to the subjects. A sum of all the individual components of FBACA was the Total FBACA score. The maximum total FBACA score was 100. Each desirable practice was given a maximum score of 5 and the most undesirable practice was given a score of zero based on their frequencies in the past week. A total FBACA score of 80 implied a 'good' quality practices were being followed. However, a Total FBACA score between 51 to 80 meant the practices 'needed improvement' while a total FBACA score less than or equal to 50 suggested 'poor' quality of dietary and physical activity practices.

Total FBACA Scores

Table 4.2.10 shows mean total FBACA scores for girls were slightly higher than boys. This difference was found to be non significant. On further age and sex wise analysis it was found that these score were lowest for girls at the age of 16 to <17 years whereas for boys it was lowest between 9 to <10 years of age. Mean total scores for girls were significantly higher ($p<0.001$) than boys at the age of 9 to <10 years. However, boys had a significantly higher score ($p<0.05$) than girls at the age of 13 to < 14 years and 16 to < 17 years of age (Table 4.2.11). Analysis of variance (ANOVA) revealed that there was no significant effect of age on Total FBACA scores.

Socio Economic Status of the Subjects and Mean Total FBACA Scores

Socio Economic status is known to affect the quality of diet. An attempt was made to see the association between Mean total FBACA scores and the socio economic parameters. Table 4.2.12 shows the mean total scores of the subjects in relation to various SES parameters. The highest Total FBACA scores were observed for Christians. However, Analysis of variance showed no significant association between religion and total FBACA scores.

Table 4.2.10: Mean Total FBACA Scores

Total FBACA Scores	(Mean + SD)		
	Boys (N=389)	Girls (N=242)	Total (N=631)
Mean	69.94+8.28	70.61+8.45	70.20+8.35

Table 4.2.11: Mean Total FBACA Scores Age and Sex wise

Age	Boys	Girls	Total
<9	71.08+8.26 (13)	68.50+8.9 (10)	69.96+8.45 (23)
9-9.11	67.23+8.65 (39)	73.71+6.88 (41)***	70.55+8.40 (80)
10-10.11	69.55+ 7.65 (88)	70.66+7.46 (53)	69.96+ 7.57 (141)
11-11.11	69.95+9.0 (83)	72.33+7.62 (54)	70.89+8.54 (137)
12-12.11	71.27+7.22 (66)	70.3+9.26 (33)	70.95+7.92 (99)
13-13.11	70.98+8.88 (52)*	65.69+8.84(26)	69.22+9.16 (78)
14-14.11	68.77+8.74 (31)	67.77+9.14 (13)	68.48+8.77 (44)
15-15.11	69.8+9.27 (10)	69.11+12.75 (9)	69.47+10.74 (19)
16-16.11	71.0+5.24 (5)*	55.0+ 0 (1)	68.33+8.04 (6)
>17	77.0+1.41(2)	72.0+ 4.24 (2)	74.5+3.87 (4)

***significant at p<0.05**

*****significant at p<0.005**

Subjects living in a nuclear family had highest total FBACA scores. There was no significant association between the types of family and the total FBACA scores of the subjects. Smaller families had higher Total FBACA scores. Subjects living in a family with less than 5 members had a mean total score of 70.52 while the subjects with more than or equal to 5 members in their family had a score of 69.65 (Table 4.2.12).

Subjects with a per capita income of < Rs 5000 had higher scores than their counterparts with higher per capita income (71.1 and 69.3).This difference was found to be significant between the two groups ($p<0.01$).However, the association between the PCI and FBACA scores was not significant as revealed by analysis of variance (ANOVA).

Children of well educated parents (Graduate or above) had higher FBACA scores as compared to others. However, the difference between the two groups was not significant. Working status of the mother had a positive effect on the total FBACA scores. Children of working mothers had higher FBACA scores as compared to the children whose mothers were housewives (71.71 and 70.03). The difference in the two groups based on mother's occupation was not significant (Table 4.2.12).

Ovo-vegetarians had the highest total FBACA scores although the difference between the groups was not significant.

Table 4.2.12: Socio economic parameters and Mean Total FBACA Scores

Socio Economic Parameter (N=631)	Mean FBACA Score	't' value / 'F' value
Religion Hindu (595) Muslim (10) Sikh (16) Christian (10)	 70.19± 8.40 71.70± 8.56 67.69±7.95 72.8± 5.03	'F'- 1.43
Type of Family Joint (63) Nuclear(459) Extended(109)	 68.94± 7.96 70.57± 8.33 69.34± 8.58	'F'- 1.76
Family Size ≥ 5 members(234) < 5 members (397)	 69.65± 8.2 70.52± 8.43	't'- 1.27
Per Capita Income ≤ Rs. 5000 (321) > Rs. 5000 (310)	 71.1± 8.28 69.26± 8.33	't'- 2.78
Father's Education Graduate or above (352) Intermediate/ Diploma or below (279)	 70.55± 8.67 69.75± 7.92	't'- 1.19
Mother's Education Bachelor degree or above (251) Intermediate/ Diploma or below (380)	 70.83± 8.03 69.78± 8.55	't'- 1.54
Mother's Occupation Housewife (568) Working (62)	 70.03± 8.44 71.71±7.42	't' – 1.51
DietaryHabits Vegetarian (358) Non-Vegetarian (196) Ovo-Vegetarian (77)	 70.08±8.07 70.18±8.88 70.81±8.29	'F' – 0.24

Assessment of the Quality of Dietary and Physical Activity Practices

More females than males had a good dietary and activity practices according to FBACA (13% v/s 8%). However most of the subjects i.e. 86% boys and 90% girls needed improvement in their habits. A very small percentage of subjects followed poor dietary and physical activity practices (Table 4.2.13).

Figure (4.2.11) shows an age wise analysis of the overall quality of practices followed by the subjects. None of the subjects above 16 years of age followed good quality practices. Similarly none of them below 9 years and above 15 years had poor dietary and activity practices. Eighty five to 100 % of the subjects needed improvement in their practices at all ages.

Mean Total FBACA Scores and the Nutritional Status of the Subjects.

On comparing the total scores with the nutritional status no significant difference between the undernourished and normal subjects was observed. However the total FBACA scores for the undernourished subjects were lower than their well nourished counterparts (Table 4.2.14).

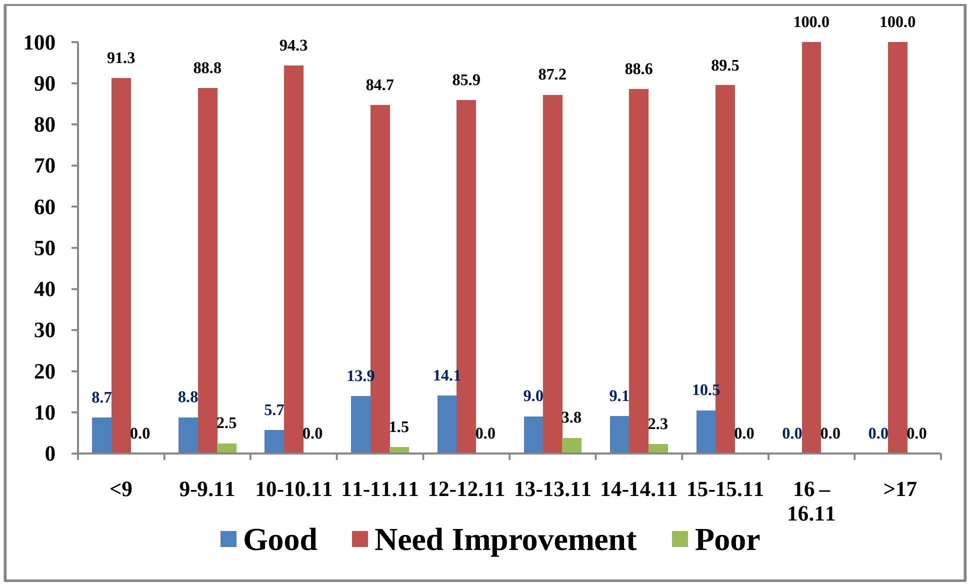
Table 4.2.13: Quality of diet and physical activity practices of the study subjects

Quality of Practices	Boys	Girls	Total
Good	8.2(32)	12.8(31)	10 (63)
Need Improvement	86.4 (209)	90.2 (351)	88.7(560)
Poor	0.8 (2)	1.5(6)	1.3(8)

Table 4.2.14: Total FBACA score according to the nutritional status

Nutritional Status	Total FBACA scores Mean±SD	't' value
WAZ		
<-2 SD	69.03±6.69	0.78
≥-2 SD	70.25 ±8.42	
HAZ		
<-2 SD	69.33 ± 9.65	0.40
≥-2 SD	70.21 ± 8.32	
BAZ		
<-2 SD	69.40 ± 8.49	0.80
≥-2 SD	70.29 ± 8.33	

Figure 4.2.11: Quality of Practices as per FBACA Scores (N=631)



Individual component scores

Breakfast consumption received a high score (4.6) although the breakfast items did not get good scores (2.15) as most of the subjects had a habit of having milk only for breakfast. Mid morning scores were quite high indicating a regular consumption of food during recess (4.53). Higher mid morning item scores (4.14) indicate the foods eaten were also healthy as most of the subjects used to carry “roti –sabji” in tiffin. Lunch (tiffin) scores (4.3) were also high thus most of the subjects consumed foods brought from home during recess (Table 4.2.15).

The highest individual scores were for vegetable consumption (4.9) indicating a regular consumption by the subjects on almost all the days. However vegetable consumption was highest for roots and tubers(4.33) followed by other vegetables (3.71). Fruit consumption (4.81) was also reported to be quite high.

Higher evening snack consumption score (4.08) indicated a regular habit of having some food item in evenings but lower scores for evening snack items (0.9) shows unhealthy foods being consumed as snacks.

An average outside food score (3.02) indicates that the subjects were not in a regular habit of consuming outside food. A good water intake score indicates satisfactory water intake by the subjects.

Playtime score of 2.68 shows, that average time for play was between 30-50 minutes daily. Leisure time score(2.34) implies that on an average leisure time was between ½to 1½ hour daily whereas study time (2.05) daily was between 8-10 hours including 5 hours of school time.

There was no significant difference in the mean individual FBACA component scores of both the sexes.

Table 4.2.15: Mean FBACA component score

FBACA Components	Mean Score (Mean + SD)			Max Score
	Boys (N= 389)	Girls (N= 242)	Total (N= 631)	
Breakfast Consumption	4.66 + 1.08	4.5 +1.43	4.6 + 1.23	5
Breakfast Item	2.14 + 1.41	2.16 + 1.45	2.15 + 1.43	5
Mid Morning	4.44 +1.45	4.66 + 1.14	4.53 +1.34	5
Mid Morning Item	4.05+ 1.68	4.29+1.47	4.14+ 1.61	5
Carry Lunch	4.3 +1.59	4.33 +1.57	4.31 +1.58	5
Vegetables	4.9 +0.59	4.89 +0.66	4.9 +0.62	5
Green Leafy Vegetables	3.24 + 1.86	3.10 + 1.80	3.18 +1.84	5
Yellow and orange Veg	2.44 + 1.98	2.15 +1.87	2.33 + 1.94	5
Roots and Tubers	4.25+1.27	4.48 +1.03	4.33 +1.19	5
Other Vegetables	3.59 +1.56	3.91+1.48	3.71 +1.54	5
Fruit Consumption	4.77 + 0.71	4.89 + 0.48	4.81 + 0.63	5
Any fruit	2.71 +1.88	2.61 +1.95	2.67 +1.91	5
Local fruits	2.86 + 1.95	3.10 +1.97	2.95 +1.96	5
Evening Snack Consumption	3.99 +1.69	4.21 +1.52	4.08 +1.63	5
Evening Snack Item	1.01 +1.57	0.9 +1.5	0.97 +1.54	5
Outside Food Consumption	3.07 +1.57	3.05+1.55	3.06 + 1.56	5
Water intake	4.29 + 1.01	4.37 +1.01	4.32 +1.01	5
Playtime	2.66 +1.54	2.71 +1.60	2.68 +1.56	5
Leisure time	2.44 +1.45	2.19 +1.46	2.34 +1.46	5
Study time	2.05 +1.84	2.05 +1.9	2.05 +1.86	5
Total Score	69.94+8.3	70.61+8.45	70.2+8.35	100

Socio Economic Status and Mean FBACA Individual Component Scores

SES parameters having significant effects on Mean FBACA individual component scores are discussed below. Analysis of variance shows a significant effect of religion on the other vegetable scores and the play score of the subjects ($p<0.05$). Consumption of other vegetables was highest amongst Christians followed by Hindus. Play score was lowest among Sikh subjects (2.75) while it was highest among Christians (4.5) (Figure 4.2.12).

A comparison between the type of family and individual component scores revealed that roots and tubers score was significantly higher in nuclear families as compared to joint ($p<0.001$) or extended ($p<0.05$) families (Figure 4.2.13). Other vegetables score which includes vegetables like ladyfinger, brinjal, cauliflower etc. was significantly higher in nuclear families as compared to joint families ($p<0.05$). Joint and extended families did not have significant differences between the scores. A comparison between nuclear and extended families shows significantly higher score($p<0.05$) for GLV, evening snack and evening snack item in the nuclear families while the extended families had significantly higher scores for any fruit (Seasonal fruits) ($p<0.05$) and study time ($p<0.05$).

Analysis of variance reflected a significant effect of the type of family on roots and tubers ($p<0.001$), other vegetables ($p<0.05$) and evening snack item ($p<0.05$) scores.

Roots and tubers ($p<0.05$) and evening snack ($p<0.01$) scores were significantly higher in families with less than 5 members (Figure 4.2.14).

Per capita income was significantly and positively correlated to mid morning item, Yellow orange vegetables and study scores of the subjects ($p<0.05$).Independent ‘t’ test also showed a significant difference between the two income groups in relation to mid morning item score ($p<0.05$) (Figure 4.2.15).

A significant difference was observed in terms of mid morning item score amongst the groups based on the education level of parents. Thus, it indicates higher education of parents helps in developing healthier habits in children. Play score was negatively associated with parents education although, the difference was not significant (Figure 4.2.16 and 4.2.17).

Figure 4.2.12: Mean FBACA Components Score and Religion

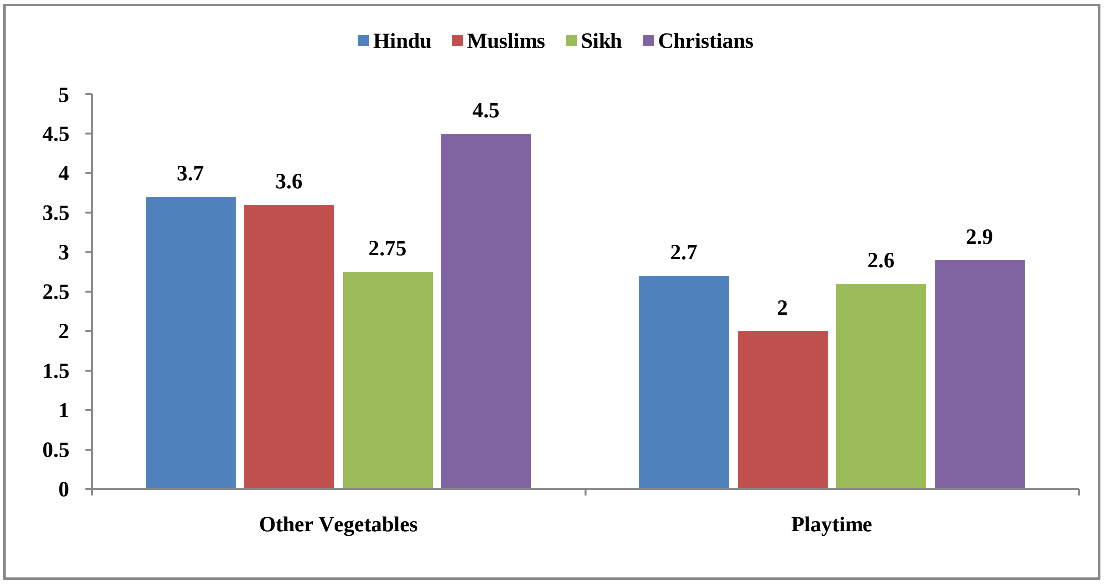


Figure 4.2.13: Mean FBACA Component Scores and Type of Family

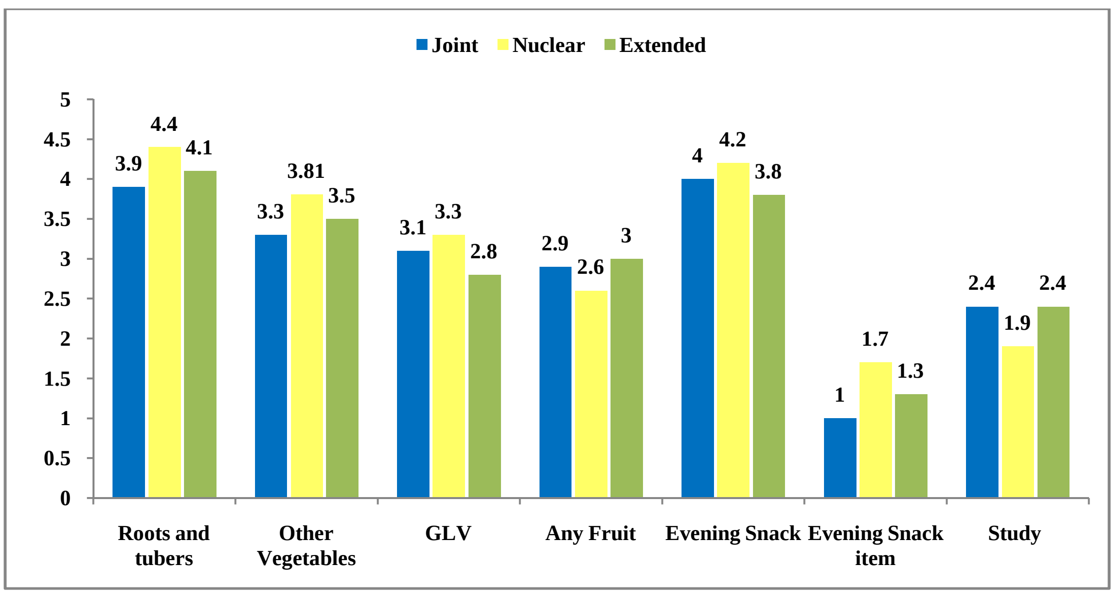


Figure 4.2.14: Mean FBACA Components Scores and Family Size

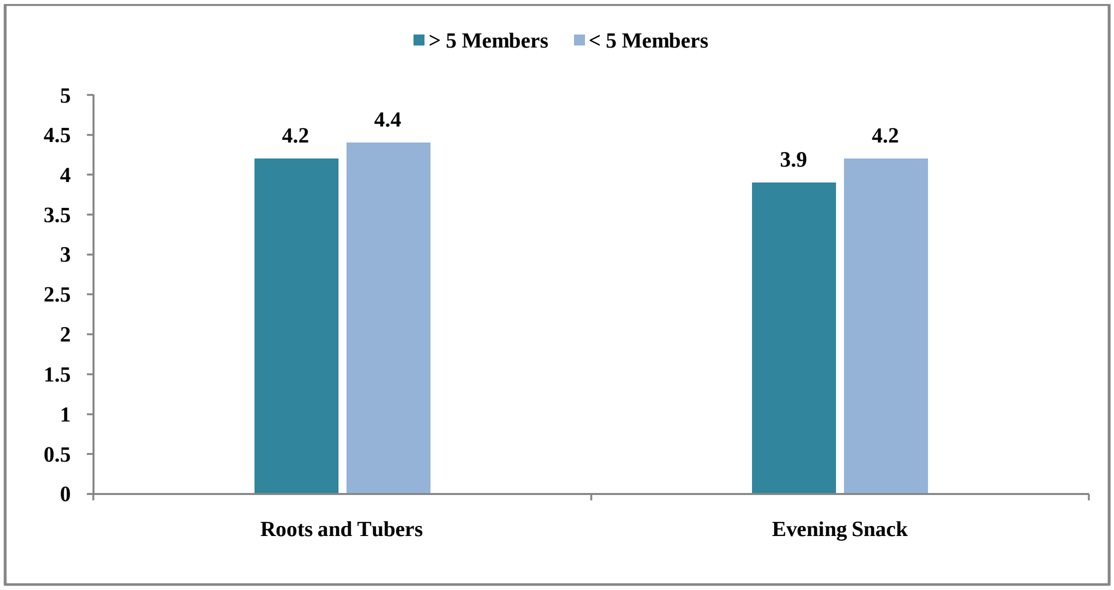


Figure 4.2.15: Relationship between Mean FBACA component Scores and Per Capita Income

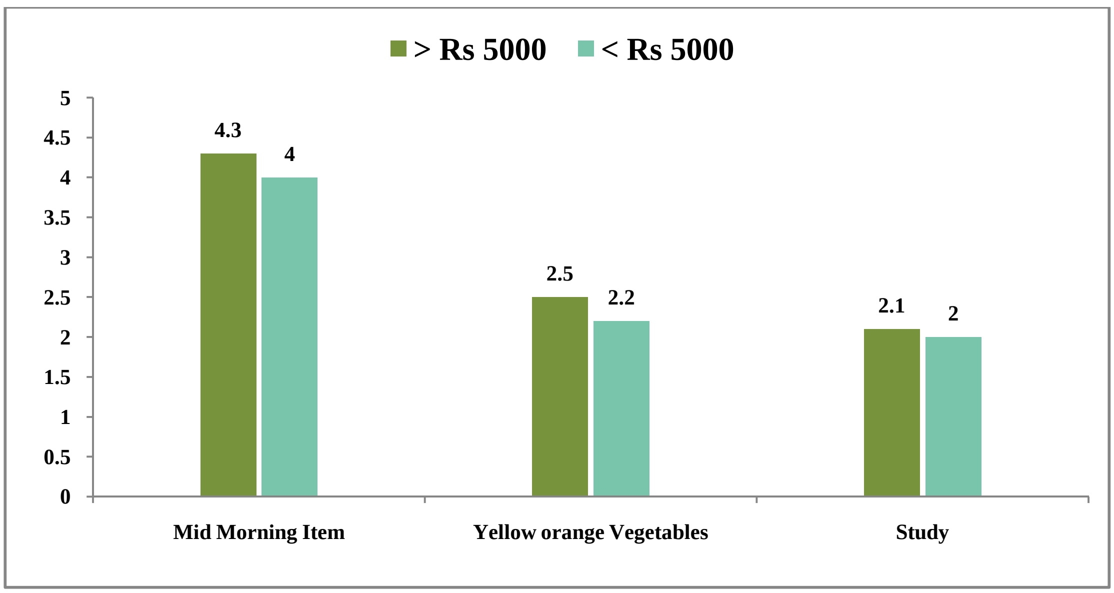


Figure 4.2.16: Mean FBACA Component Scores and Father's Education

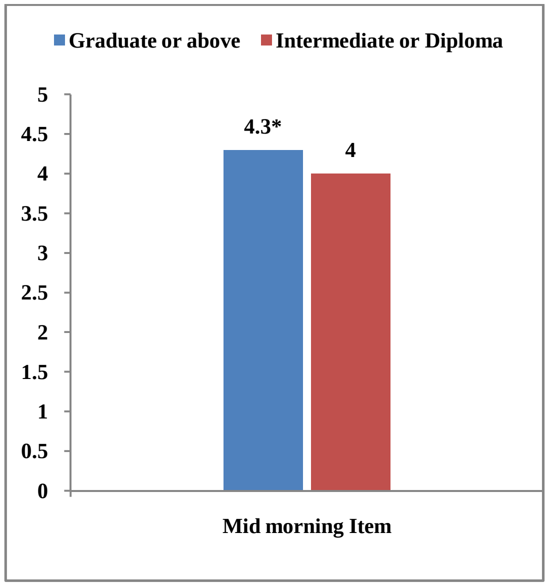
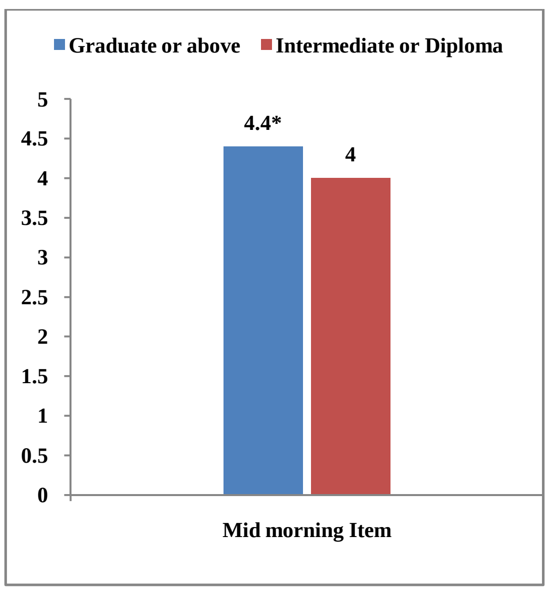


Figure 4.2.17: Mean FBACA Component Scores and Mother's Education



Green leafy vegetable (GLV) scores were significantly higher amongst children of working mothers ($p<0.05$) (Figure 4.2.18). Outside food score was significantly higher in vegetarians as compared to non-vegetarians. Breakfast score which indicates the frequency of breakfast consumption was significantly higher in ovo-vegetarians as compared to vegetarians or non-vegetarians. Evening snack item score was significantly higher in ovo-vegetarians than in non-vegetarians (Figure 4.2.19). Thus, the overall scenario showed better quality practices regarding outside food consumption, breakfast consumption and healthy evening snack consumption amongst ovo-vegetarians, followed by vegetarians.

Frequencies of Individual FBACA component scores

Figure 4.2.20 shows the scatter plot for the frequencies of various individual component scores. Breakfast consumption was reported by 87% girls and 88% boys on $\geq$ 5 days/ week. Forty six percent boys and 36% girls consumed tea/coffee along with biscuits for breakfast while 26% boys and 29% girls consumed milk with biscuit for $\geq$ 5 days.

Mid morning food consumption was reported by 84% and 88% boys and girls respectively for $\geq$ 5 days during the last 7 days. Around three fourths of boys and girls consumed Cereals along with vegetable or pulses or milk as mid morning food item. This explains a high mean for mid morning item score.

Ninety six percent subjects reported vegetable consumption for$\geq$ 5 days. Majority of the subjects consumed roots and tubers for 5 or more days. A regular consumption of yellow orange vegetables was reported by nearly 40% of the subjects. As high as 94% girls and 88% boys reported fruit consumption for $\geq$ 5 days in the past week whereas local or seasonal fruit consumption was less.

Around 70% subjects consumed evening snacks for 5 or more days. Zero score was given to 65% boys and 62% girls for evening snack item which means that these subjects were consuming unhealthy foods like fried foods, namkeen, farsan, bakery items etc. as snacks in the evenings for $\geq$ 5 days. Forty six percent girls and 50% boys reported outside food consumption for 4 or more days. This score mainly included foods eaten by them in the canteen, outside school, after tuition classes or with friends and family outside the house. Eighty one percent of the subjected reported of carrying tiffin to school. Water intake of $\geq$ 8 glasses per day was

Figure 4.2.18: Mean FBACA Component Scores and Mother's Occupation

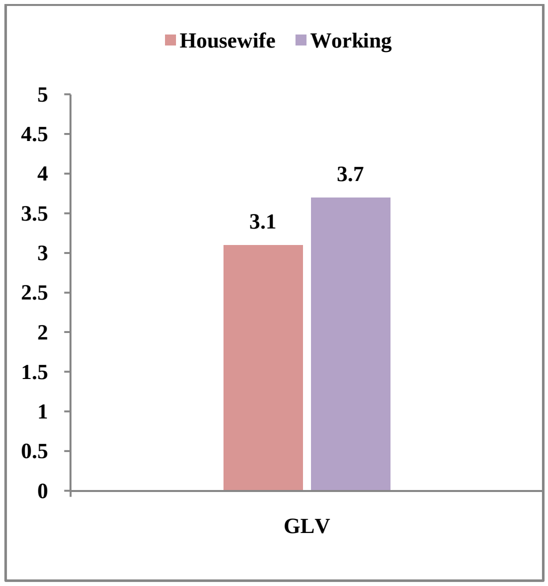


Figure 4.2.19: Mean FBACA Component Scores and Dietary Habits

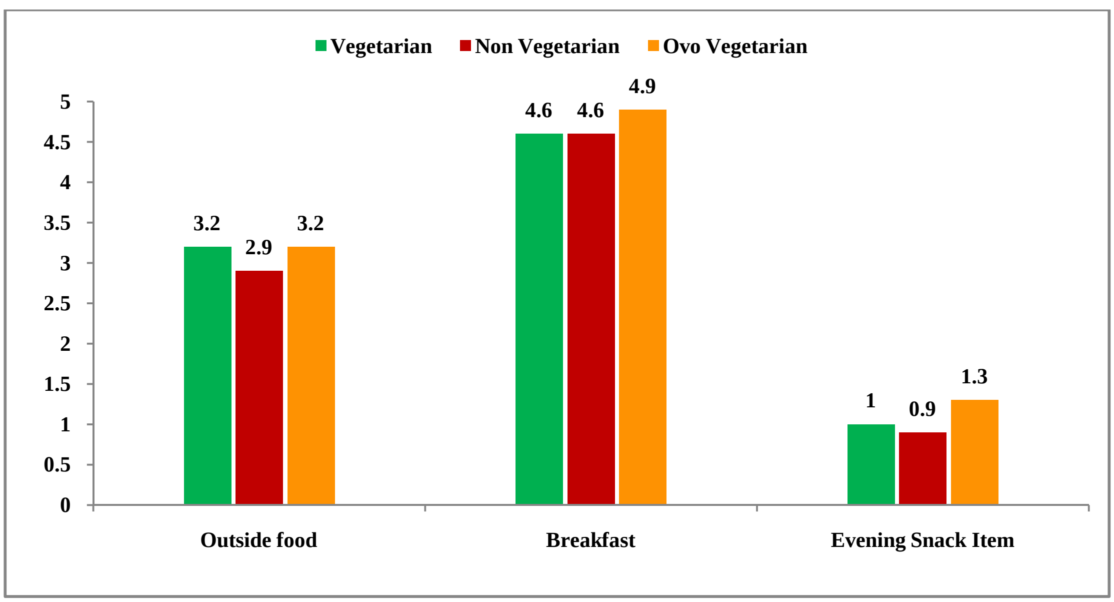
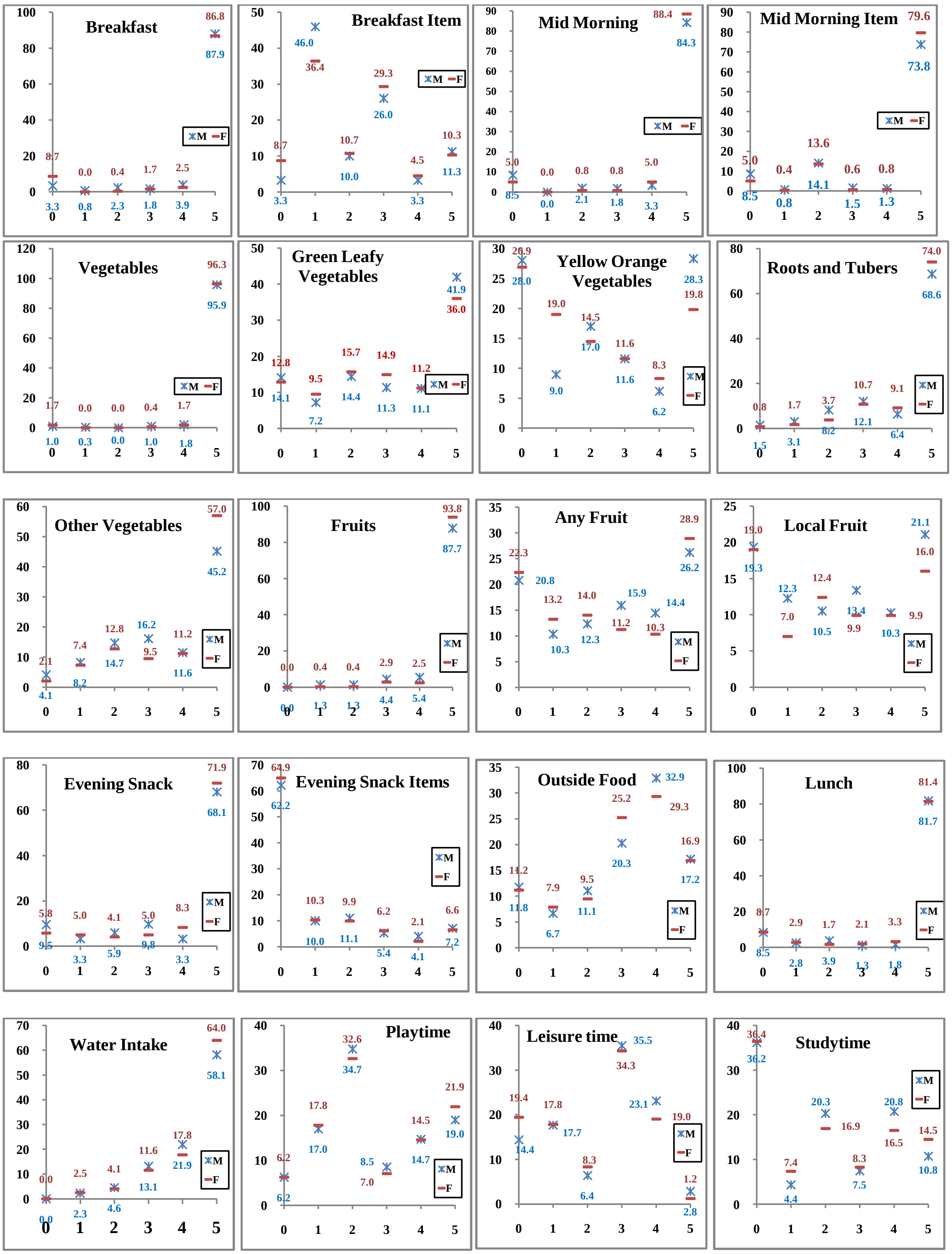


Figure 4.2.20: Scatter plot showing FBACA scores for Individual Components

X-Axis: FBACA Scores Y Axis: Percent Subjects



reported by 64% girls and 58% boys. Nearly 7% of the subjects had water intake $\leq$ 4 glasses per day. More than half of the subjects played for 40 minutes or less while one third of the subjects played for 50 minutes or more daily.

Around 35% of the subjects reported their leisure time to be between ½ to 1 hour daily which included mostly TV viewing, computer or video games. Leisure time of 2 hours or more was reported by 14% boys and 19 % girls on a daily basis (Figure 4.2.20).

Thirty six percent subjects reported to be studying for 11 or more hours daily. This study time includes their 5 hours of school. Six to seven hours of study time was reported by 11% boys and 15% girls. This explains the low overall mean study time score.

Psychometric properties of HEIA and FBACA evaluated

Validity

Content Validity

Content Validity examines qualitatively the extent to which an index represents the variety of attributes that make up diet quality in case of HEIA and the quality of practices in case of FBACA.

The key recommendations applicable to adolescents were used from 'Dietary guidelines for Indians- 2010'. These recommendations are linked to related components of HEIA and are shown in Table 4.2.16. All the components that relate to diet quality are reflected in HEIA and some in FBACA. By design HEIA does not cover physical activity, body weight management, water intake, food safety, cooking methods and healthy eating habits. FBACA on the other hand alongwith dietary habits covers physical activity and water intake.

Construct and Criterion Validity

Construct and criterion validity measure how well the index measures diet quality.This is done in four different ways.

The HEIA scores for the four sets of menus for adolescents (13-15 years) were quite high as shown in Table 4.2.17. The scores based on balanced diets for adolescents according to portion sizes were the highest as these plans were used to formulate HEIA. The HEIA score for the sample diet plan for boys by 'Dietary guidelines for Indians' (ICMR, 2010), was low as the total

Table 4.2.16: HEIA / FBACA Components mapped to Dietary Guidelines for Indians

Dietary Guidelines – Key recommendations	HEIA/ FBACA Components	Comment
• Eat variety of foods to ensure a balanced diet	**HEIA Components** • Total Grains • Total pulse/ meat, fish and poultry • Total vegetables • Total green, yellow and orange vegetables • Total fruits • Total Milk • Total oil • Total Sugar • Variety • SOFAAS	HEIA assesses intake of all the food groups. It also includes 'Variety' to ensure use of all major foods in the diet. SOFAAS component covers all the additional calories consumed in the form of extra sugar and fat.
	FBACA Components • Breakfast item • Mid morning item • Vegetables • Green leafy vegetables • Yellow and orange vegetables • Roots and tubers • Other Vegetables • Fruits • Any fruit • Seasonal fruit • Evening snack Item	FBACA assesses the frequency of various dietary practices and ensures a variety of foods are consumed. Evening snack, mid morning food item and outside food consumption takes into account the healthy and unhealthy practices.
• Eat plenty of vegetables and fruits	**HEIA Components** • Total vegetables • Total green, yellow and orange vegetables • Total fruits **FBACA Components** • Vegetables • Green leafy vegetables • Yellow and orange vegetables • Roots and tubers • Other Vegetables • Fruits • Any fruit • Seasonal fruit	These components cover the recommended intakes for vegetables and fruits for HEIA and their frequencies for FBACA.
• Ensure moderate use of edible oils and animal foods and very less use of ghee/ butter/ vanaspati	• Total oil • SOFAAS	A score of 8 is given to total oil component meeting the requirements whereas a score of 10 is given to an intake of 20% less than the requirement. Additional fat intakes apart from edible oil are counted as SOFAAS. Higher intakes results in lower scores for total oil and SOFAAS components.

Table 4.2.16 : HEIA / FBACA Components mapped to Dietary Guidelines for Indians (contd.)

Dietary Guidelines – Key recommendations	HEIA/ FBACA Components	Comment
• Overeating should be avoided to prevent overweight and obesity		HEIA/ FBACA do not measure energy intakes because it assesses quality rather than quantity. Also higher Scores than requirements for Total oil, Total Sugar and SOFAAS results in lower scores. Consumption of unhealthy foods frequently also leads to lower FBACA scores.
• Exercise regularly and be physically active to maintain ideal body weight	**FBACA Components** • Play time • Leisure time • Study time	HEIA does not include physical activity. Measures of physical activity can be used along with HEIA. FBACA measures the frequency of various activities as per the guidelines for Indian Adolescents.
• Ensure the use of safe and clean foods		By design HEIA/ FBACA do not address food safety.
• Practice right cooking methods and healthy eating habits		HEIA / FBACA do not include healthy eating habits and methods of cooking.
• Drink plenty of water and take beverages in moderation	**FBACA Components** • Water intake	HEIA does not cover water intake. FBACA covers water intakes as water intake score.
• Minimize the use of processed foods rich in salt, sugar and fats	**HEIA Components** • Total Oil • Total Sugar • SOFAAS **FBACA Components** • Breakfast item • Mid morning food item • Evening Snack item	Higher intakes of the mentioned components yield a lower score thus discouraging the use of higher amounts of fats and sugars. Frequent consumption of unhealthy foods leads to a lower FBACA scores. By design HEIA / FBACA do not cover salt intake.

Table 4.2.17: Quality of sample diets as per HEIA

Components	Balanced Diet (NIN) Boys (13-15y)	Balanced Diet (NIN) Girls (13-15y)	Sample Diet Plan (NIN) Boys (13-15y)	Sample Diet Plan (NIN) Girls (13-15y)
Total Grains	10	10	8	9
Total pulse/Meat Fish & Poultry	10	10	8	10
Total Vegetables	5	5	5	5
Total Green, Yellow & Orange vegetables	5	5	5	5
Total Fruits	10	10	10	10
Total Milk	10	10	10	10
Total Oil	8	8	9	10
Total Sugar	10	10	7	10
Variety	10	10	10	10
SOFAAS	20	20	20	20
Total Score	98	98	92	99

Table 4.2.18: Mean Total HEIA and individual component score according to the Nutritional Status

Components	Score (Mean + SE)	
	Undernourished (N=24)	Well nourished (N=454)
Total Grains	6.31+ 0.3	6.64+ 0.09
Total pulse /Meat , Fish & Poultry	6.71+ 0.68	5.85+ 0.13
Total Vegetables	1.69+0.24	2.67+ 0.06***
Total Green, Yellow & Orange vegetables	0.21+ 0.12	0.51+ 0.04
Total Fruits	0.97+ 0.43	1.01+ 0.11
Total Milk	2.04+ 0.45	3.73+ 0.09***
Total Oil	9.67+ 0.17	9.47+ 0.04
Total Sugar	9.68+ 0.19	9.81+ 0.03
Variety	3.28+ 0.31	4.03+ 0.08*
SOFAAS	19.83+ 0.12	19.78+ 0.05
Total Score	60.39+ 0.97	63.5+ 0.24***

*significant at p<0.05
***significant at p<0.005

The correlations between each of the HEIA component scores and energy intake are shown in Table 4.2.19.The components with the highest positive correlations with energy were the milk score (0.5) and the variety score (0.35). The component scores with the highest negative correlation were the SOFAAS score (-.41) and the oil score (-.35). HEIA was able to uncouple diet quality with diet quantity which can be seen by the low correlations of the total and component scores with energy.

FBACA Component scores and their correlations are shown in Table 4.2.20. As expected the individual components had very low correlations with energy. Eleven out of 20 components had negative correlations with energy intakes. The highest positive correlation was observed for Lunch score (0.11) with energy. Correlation of Total FBACA scores with energy was very low (-0.02) indicating independence of FBACA from energy intakes.

The scree plot from the Principal Component Analysis (PCA) showed that multiple factors form HEIA. The plot shows the amount of variance each principal component or factor contributes. Around 69% of the variance is explained by the first five components and 90% by the first eight components. The optimal number of factors is the place where the curve forms a flat horizontal line. Figure 4.2.21 shows that the flat line appears between six and eight factors.

Another way of finding out the number of factors is an Eigenvalue greater than 1. The scree plot shows that at least five factors are there in HEIA with eigenvalue more than 1. Thus, the PCA showed that no single linear combination of components of HEIA accounted for a significant proportion of the covariation in dietary patterns of the subjects.

Figure 4.2.22 shows the scree plot for PCA of FBACA and it was found that multiple factors underlie FBACA. About 63% of the variance is shown by the first eight components of FBACA. The flat line appears between eight and seventeen components.

The scree plot reveals that there are at least 8 factors with eigenvalue more than 1. Therefore it was estimated that no single linear combination of components of FBACA accounted for a significant proportion of the covariation in the dietary and physical activity practices of the subjects in the present study.

Table 4.2.19: Correlations of 3-day HEIA component and total score and energy intake

Component	Total Grains	Total pulse /Meat , Fish & Poultry	Total Vegetables	Total Green, Yellow & Orange vegetables	Total Fruits	Total Milk	Total Oil	Total Sugar	Variety	SOFAAS	Total Score	Energy Intake
Total Grains	1											
Total pulse /Meat , Fish & Poultry	-0.02	1										
Total Vegetables	0.11*	-0.25**	1									
Total Green, Yellow & Orange vegetables	0.11*	0.01	0.2**	1								
Total Fruits	-0.09*	-0.12**	-0.00	-0.01	1							
Total Milk	0.08	-0.17**	0.24**	0.05	0.08	1						
Total Oil	-0.17**	-0.14**	0.06	0.09*	-0.11*	-0.12**	1					
Total Sugar	0.06	0.08	-0.15	0.01	-.28**	-0.03	0.06	1				
Variety	-0.09*	0.12**	0.30**	0.08	0.25**	0.43**	-0.21**	-0.04	1			
SOFAAS	-0.18**	-0.02	-0.06	-0.23**	-0.01	0.01	0.05	0.00	0.06	1		
Total Score	-0.13**	-0.02**	0.14**	0.11*	-0.05	0.12*	-0.24**	-0.08	0.44**	-0.10*	1	
Energy Intake	0.19**	0.10*	0.29**	0.22**	0.13**	0.50**	-0.35**	-0.02	0.32**	-0.41**	0.44**	1

*significant at 0.05 level (2- tailed)
**significant at 0.01level (2- tailed)

Table 4.2.20: Correlations of 7-day FBACA components and total score

Component	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total Score
1	1																				
2	0.33	1																			
3	0.09	0.5	1																		
4	0.04	0.12	0.72	1																	
5	0.004	0.05	0.04	0.14	1																
6	0.09	0.15	0.08	0.16	0.25	1															
7	0.10	0.05	0.13	0.11	0.19	0.38	1														
8	-0.03	0.01	0.04	0.06	0.32	0.07	0.10	1													
9	0.09	0.08	0.05	0.13	0.21	0.18	0.20	0.21	1												
10	0.02	-.04	0.05	0.03	-.03	-.05	0.07	0.07	0.04	1											
11	0.04	-.04	0.01	0.04	-.03	-.01	0.06	0.02	-.04	0.12	1										
12	-0.6	.04	-.01	-.04	.01	-.01	-.07	.02	0.03	0.33	-.8	1									
13	-.13	-.03	-.01	-.02	-.03	0.07	0.04	0.01	0.03	0.01	-.09	.08	1								
14	0.06	-.01	-.02	-.03	0.04	-.04	-.01	-.02	-.03	0.01	0.20	-.19	-.62	1							
15	0.02	-.05	.000	0.02	0.05	0.01	-.004	.05	-.01	-.01	0.09	-.10	-.19	0.25	1						
16	-.06	-.04	-.06	-.12	-.02	-.02	-.13	-.01	-.01	-.01	-.11	0.13	0.17	-.13	.01	1					
17	-.06	.03	-.02	.02	-.00	0.00	-.05	0.03	-.04	-.01	-.07	.05	.10	-.06	.04	-.001	1				
18	.02	.02	.06	.06	.05	.001	.02	.004	-.02	-.01	.03	-.02	0.11	-.06	0.01	0.07	0.19	1			
19	-.01	.00	-.00	.02	-.03	-.012	-.04	-.02	-.03	-.02	-.07	.04	-.04	.01	-.01	.02	-.12	-.33	1		
20	.02	.01	-.01	-.02	-.08	-.04	-.05	-.06	-.04	-.01	.06	-.08	-.03	-.03	-.05	-.01	-.16	-.15	.19	1	
Total Score	.27	.31	.40	.45	.33	.55	.54	.35	.45	.24	.09	.03	0.11	.05	0.20	0.12	0.09	0.18	0.11	0.16	1
Energy	-.03	-.02	-.07	-.01	-.08	-.001	-.03	-.003	.001	.03	.08	-.03	.06	-.05	.01	.11	.05	.01	.01	-.02	.01

Significant at p<0.005 **Significant at p<0.01** **Significant at p<0.05**

Figure 4.2.21: Scree plot – Principal Component Analysis of HEIA

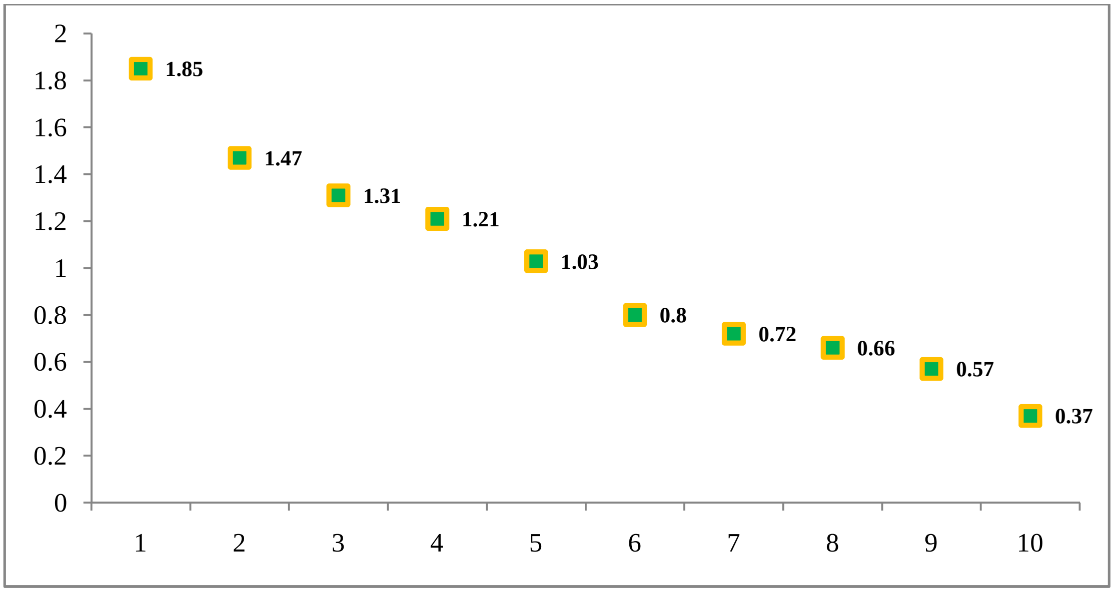
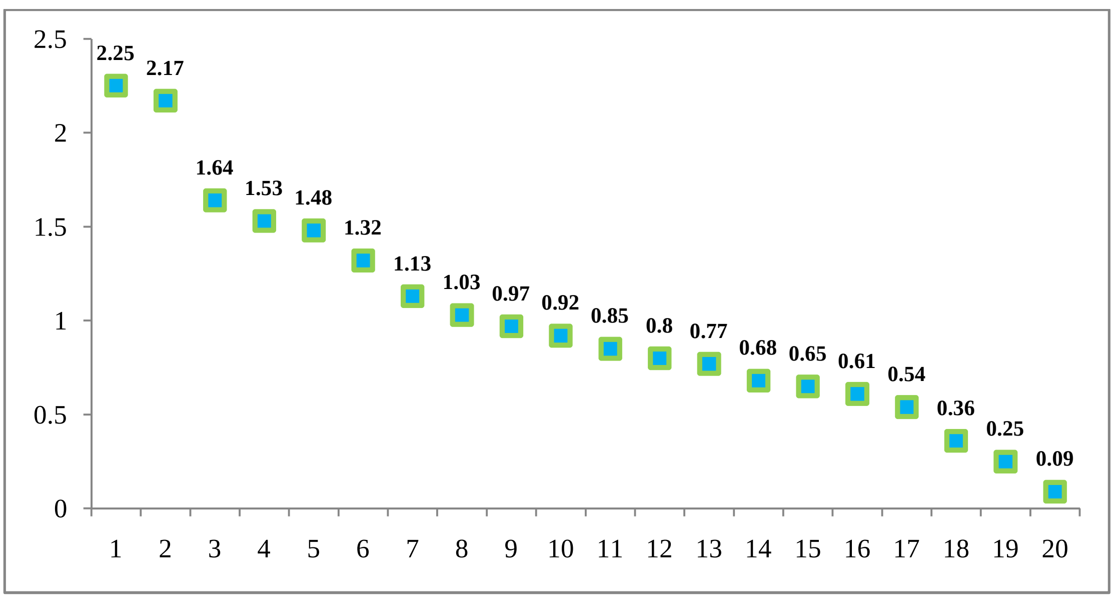


Figure 4.2.22: Scree plot – Principal Component Analysis of FBACA



Reliability

Test retest and inter-rater reliability is the most widely recognized forms of reliability. HEIA or FBACA were developed to be identical for identical diets or practices that are recalled, recorded and coded the same way. The test retest measurement error in this case could be attributed to respondent recall or data collection and processing. Inter-rater reliability was not needed as no judgment was required for scoring. Thus, these two reliabilities were perfect.

Cronbach's coefficient alpha is a measure of internal consistency of an index (Refer Methods and Materials) For HEIA, the Cronbach's coefficient alpha is-0.017 and for FBACA it was 0.17. The Cronbach's Alpha was expected to be low because diet quality is known to be a complex and multidimensional construct. Also because there is no consistency in individuals meeting all the dietary standards used to assess diet quality. Therefore, internal consistency was not a necessary characteristic of HEIA or FBACA.

The component score most highly correlated with the total HEIA score were variety (0.44) other positively correlated components were vegetables (0.14 and 0.11) and milk (0.12). Six of the component scores had low negative correlations with the total score ranging from-.22 to -.02.

The component score most highly correlated with the total FBACA score was Vegetables (0.55). None of the component score was negatively correlated to the total FBACA score. The correlations of the components ranged from 0.02 to 0.55.

Key Findings

- Healthy Eating Index for Adolescents (HEIA) in the Indian context was developed using 'Dietary Guidelines for Indians - A Manual'. HEIA consisted of 10 dietary components.
- Mean Total HEIA scores were found to be 63.34$\pm$ 5.2, mean total HEIA scores were higher for males than females. The highest mean total HEIA scores were at 12 years of age.
- Religion, type of family, family size, per capita income and parent's education affected mean HEIA scores.
- Mean total HEIA scores were significantly affected by the dietary habits of the subjects. Vegetarians had highest scores followed by non-vegetarians and ovo-vegetarians.
- Most of the subjects were in the 'need improvement' category. None of the subjects had 'good' dietary quality.

- WAZ scores and HAZ scores were significantly associated with the mean total HEIA scores.
- Highest scores were obtained for SOFAAS, Total Oil and Total Sugar, indicating healthier dietary habits.
- Food Behaviour and Activity Checklist for Adolescents (FBACA) was developed with 20 dietary and physical activity practices.
- Mean FBACA scores were found to be 70.20$\pm$ 8.35 and were higher for girls than boys.
- Mean FBACA scores were significantly higher in girls at 9 years of age while it was significantly higher in boys as compared to girls at 13 and 16 years of age.
- Most of the subjects (89%) were in the ‘need improvement’ category while around 10% subjects had good dietary and physical activity practices as per the FBACA scores.
- Socio economic parameters did not have any significant effect on the FBACA scores.
- Highest scores for individual FBACA components were for vegetable consumption followed by fruits and breakfast consumption.
- HEIA and FBACA were found to be valid and reliable tools for measuring dietary quality and for measuring the quality of dietary and physical activities respectively.

Discussion

As tools similar to HEIA and FBACA have not been developed in India, the discussion would mainly be based on studies carried out in other countries. Mean HEIA / FBACA scores were higher for boys than girls in the present study. Females had higher mean HEI scores as compared to males as shown by CNPP surveys (Kennedy et al, 1995; Bowman, 1998; Basiotis et al, 2002; Guethner et al, 2011; Lin, 2005). This can be explained by a higher intake of nutrients by boys as compared to girls in the present study.

The mean scores were almost consistent or increased between the ages of 9 to 12 years and then decreased as age advanced. This can be explained by lower mean nutrient intakes by these groups (as discussed in Phase I). CNPP surveys indicate the highest scores were obtained by children and as age advanced the mean total HEI scores declined (Kennedy et al, 1995; Bowman, 1998; Basiotis et al, 2002).

Various socio demographic factors have shown an influence on the HEIA scores in the present study. CNPP survey conducted in 2005 has shown that although the mean HEI scores were higher for higher income group subjects but the difference found was not significant (Guenther, 2008). This supports the findings of the present study where subjects with per capita income of Rs. 5000 or more had higher HEIA scores. Lin (2005) also reported of no significant difference between the mean HEI scores of school age children with regards to income level.

CNPP survey considered education level and found mean HEI scores to be higher in well educated subjects (Kennedy et al, 1995; Bowman, 1998; Basiotis et al, 2002). The present study took education level of the parents into consideration and reported higher education of parents had positive effects on the mean HEIA scores of the subjects. Education may be a predictor of people’s ability to translate nutrition guidance information into better dietary practices (Variyam et al, 1998).

Mean component scores were found to be highest for SOFAAS (19.8 out of 20) followed by Total sugar (9.8) and Total oil (9.5) amongst the subjects in the present study. The lowest scores were reported for fruits in the present study. However, USDA’s report of HEI 89-90, 94-96, 99-00 shows the highest scores for Cholesterol and lowest scores for fruits (Table 4.2.21). The reason for this could be that the SOFAAS component was added to the HEI in 2005 (Guenther et al,2007) previously components like saturated Fat and cholesterol were used in HEI since 1989 (Kennedy et al, 1995).

HEI was revised in 2005 and the highest component scores were 10/ 10 for meat and beans and 5/ 5 for total grains. However, the lowest scores were 1/5 for Whole grains (Ervin B, 2011). FBACA was developed for the adolescents in the present study based on the frequency of dietary and physical activity practices in the past week. FBACA was found to be a valid and reliable tool in assessing the quality of practices followed by the subjects regarding diet and physical activity. However, similar checklists have not been developed in India. Blackburn et al (2006) developed a Food Behaviour Checklist (FBC) for fruits and vegetables consumption, it was evaluated among ethnically diverse women in the Food Stamp Nutrition Education Program (FSNEP) and Expanded Food and Nutrition Education Program (EFNEP). FBC was found to be a valid and reliable indicator of fruit and vegetable intakes.

Table 4.2.21: Comparison of Total HEI scores, highest and lowest component scores v/s HEIA scores present study

Study/ Year	Author/ Place	Mean Total HEI Scores			Highest Component Score / 10	Lowest Components Score / 10
		Males	Females	Total		
Present Study, 2013	Vadodara, India	63.4	63.2	63.3	19.8 SOFAAS*	1.01 Total Fruits and 0.5 Total G/Y/O^ veg**
HEI – 1989, 1995	Kennedy et al, USA	62	65.6	63.8	7.9 Cholesterol	4.0 Fruits
HEI – 94 -96, 1998	Bowman et al, USA	62.9	64.4	63.6	7.8 Cholesterol	3.9 Fruits
HEI-99-00, 2002	Basiotis et al, USA	63.2	64.5	63.8	7.7 Cholesterol & Variety	3.8 Fruits
HEI 2005, 2011	Ervin B, USA	54.8	60.3	57.2	10 Meat and Beans 5 Total Grains**	1 Whole grains**

*Maximum score 20 **Maximum Score 5 ^G/Y/O – Green Yellow Orange vegetables

YHEI (Youth Healthy Eating Index) was developed by (Hurley et al, 2009) for children and adolescents. YHEI was an adaptation of HEI as it used FFQ (Food frequency questionnaires instead of 24 hour recalls). Both HEI and YHEI were useful in predicting dietary quality.

In order to bring a change in the dietary practices, it is very important to assess their quality first. Thus, HEIA and FBACA, developed in the present study should be used to assess the diet quality as well as the quality of practices being followed by adolescents. This can be followed by targeting various strategies for improvement in the practices.

Section III Planning, Development and Implementation of the Nutrition Communication Program for Adolescents - Creating Healthy and Active Learning Kids (CHALK) Programme

Nutrition education has been defined as “any combination of educational strategies, accompanied by environmental supports, designed to facilitate voluntary adoption of food choices and other food and nutrition – related behaviours conducive to health and well- being; nutrition education is delivered through multiple venues and involves activities at the individual, community, and policy levels” (Contento IR, 2007).

Schools offer many opportunities to promote healthy dietary and physical activity patterns for children. The universality of school setting for gaining access to children makes it highly relevant to global efforts to combat the increasing public health problems of the double burden of malnutrition.

WHO Information Series on School Health (1998) also justifies the decision to support school based interventions among adolescents. Improving the nutritional status of school age children and adolescents is an effective investment for the future generation, as well as for combating the development of obesity and other nutrition related chronic diseases later. Nevertheless schools can be an important setting to address the problems of undernutrition and anaemia also.

School based nutrition education is particularly important because today’s children and adolescents frequently decide what to eat, with little adult supervision (WHO, 2000)

School systems, if wisely used, can become a valuable “second front” in the battle against ill health and under nutrition and could thus become a valuable adjunct to the conventional health care system (Gopalan, 1993).

Previous sections had shown the prevalence of dual burden of malnutrition among the study subjects and a closer look into the dietary practices revealed many flaws in practice. The mean nutrient intakes were quite low amongst the subjects. HEIA and FBACA evaluations (Phase II) show that most of the subjects needed improvements in their diets which can be effectively addressed by a well designed nutrition communication program for these subjects.

In all there were 478 subjects enrolled for Phase III. Based on their present knowledge, attitudes and practices related to healthy foods and healthy eating, dietary and physical activity practices, a nutrition communication programme (NCP)was developed to improve the practices of the subjects. The NCP was termed the CHALK program – Creating Healthy And Active Learning Kids.

Phase III covers the planning, development and implementation of the CHALK program aimed at bringing about improvements in dietary practices followed by the subjects.

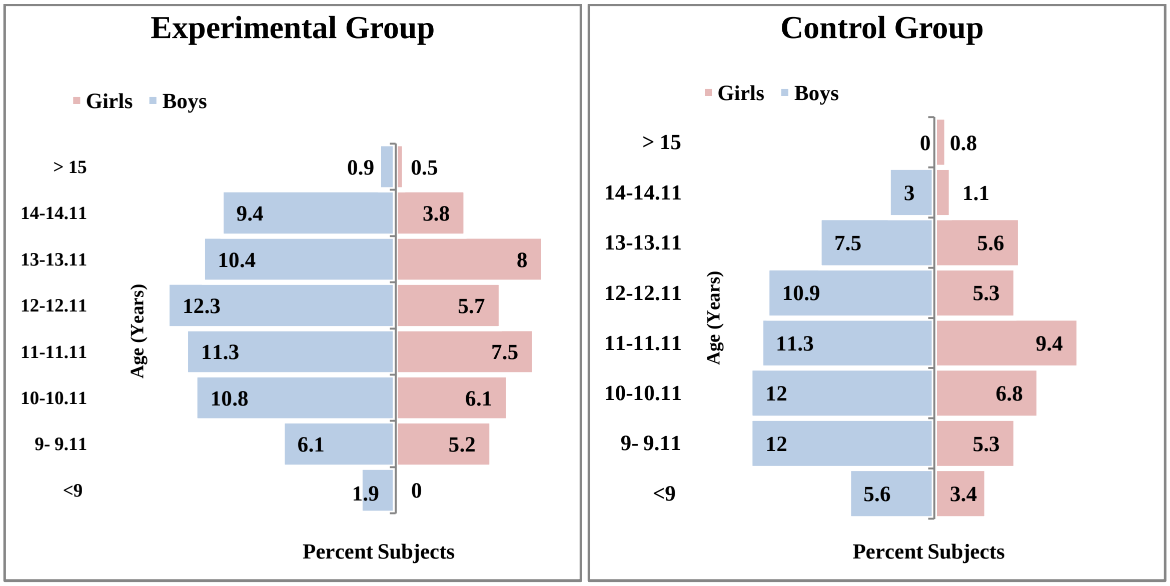
Formative Research for the development of CHALK Program

Subjects from two schools were allotted to the Experimental and Control group. Experimental group (EG) consisted of 212 subjects, comprising 134 boys and 78 girls while a total of 266 subjects constituted the Control Group with 166 boys and 100 girls. Figure 4.3.1 shows the age and sexwise distribution of the subjects in both the groups. Mean age of the subjects was 12.1 years and 11.3 years in the experimental and the control group respectively. Irrespective of the sex, most of the subjects were between the age group of 10-14 years.

Assessment of the knowledge levels regarding healthy eating and physical activity practices, followed dietary practices and food and nutrient intakes of the subjects

An evaluation of the knowledge levels regarding dietary practices and physical activity was carried out. In addition an assessment of the dietary and physical activity practices of the subjects was done. Table 4.3.1 shows the knowledge levels of the study subjects. Overall, subjects in the experimental group had a higher knowledge level regarding various aspects of healthy eating as compared to the control group.

Figure 4.3. 1: Age and Sexwise Distribution of the Study Subjects



On the other hand, the subjects in the control group had significantly higher knowledge as compared to the experimental group regarding the requirements for healthy growth and development. More than half (57%) of the subjects in the control group and half (49%) of the experimental group subjects considered breakfast as a very important meal of the day, this again was a significant difference among the groups. Knowledge regarding functions of food, food groups, benefits of eating fruits / vegetables and appropriate weight was significantly higher in the experimental subjects, yet the number of correct responses was very low. This indicates lack of knowledge amongst most of the subjects in both the groups.

A significantly higher number of subjects in the experimental group chose the most healthy choices out of the three options given, while, a significantly higher number of control group subjects reported soft drinks and fast foods to be unhealthy.

Majority of subjects in both the groups (>90%) stated, physical activity as very important for them. An overview suggested a very low knowledge level regarding healthy foods, healthy diet, food groups, food pyramid, number of complete meals, appropriate weight etc.

Assessment of the Dietary Practices followed by the study subjects in the two groups

A recall of the past seven days was taken for the subjects in order to assess their dietary and physical activity practices. Table 4.3.2 shows the dietary practices followed by the study subjects in the two groups.

Breakfast, mid-morning food and vegetable consumption

Assessment reveals that although a high number of subjects reported (EG 88% and CG 67%) of having breakfast daily, the food items consumed for breakfast were not satisfactory. Almost half of the subjects in both groups reported only milk consumption for breakfast. One fourth of them did report of consuming cereals along with milk for breakfast. Consumption of breakfast on all 7 days was significantly higher in the experimental group than the control group.

Another significant observation between the experimental and control group related to mid-morning food consumption in school revealed that a significant difference between the groups. This can be attributed to the fact that the control group had its own canteen facility while the experimental group school had no canteen facility; therefore, most of the subjects bought foods from the local vendor during the recess time. The local vendor sold vegetable puffs (a snack item) and muffins. Though the choices were few, yet around 30 % reported an irregular mid-morning food consumption indicating unhealthy eating practices in the experimental group.

Daily vegetable consumption was reported to be high in both the groups. However, consumption of green leafy vegetables and yellow or orange vegetables was very low on a daily basis.

Evening snacks and outside food consumption

Regular evening snack consumption was significantly higher in the control group. Consumption of unhealthy foods as evening snacks was higher in the experimental group. This difference was however insignificant between the groups. Around half of the subjects in both groups reported outside food consumption for < 2 days in the past week.

Assessment of the Daily Physical Activity Practices of the Study Subjects

Assessment of physical activity levels was carried out on the study subjects. Playtime was the total time in the past 24 hours spent on moderate and heavy activities (mainly games and sports).It included the playtime in school as well as at home. Leisure time was the total time spent on leisurely activities like watching TV, video and computer games, conversing on phone etc. Studytime was the total time spent on studies, apart from 5 hours of school time.

Table 4.4.3 shows the physical activity practices of the subjects. CDC (2008) recommends 60 minutes or more of physical activity daily including moderate and heavy activity for adolescents. National Sleep Foundation (2000) recommends a sleep time of 8.5 to 9.25 hours daily for adolescents. Leisure time (mostly screen time) should be restricted to <2 hours / day (Misra et al, 2009). Together the above activities and 5 hours of school time account for 16.5 to 17.25 hours per day. Thus, a study time of 3 hours or less (apart from the school time) was considered suitable for the subjects.

Playtime was significantly higher in the control group with about 66% subjects in the control group spending 60 minutes or more per day on playtime as against only 57% subjects in the experimental group.

Table 4.3. 1 Assessment of the Knowledge Level of the Study Subjects in the two groups

Message content	Percent Response (%)		Chi Square
	EG	CG	
Awareness about	**(N=212)**	**(N=266)**	**A v/s C**
Growth and development	10.4 (22)	18.8 (50)	6.54**
Healthy food	8 (17)	6.4 (17)	0.47
Healthy eating behaviours	4.2 (9)	3.8 (10)	0.07
Functions of food	15.6 (33)	0.8 (2)	38.15***
Food groups	1.9 (4)	0 (0)	5.06*
Concept of complete meals	7.5 (16)	9.4 (25)	0.52
Importance of breakfast	48.6 (103)	57.9 (154)	4.11*
Constituents of a healthy breakfast	12.7 (27)	10.9 (29)	0.38
Benefits of eating fruits and vegetables	4.7 (10)	0.8 (2)	7.58***
Healthy Food choices			
• Group A	49.1 (104)	25.2 (67)	29.25***
• Group B	42.5 (90)	16.5 (44)	39.26***
• Group C	57.1 (121)	36.8 (98)	19.46***
Food Pyramid	0.5 (1)	0 (0)	1.26
Soft drinks – Bad for Health	74.1 (157)	86.8 (231)	12.62***
Fast foods- Bad for Health	73.6 (156)	83.8 (223)	7.55**
Physical activity importance	94.3 (200)	91.7 (244)	1.22
Minimum level of physical activity	39.2(83)	35 (93)	0.89
Prolonged TV viewing affects Growth and Development	58.9 (126)	47.4 (126)	6.89**
Physical education	67.9 (144)	54.9 (146)	8.4***
Appropriate weight	11.8 (25)	0.4(1)	29.9***

Table 4.3. 2: Assessment of the Dietary Practices followed by the subjects in the two groups for the past 7 days

Dietary Practices Followed (reported consumption)	Percent Response (%)		Chi Square
	EG (N=212)	CG (N=266)	
Breakfast			
• Daily consumption	88.2 (187)	66.9 (178)	29.62***
• Milk	46.2 (98)	44.4 (118)	0.17
• Milk and cereals	25.5 (54)	20.7 (55)	1.54
Mid Morning food			
• Daily consumption	68.4 (145)	56 (149)	7.64**
• Cereal and veg	62.7 (133)	46.2 (123)	12.91***
• Cereal, pulse and milk product	23.6 (50)	16.9 (45)	3.29
Vegetables			
• Daily consumption	87.7 (186)	82.3 (219)	2.66
• Green Leafy Vegetables	26.4 (56)	20.7 (55)	2.18
• Yellow and orange veg	15.6 (33)	13.9 (37)	0.26
Fruit	72.2 (153)	72.2 (192)	0
Evening Snack			
• Daily consumption	48.6 (103)	59.4 (158)	5.57*
• Namkeen and Farsan≤ 2 days	24.5 (52)	18 (48)	3
• Bakery items≤ 2 days	12.7 (27)	7.5 (20)	3.62
Outside Food (<2times per week)	48.1 (102)	50.4 (134)	0.24
Water Intake (>7 glasses/ day)	73.6 (156)	82 (218)	4.86*

Table 4.3. 3:Assessment of the Physical Activity Practices followed by the subjects in the two groups daily

Practices Followed	Percent Response (%)		Chi Square
Physical Activity Practices (Reported/ Day)	**EG (N=212)**	**CG (N=266)**	
Playtime in school and home (≥ 60 minutes)	57.1 (121)	65.8 (175)	3.8*
Leisure time (<120 minutes)	90.6 (192)	89.5 (238)	0.16
Studytime* (≤ 180 minutes)	45.8 (97)	45.9 (122)	0

*Studytime excluding school time

More than half of the subjects in both the groups were spending > 180 minutes a day on studies. This accounts for more than 8 hours as study time including the school time. Almost all the subjects (90%) spent < 2 hours on leisurely activities. Thus, this indicates a need to increase awareness amongst these children regarding required levels of physical activities for them as well as the benefits of the same.

Assessment of the Self-Perception of the study subjects in the two groups

Self-perception of the subjects was assessed by showing them a picture of 3 figures. The three figures were of an ectomorphic (Tall and thin type), a mesomorphic (well-built bone structure and well defined muscles type) and an endomorphic (large with round and soft body type) body structure. Table 4.3.4 shows more than half (61%) of the experimental group subjects and about one – third (36%) of the control group subjects believed themselves to be ectomorphs. Of these half of the subjects in the experimental group were actually underweight while, the remaining were normal. None of the subjects in the control group who perceived themselves as ectomorphic were actually underweight. On the other hand 45% percent of them were either overweight or obese. One-fourth of the subjects in the experimental group who considered themselves mesomorphic were underweight. However, almost the same percentage of subjects in the control group was overweight or obese. Around 7% and 9% of the subjects considered themselves as endomorphs in the experimental and control group respectively. Of these 29% in the experimental group were underweight while 13% of the subjects in the control group were overweight.

Overall, 72% and 38% of the subjects had incorrect self-perception, in relation to their BMI for age z scores, in the experimental and control group respectively.

Assessment of the Food and Nutrient intakes of the subjects in the Experimental and Control Group

Dietary intake analysis was carried out on all the subjects using a 24 hour recall method for 3 consecutive days and also through food frequency questionnaire of commonly consumed healthy and unhealthy foods.

Table 4.3.4: Assessment of the Self Perception of the Study Subjects in the two groups

BMI for Age Zscore	Self-Perception % (n)					
	Ectomorphic		Mesomorphic		Endomorphic	
	EG (N=212)	CG (N=266)	EG (N= 212)	CG (N=266)	EG (N= 212)	CG (N=266)
<-3	5 (6)	0 (0)	6(5)	0(0)	14.3 (1)	0(0)
<-2 to -3	12.4 (15)	0(0)	20.2 (17)	0(0)	14.3(1)	0(0)
-2 to <-1	32.2 (39)	0(0)	73.8 (62)	0(0)	71.4 (5)	0(0)
-1 to <1	50.4 (61)	54.7 (52)	0 (0)	75.5 (111)	0(0)	87.5 (21)
1 to <2	0(0)	33.7 (32)	0(0)	20.4 (30)	0(0)	12.5 (3)
>2	0(0)	11.6 (11)	0(0)	4.1 (6)	0(0)	0 (0)
Total	57.1(121)	35.7 (95)	39.6(84)	55.3 (147)	7(3.3)	9 (24)

Mean intakes of food groups by the subjects in the two groups

Table 4.3.5 shows mean intakes of the food groups of the subjects in the two groups. Mean intakes of fruits was very low in both the groups which can be attributed to the low knowledge level of the subjects regarding benefits of eating fruits and vegetables. Mean intakes of vegetables, fruits and fat in the control group was lower than the experimental group. However, there was no significant difference observed in the mean intakes of food groups in the two groups.

Mean nutrient intakes of the subjects in experimental and control group

Mean nutrient intakes of the subjects were calculated over a period of 3 consecutive days. The intakes presented in Table 4.3.6 are the means derived for various nutrients from their 3 day intakes. Mean intakes for energy, protein and iron were higher in the control group while mean intakes for fat and calcium was higher in the experimental group. This could be attributed to a slightly higher intake of milk in the experimental group. However, there was no significant difference observed in the mean nutrient intakes of the subjects in both the groups.

Frequency of consumption of various healthy and unhealthy foods

Food frequency data revealed that consumption of pulses or legumes on a daily basis was reported by around 65% subjects in both the groups. Approximately 85% subjects reported consumption of milk daily although as observed by the mean food group intakes it was less than 40% of the recommended amount. Consumption of green leafy vegetables on a daily basis was reported by about 50% of the subjects. There was a significant difference observed in the consumption of fruits between the experimental and control group subjects. This can be related to the knowledge levels of these subjects where a significant difference was observed in the knowledge regarding benefits of eating fruits and vegetables (Table 4.3.7).

Another important observation was in relation to the consumption of soft drinks. It was observed that the consumption of aerated drinks was significantly higher in the control group (7.9%) as against 2.4% in the experimental group, even though there was a significantly higher number of subjects in the control group who reported soft drinks as bad for health (Refer assessment of knowledge in this chapter previously). The main reason for this can be the canteen facility which was available in the control group. This is also a reason for a higher consumption of fried foods in the control group. However, the difference foundbetween the control group and experimental group was insignificant.

Around half of the subjects made healthy food choices in the experimental group, while the subjects in the control group had significantly poor food choices when asked to select foods from different groups (shown previously in the knowledge part of this section).This was reflected in the high consumption of various accessories like jams, murabbas, chutneys, pickles, papad etc. along with food in the control group.

The presence of the canteen facility and poor food choices would have been responsible for the significantly high consumption of sweets, chocolates, candies etc.

Selection of key messages and development of the CHALK Programme

The key messages selected for the development of the nutrition communication program (CHALK Programme) are shown below. It included the topics about which the subjects had less information and to target towards healthy eating and physical activity. The content was decided on the basis of their previous knowledge as well as the requirements.

Key concepts for Nutrition Communication

- Correct concept of Growth and Development of Adolescents
- Healthy food (Balanced diet) and Healthy Eating Behaviours
- Functions of foods and various food groups
- Meal Patterns and Breakfast consumption
- Dietary guidelines and Food Pyramid
- Healthy food choices (outside as well as at home)
- Fruit consumption
- Fast foods and soft drinks consumption
- Physical Activity
- Appropriate weight
- Self-perception

Based on the above key concepts a nutrition communication strategy was developed as shown in the Table (4.3.8).

Table 4.3. 5: Mean Intake of Food Groups of the study subjects in the two groups

Food Groups	Mean Food group intake (Mean ± SD)		't' value
	EG (N=212)	CG (N=266)	
Total Grains	193.65± 39.62	196.79±44.44	0.87
Pulses/ legumes	38.68±18.41	38.35±19.4	0.34
Vegetables	185.05±100.29	175.87±82.26	1.12
Fruits	19.28±39.86	13.87±44.77	1.08
Milk	189.64± 10.66	189.19±103.51	0.09
Edible Oil	23.08± 7.01	22.2±5.39	1.25
Sugar	11.71± 5.58	11.95±5.64	0.44

Table 4.3. 6: Mean Nutrient Intake of the study subjects in the two groups

Nutrients	Mean Intake		't' Value
	EG (N=212)	CG (N=266)	
Energy(Kcal)	1473.27±326.14	1480.48±312.41	0.30
Protein (g)	43.07±11.14	43.87± 12.62	0.42
Fat (g)	47.66±16.92	47.05±14.86	0.33
Calcium(mg)	390.96±126.02	385.96±124.17	0.82
Iron (mg)	10.68±2.48	10.71±2.59	0.39

Table 4.3. 7: Assessment of Frequency of consumption of healthy and unhealthy foods (Daily) in the study subjects

Food items	EG (N=212)	CG (N=266)	Chi square
Pulses	67.5 (143)	65 (173)	0.31
Milk	87.7 (186)	83.8 (223)	1.45
Eggs	3.3 (7)	4.1 (11)	0.23
Green Leafy Vegetables	53.8 (114)	46.6 (124)	2.42
Yellow and orange Vegetables	15.1 (32)	13.9 (37)	0.13
Other Vegetables	52.8 (112)	48.9 (130)	0.74
Roots and tubers	45.3 (96)	44.7 (119)	0.01
Fruits	64.6 (137)	42.9 (114)	22.41***
Butter	15.6 (33)	18 (48)	0.52
Ghee	55.7 (118)	56.8 (151)	0.06
Fried Food	13.2(28)	18.8 (50)	2.7
Baked Food	48.1 (102)	47 (125)	0.06
Fast Food	8 (17)	7.1 (19)	0.13
Accessories	37.3 (79)	63.9 (170)	33.56***
Fresh Fruit Juice	19.3 (41)	24.4 (65)	1.78
Tinned Fruit Juice	6.1(13)	9 (24)	1.38
Aerated Soft Drinks	2.4 (5)	7.9 (21)	7.03**
Non Aerated soft Drinks	3.8 (8)	4.9 (13)	0.35
Sweets, Chocolate, Candies and Ice creams	23.6 (50)	46.6 (124)	27.03***

**** significant at p<0.01   *** significant at p<0.001**

Table 4.3. 8: Nutrition Communication Strategy for the CHALK Program

Concept	Content	Approach	Visual aids used
Growth and development	• Adolescence • Stages of Adolescence • Effect of adolescence on these children • Growth and development during adolescence • Importance of nutrition	• Group discussion • Audio visual aids	• Poster • PowerPoint presentation
Healthy Foods and Healthy eating behaviours	• Balanced diet • Hygienic habits • Eating Habits Habits related to environment while eating	• Group discussion • Audio visual aids • Games	• Poster • PowerPoint presentation • Puzzles • Video Clip
Functions of foods and various foods groups	• Energy giving foods • Body building foods • Protection from diseases • Food groups	• Group discussion Audio Visual aids	• Poster • PowerPoint presentation Comic
Meal Pattern and breakfast consumption	• Concept of 4-6 meals a day • Importance of daily breakfast • Kind of breakfast • Requirements of a healthy breakfast	• Group discussion • Audio Visual aids	• Poster • PowerPoint presentation • Puzzle
Dietary guidelines and food pyramid	• Dietary guidelines • Food Pyramid	• Group discussion • Audio Visual aids	• Poster • PowerPoint presentation
Healthy Food choices	• Healthy snacking options • Healthy choices from the food groups • Healthy change	• Group discussion • Audio Visual aids • Involvement of mothers (Passive)	• Poster • PowerPoint presentation • Comic
Fruit and vegetable Consumption	• Advantages and amount required daily	• Group discussion • Audio Visual aids	• PowerPoint presentation

Table 4.3. 9: Nutrition Communication Strategy for the CHALK Program (contd.)

Concept	Content	Approach	Visual aids used
Fast foods and soft drinks consumption	• Examples • Health implications	• Group discussion • Audio Visual aids	• Poster • PowerPoint presentation
Physical activity	• Types • Duration required • Health advantages • Physical activity pyramid • Disadvantages of sedentary activities	• Group discussion • Audio Visual aids	• Poster • PowerPoint presentation
Appropriate weight	• Definition • Importance • Concept of BMI • How to attain appropriate weight	• Group discussion • Audio Visual aids	• PowerPoint presentation
Self-Perception	• Body Types • How it affects health	• Group discussion	• PowerPoint presentation

Implementation of the CHALK program strategy in the school

In all 7 sessions were conducted covering all the concepts for the subjects in the experimental group, while the control group received no intervention. The sessions were conducted on a weekly basis for boys and girls separately over a period of 3- 4 months. Various communication methods like PowerPoint presentations, posters, puzzles and video clips were used to impart the information. Each session was planned for 45 minutes. These were followed by reinforcement sessions, which were conducted fortnightly for a period of 2 months. These reinforcement sessions were mainly a recap of the above mentioned sessions along with questions answer session. The total time for the implementation of CHALK program was six months. Average attendance for each session was 12 – 16 girls and 25-28 boys. The teachers, although not a part of the intervention, were requested to attend the sessions as it gave them a better understanding of adolescence.

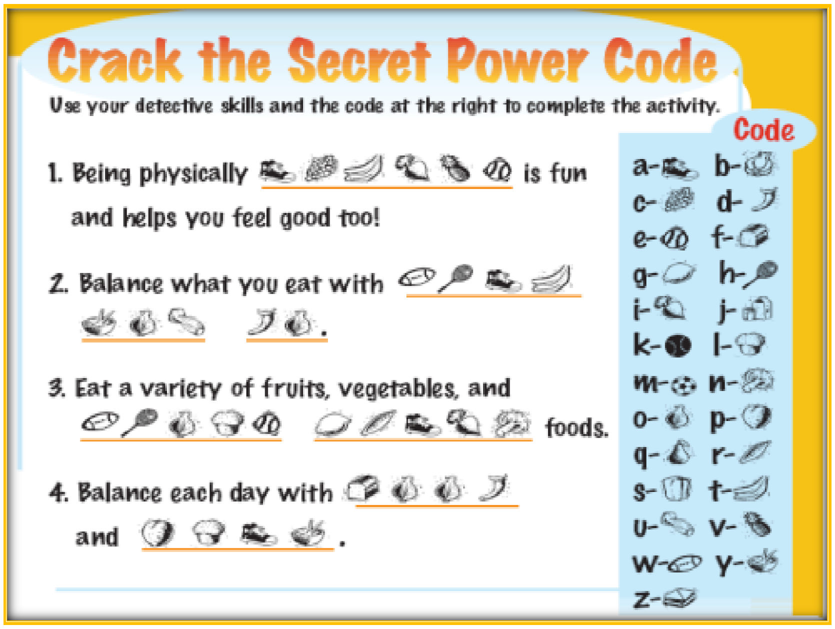
The detailed description of each session is shown below:

Session 1

- Information regarding adolescence, various stages of adolescence, how adolescence affects these children
- They were asked as to what do they think is important for growth and development
- Reasons were given to them as to why nutrition is important for them.
- What are healthy foods?

Session 2

- Small puzzle given to find out simple phrases like -
    - ✓ Being physically active is fun and helps you feel good too.
    - ✓ Balance what you eat with what you do.
    - ✓ Eat a variety of fruit, vegetables and whole grain foods.
    - ✓ Balance each day with food and play.



- Healthy Eating Habits
    - ✓ Hygienic habits
    - ✓ Eating habits
    - ✓ Habits related to environment while eating
- Video related to proper hand washing method was shown

Session 3

- Comic on transformation in dietary habits and consequences was shown to the subjects

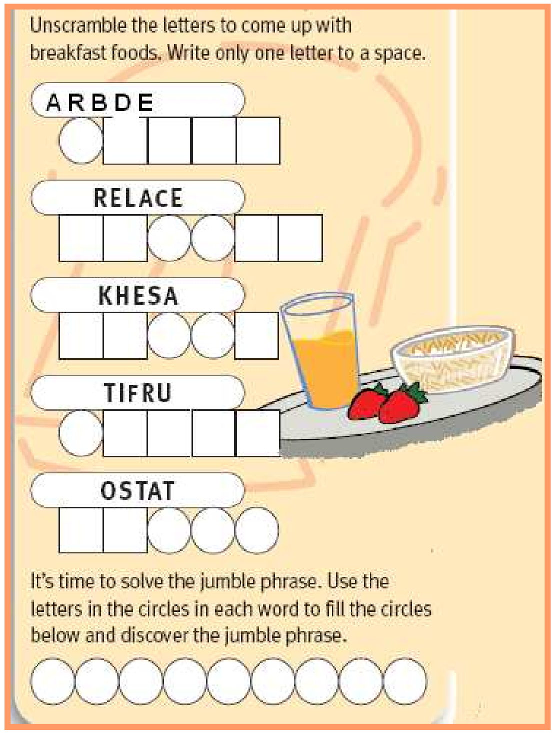
- Functions of food were explained to the subjects along with the examples of various foods
  - ✓ To provide energy to the body for sustenance, work & other activities.
  - ✓ To provide foods for building, maintenance & repair of body.
  - ✓ To protect us from various diseases.

Session 4

- Knowledge about the various food groups was dispersed
  - ✓ Cereals Grains and products
  - ✓ Pulses and legumes
  - ✓ Milk and Milk Products
  - ✓ Vegetables and fruits
  - ✓ Fats and Sugars
  - ✓ Meat and products
  - ✓ Nuts and oilseeds
- Subjects were asked to name any three foods which they thought helped them to grow well. Responses were noted down.
- Food Pyramid was introduced to the subjects

Session 5

- Concept of at least 4-6 meals per day was told.
- Importance of having breakfast daily, kind of breakfast to be consumed and the requirements of a healthy breakfast were discussed.
- Puzzle showing common breakfast items.



- Fast foods and its implications on health were explained to the students
- Problems arising due to consumption of aerated soft drinks were discussed.
- Healthy snacking options were given to the children.
- Subjects were asked to get one healthy recipe for breakfast or evening snack from their mothers and discuss in the next session

Session 6

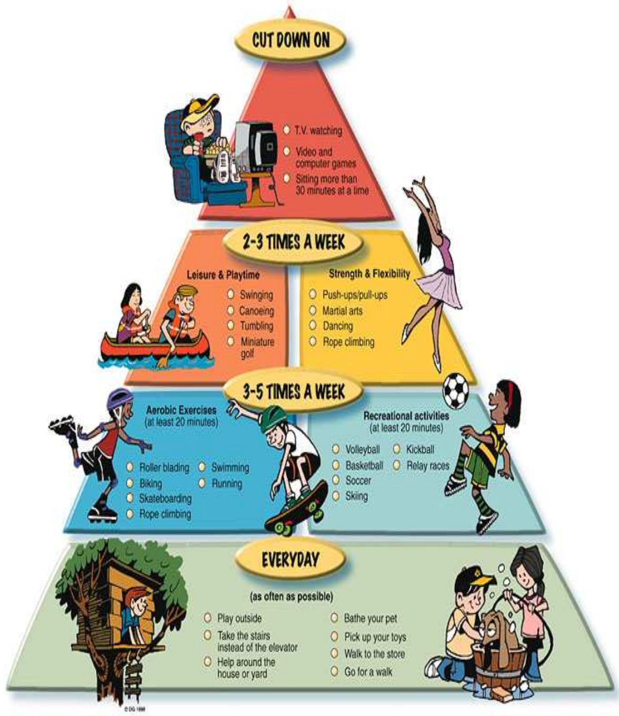
- Healthy recipes and their advantages were discussed in the class.
- Comic on why a healthy change is good was shown to children.

- Physical activity – types, duration, ways and its health advantages were discussed.

Session 7

- Concept of healthy physical activities was further strengthened using a physical activity pyramid.
- Disadvantages of sedentary activities like video games, computer games and television watching were discussed.

At the end of the intervention programme, impact of the CHALK programme on the knowledge and dietary practices of the subjects was carried out. The next section presents the Phase IV of the study - Impact evaluation of the CHALK program.



Discussion

Understanding the perceived needs and barriers to healthy dietary behaviour contribute to develop appropriate educational programmes for the community (Nicklas et al, 1997).

Studies show that even though the knowledge of adolescents regarding healthy eating habits and consumption of fruits and vegetables is low, their attitude towards learning about healthier eating practices is favourable (Reynolds et al , 1999; Beech rice, Meyers, Johnson and Nicklas, 1999)

Interventions that cover nutrition, physical activity and overall health education have the potential to improve lifestyle habits and influence the future health of adolescents despite the method of delivery (ADA, 2000).

School settings provide the most effective platform for nutrition education as the school children serve as change agents by spreading the messages to a large segment of population (Lionis et al, 1991).

A meta-analysis revealed that school- based interventions can improve dietary and physical activity behaviour in low and middle income countries and that 8 out of 12 interventions had a statistically significant effect on BMI (Verstraeten, 2012).

Section IV: Assessing the Impact of Nutrition Communication Programme (CHALK Programme) on the Dietary Practices of the Subjects

As can be observed, from the previous sections that the level of knowledge regarding healthy food and healthy eating practices was low among the subjects. A Nutrition Communication Programme, the CHALK program, was developed, to impart nutrition education to these subjects in order to improve their dietary practices, as discussed in Phase III. The Major objective of Phase IV was to assess the impact of the CHALK Programme on the dietary practices of the subjects. To assess the impact of the nutrition communication program, data was obtained on knowledge, attitudes and practices regarding healthy eating and physical activity; dietary and physical activity practices for past 7 days; food and nutrient intakes and frequency of consumption of healthy and unhealthy foods. This section deals with the findings of Phase IV. Key findings of Phase III are shown below:

Understanding the perceptions of the subjects regarding health, healthy food, healthy eating habits, meal patterns and physical activity

Formative research was carried out to understand the perceptions of the subjects regarding healthy food, healthy eating habits, meal consumption pattern, breakfast consumption, food pyramid, physical activity etc. A pre tested semi- structured questionnaire was used and the data was collected by interview method.

Concept of growth and development, healthy food and healthy eating behaviours

One-third subjects perceived either diet alone or any specific food item was required for their healthy growth and development. Healthy food for most of them was some specific food item. Majority of the responses for heathy eating behaviours were either hygiene related or eating related. According to them their mothers mostly instructed them to eat with a spoon or wash their hand before eating.

Concept regarding functions of food, food groups, meal patterns and breakfast

Majority of the subjects were unable to answer correctly about the functions of food and names of different food groups. Slightly more than half of the subjects believed breakfast to be a very important meal and a majority of them perceived cereals and milk as the ‘Best breakfast’.

Concept of benefits of fruit and vegetable consumption, healthy food choices and food pyramid

Majority subjects could not correctly answer about the functions of food. Subjects did not have a correct idea of the amount of fruits needed by them. Knowledge regarding healthy food choices was mediocre and needed an improvement. Most of the subjects did not know about the food pyramid.

Concept of fast foods and soft drinks etc.

Most of the subjects reported of no health benefits of soft drinks and a majority did not know about the ill effects it had on their health. A similar finding was observed in the case of fast food consumption where most of the subjects did not know about its ill effects on health.

Concept of physical activity and T.V. viewing

Although most of the subjects believed that being physically active was important for them, a large number were unaware of the duration and type of physical activity required by them. Almost half of them felt that prolonged T.V. viewing did not affect their growth and development. Nearly half of the subjects reported to being taught about physical activity at the most twice during the last year.

Concept of physical education and appropriate weight

Majority of the subjects felt that physical education is fitness or exercise as they were made to exercise during PE class. Most of the subjects could not define appropriate weight. Most of them reported their own weight as appropriate weight for them, and half of them felt that having appropriate weight was important for them.

Self- Perception

One - fifth of the subjects who were overweight believed themselves to be underweight and vice versa. One-third of thin subjects perceived themselves as a normal healthy person and less than one-fifth of the overweight or obese subjects called themselves healthy and normal weight.

Behaviour related to healthy eating, meals and meal pattern

Almost all the subjects reported consuming breakfast, while only half of them regularly. Cereals and milk were the most common choices. Still a very high percentage of subjects consumed bakery foods for breakfast and as evening snacks. Half of the subjects consumed bakery items after reaching home and before lunch. As seen in the dietary intake section, milk intake was low in these children. The mean intake for milk was found to be around 190 ml/ day which is very as compared to the recommended amounts of 500ml / day for adolescents.

Behaviour related to fruit and vegetable consumption, healthy choices and water intake.

Most of the subjects, reported to have fruits but there were very few who reported consuming it on a regular basis. This irregularity is further proved by the fact that mean fruit intake amongst the subjects was very low (16 gm daily against the requirement of 100gm/ day). One third of the subjects had water consumption of 6 glasses or less.

Behaviour related to soft drinks, fast foods and outside food consumption

Most of the subjects ate out with family or friends weekly. Majority of them made unhealthy choices while eating out. Half of the subjects, who got pocket money, spent it on buying baked items (mostly vegetable puffs).

Behaviour related to physical activity

Although half of the subjects reported of moderate to rigorous activity for one hour or more, on taking a recall it was found that a little lesser than one fifth of the subjects actually did it the previous day. Most of them were not aware of the amount of physical activity needed by them.

Behaviour related to self perception

Although the behaviours consequent to self perception have not been analysed but some of the common comments are discussed here. Older girls even though underweight believed that they needed to reduce their belly size, the comments related were*"mera waist size bahutzyadahai" / "Zero size waist honichahiye"* (my waistline is very high / my waist should be zero size) etc.

Most boys most of the time were worried about their height and not weight like the girls. A common excuse given by some of the subjects for not consuming breakfast was *"Aise hi mote hain, hum aur mote (fat) ho jaayenge agar roz breakfast karenge"*. (As such we are fat if we consume breakfast we will be fatter).

Girls were also concerned about their looks especially skin and hair.

Understanding the dietary and physical activity practices followed by the subjects

Past seven day recall was taken to assess the dietary and physical activity practices of the subjects. It was observed that although most of the subjects consumed breakfast on all 7 days, a majority of them took only milk for breakfast. Vegetable consumption on a daily basis was reported by almost all the subjects. Regular consumption of green leafy and yellow, orange vegetable was very low.

Fruit consumption on a regular basis was very low amongst the subjects. Around half of the subjects consumed evening snacks on all 7 days. Namkeen and farsan (deep fried dry salted snacks) were consumed by around one third of the subjects. One-third of the subjects consumed bakery items (mainly biscuits and vegetable puffs) as snacks.

Three –fourths of the subjects reported consumption of outside food with family and friends for less than or equal to 2 days in a week. Around half of the subjects carried their tiffins with them on all the 7 days. Some of the subjects reported a very low water intake i.e. less than 3 glasses a day.

One fourth of the subjects had a physical activity level of less than an hour. Leisurely activities like TV watching, computer or video games and conversing on phone were limited to less than 2 hours for these children, for the reason that they did not have enough time left after school and tuitions. One third of the children spent 5 hours daily for studies apart from 5 hours of school time.

Thus, the overall scenario reflects the need of a focused nutrition communication programme in order to bring about the positive change required in the dietary and physical activity practices of the subjects. For this purpose the CHALK programme which was developed in the Phase III of the study, was imparted to the experimental subjects for a period of 5-6 months. The CHALK programme was designed keeping in mind the existing knowledge, attitudes and behaviours of the subjects regarding healthy food, healthy eating and physical activity.

Assessing the Impact of Nutrition Communication Programme (CHALK Programme) on the Knowledge levels, Dietary and Physical Activity Practices of the Subjects – Post Intervention

At the end of the intervention, data was obtained on the same parameters as used before the intervention. Data was collected for the knowledge, attitudes and practices of the subjects, dietary and physical activity practices followed (past 7 days), food and nutrient intakes of all the subjects. Some subjects dropped out of the study due to transfer of their parents, accident or death. At the end of the intervention the experimental group consisted of 191 subjects while there were 245 subjects in the control group. There were 121 boys and 70 girls in the experimental group while the control group consisted of 154 boys and 91 girls. Hence, the analysis for assessing the impact of the nutrition communication program has been limited only to the subjects in the 2 groups who completed the study, 191 in experimental group and 245 in control group.

Impact of the CHALK Programme on Knowledge Levels of the study subjects– Post Intervention

As discussed previously the responses of the subjects were taken to assess their knowledge levels regarding healthy eating and dietary practices. Table 4.4.1 shows the knowledge levels of the two groups before and after the intervention.

An overview of the knowledge levels shows that the subjects in the experimental group had significantly higher knowledge than the control group, before the intervention, regarding functions of foods, food groups, constituents of healthy breakfast, benefits of eating fruits and vegetables, healthy food choices, effect of TV viewing on growth and development, physical education and meaning of appropriate weight. The control group had significantly higher knowledge regarding the requirement of a healthy growth and development, importance of breakfast, unhealthy foods like soft drinks and fast foods before the intervention period.

Impact on Knowledge regarding Growth and Development, Healthy Foods and Healthy Eating Behaviours

Table 4.4.1 shows the impact of CHALK Programme on the knowledge levels of the subjects. There was a significant increase in the subjects understanding of what was important for their growth and development in the experimental group (10% to 39%). Control group (17%) which had a significantly higher understanding, regarding the requirements for healthy growth and development, than the experimental group (10%) initially, showed a slight increase. However, the experimental group was significantly higher, in knowledge regarding the requirement of diet and exercise together for healthy growth and development, than the control group after the intervention (39% v/s 19%).

No significant difference was observed between the two groups regarding healthy food before the intervention (EG 8.4% and CG 4.5%) while a significant improvement in the experimental group was seen after the intervention (EG 58% and CG 6%). Experimental and control group were almost similar in correct responses regarding healthy eating behaviours prior to the intervention (EG 43% and CG 4.5 %), while after intervention experimental group showed a tenfold rise (4.3% to 44%) in the correct responses and the control group gave the same number of correct responses. The experimental group was significantly higher than the control group regarding the knowledge of healthy eating behaviours after the intervention.

Impact on Knowledge regarding Food Groups, Number of Complete Meals and Breakfast Consumption

Merely 2% subjects, in the experimental group, could correctly state the different food groups before the CHALK programme while 31% subjects gave correct response for the same after the CHALK programme. This difference was found to be significant in the experimental group. However, in the control group no subject gave a correct response regarding the food groups before and after the intervention period (Table 4.4.1).

More than one-fourth (25.7%) of the experimental group subjects, after the intervention, knew that they were supposed to have 5-6 complete meals daily, as against only 7% of the subjects initially. This difference, before and after the intervention, in the experimental group was found to be significant while in the control group the percent response (Pre CG 9.4% and Post CG 9.8%) was almost the same regarding number of complete meals before and after the intervention. Before intervention there was no significant difference between the two groups regarding the concept of complete meals, while after the intervention the experimental group had significantly higher percentage of correct responses as compared to the control group (EG 26% v/s CG 10%).

The number of subjects reporting breakfast as a very important meal significantly rose from around 50% to 70 % in the experimental group post intervention. Although there was an increase in the knowledge regarding constituents of a healthy breakfast after the intervention, in the experimental group subjects, but the difference was found to be non significant. However, on comparison with the control group, knowledge regarding constituents of a healthy breakfast, experimental group was significantly better after the intervention.

Impact on Knowledge regarding Healthy Food Choices, Food Pyramid and Appropriate Weight

There was no significant difference observed in terms of healthy food choices in the experimental group. Subjects did show improvement in their choices of healthier foods if not healthiest foods. A significant finding in experimental group subjects with regard to the above statement was seen in Group B, where 38% and 19% subjects chose chips and plain biscuits respectively prior to the intervention while post intervention it was found to be 26% and 40% respectively (plain biscuits being healthier as compared to chips). However, in the control group there was no significant difference between the food choices made before and after the intervention period (Table 4.4.1).

No difference was seen in the two groups in terms of correct response regarding food pyramid after the intervention. However, the number of partially correct responses related to food pyramid were significantly higher in the experimental group after the intervention (3.7% EG and 0.8% CG; $p<0.05$).

Another significant finding among the experimental subjects was regarding appropriate weight. Most of the subjects (11%) before intervention believed that the appropriate weight for them was their own weight, while after intervention a significant three fold rise was observed in the number of subjects (31%) stating that appropriate weight is the weight according to age and sex. There was no change in the knowledge of control group regarding appropriate weight before and after the intervention period.

Table 4.4.1: Impact of the CHALK Programme on the Knowledge Level of the Subjects – Post Intervention

Message content	Percent Response [%(n)]				Chi Square			
	EG (Pre) A	EG(Post) B	CG (Pre) C	CG (Post) D				
Awareness about	**(N=191)**	**(N=191)**	**(N=245)**	**(N= 245)**	**A v/s C**	**A v/s B**	**C v/s D**	**B v/s D**
Growth and development	9.9 (19)	38.7 (74)	16.7 (41)	19.2 (47)	4.17*	42.99***	0.5	20.48***
Healthy food	8.4 (16)	58.1 (111)	4.5 (11)	6.1 (15)	2.79	106.46***	0.65	141.2***
Healthy eating behaviours	4.3(8)	44 (84)	4.5 (11)	4.5 (11)	0.02	82.7***	0.0	98.21***
Functions of food	15.7 (30)	20.4 (39)	0.8 (2)	0.8 (2)	34.99***	1.43	0.0	48.41***
Food groups	2.1 (4)	31.4 (60)	0 (0)	0 (0)	5.18*	58.86***	0	89.24***
Concept of complete meals	6.8 (13)	25.7 (49)	9.4 (23)	9.8 (24)	0.94	24.95***	0.02	19.36***
Importance of breakfast	46.6 (89)	68.6 (131)	58.4 (143)	60 (147)	5.97*	18.91***	0.14	3.42
Constituents of a healthy Breakfast	15.2 (29)	16.7 (32)	8.6 (21)	6.5 (16)	4.62*	0.18	0.73	11.45***
Benefits of eating fruits and vegetables	4.7 (9)	5.7 (11)	0.8 (2)	0.8 (2)	6.62 **	0.21	0.00	9.06***
Healthy Food choices								
• Group A	42.9 (82)	50.8 (97)	29 (71)	26.1 (64)	9.17***	2.37	0.5	28.03***
• Group B	31.9 (61)	33.5 (64)	19.6 (48)	16.7 (41)	8.72***	0.11	0.67	16.52***
• Group C	57.1(109)	63.4(121)	36.3 (89)	37.6 (92)	18.63***	0.08	0.03	28.59***
Food Pyramid	0(0)	0 (0)	0 (0)	0 (0)	-	-	-	-
Soft drinks – Bad for Health	73.8 (141)	80.1 (153)	88.2 (216)	86.5 (212)	14.88***	2.13	0.3	3.25
Fast foods – Bad for Health	74.3 (142)	73.8 (141)	85.3 (209)	83.7 (205)	8.22* **	0.01	0.25	6.36*
Physical activity importance	94.2 (180)	95.3 (182)	90.6 (222)	91.4 (224)	1.94	0.21	0.1	2.5
Minimum level of physical activity	30.9 (59)	34.5 (66)	32.2 (79)	34.3 (84)	0.09	0.58	0.23	0.0
Prolonged TV viewing affects Growth and Development	58.1 (111)	60.7 (116)	43.3 (106)	47.3 (116)	9.47***	0.27	0.82	7.72**
Physical education	68.6 (131)	77.5 (148)	55.5 (136)	54.7 (134)	7.73**	3.84*	0.03	24.41***
Appropriate weight	11.5 (22)	31.4 (60)	0.4 (1)	0.4 (1)	26.51***	22.42 ***	0	85.74***

*significant at p<0.05 **significant at p<0.01 ***significant at p<0.005

Impact of the *CHALK* Programme on the Dietary Practices of the Subjects – Post Intervention

A past seven day recall was obtained for the dietary practices mentioned in Table 4.4.9.Daily breakfast consumption showed a rise of 6% among the experimental group subjects. Daily consumption of only milk decreased while subjects consuming a combination of milk and cereals increased significantly in the experimental group. In the control group there was no significant difference observed related to breakfast consumption before and after the intervention.

The experimental group showed a significant rise in daily mid morning food consumption after the intervention. Despite the positive attitude of the teachers, (100% Teachers, Principals and PE Teachers responded to a cereal vegetable combination as the best food item for these children in the school, as discussed in Phase I) only 68% subjects in the experimental group and 56% subjects in the control group consumed mid morning food regularly. After the intervention a 10% increase was observed in the subjects who had ‘roti and sabji’ (a cereal vegetable combination) in the school. A significant rise was observed in the consumption of cereals and vegetables after the intervention. However, there was no significant change observed in the control group. Thus, this positive change in the dietary practice of the subjects can be attributed to the CHALK intervention.

Daily vegetable consumption improved significantly in the experimental group after the intervention and could be attributed to the increase in the consumption of a cereal vegetable combination for mid mornings, while there was no significant change in the control group. There was no significant difference observed in the consumption of green, yellow or orange vegetable consumption. A possibility could be an increase in either other vegetable intake or in the intake of roots and tubers (Table 4.4.2).

There was no significant change in both groups regarding fruit intake. However, there was an increase in the number of subjects consuming fruits daily in the experimental group after the nutrition communication programme.

There was no significant change in the consumption of evening snacks, outside food and water intake in both the groups before and after the intervention.

Table 4.4.2: Impact of the *CHALK* Programme on the Dietary Practices of the Subjects– Post Intervention

Practices Followed	Percent Response [%(n)]				Chi Square			
	EG (Pre) A	EG (Post) B	CG (Pre) C	CG(Post) D				
Dietary Practices (reported consumption)	**(N=191)**	**(N=191)**	**(N=266)**	**(N= 245)**	**A v/s C**	**A v/s B**	**C v/s D**	**B v/s D**
Breakfast								
• Daily consumption	89(170)	94.8 (181)	68.2 (167)	66.5(163)	26.56***	4.25*	0.15	51.39***
• Milk	46.1 (88)	36.6 (70)	42.9 (105)	44.5(109)	0.45	3.5	0.13	2.73
• Milk and cereals	24.6 (47)	34 (65)	20.4 (50)	20.4 (50)	1.09	4.09*	0	10.26***
Mid Morning food								
• Daily consumption	68.1(130)	77.5 (148)	55.5 (136)	57.1(140)	7.11**	4.28*	0.13	19.81***
• Cereal and veg	61.8(118)	72.3 (138)	46.1 (113)	45.7(112)	24.13***	4.74*	0.01	30.9***
• Cereal, pulse and milk product	23.6 (45)	20.4 (39)	15.9 (39)	17.6 (43)	6.95**	0.55	0.23	0.58
Vegetables								
• Daily consumption	86.9(166)	94.2 (180)	86.1 (211)	82.9(203)	0.06	6.01**	1.0	13.03***
• Green Leafy Vegetables	27.2 (52)	27.2 (52)	20 (49)	21.6(53)	43.54***	0	0.2	1.84
• Yellow and orange veg	16.2 (31)	16.2 (31)	12.7 (31)	13.5(33)	1.13	0	0.07	0..65
Fruit	72.3(138)	78 (149)	72.2 (177)	72.2(177)	0.0	1.7	0	1.89
Evening Snack								
• Daily consumption	47.6 (91)	50.3(96)	55.1(135)	57.6(141)	2.39	0.26	0.3	2.3
• Namkeen and Farsan≤ 2 days	19.9 (38)	23(44)	16.7 (41)	18 (44)	0.76	0.56	0.13	1.72
• Bakery items≤ 2 days	11 (21)	13.1 (25)	6.9 (17)	7.8 (19)	2.22	0.4	0.12	3.37
Outside Food (<2times per week)	52.3(100)	49.2 (94)	50.6 (124)	51.8(127)	0.13	0.38	0.07	0.3
Water Intake (>7 glasses/ day)	73.8(141)	76.5 (146)	81.2 (199)	81.2(199)	3.43	0.35	0	1.49

*significant at p<0.05 **significant at p<0.01 ***significant at p<0.005

Impact of the CHALK Programme on the Physical Activity Practices of the Subjects– Post Intervention

Table 4.4.3 shows the physical activity levels of the subjects and also the impact of the CHALK program on the level of physical activity performed by the subjects.

Playtime (>60 minutes / day) was significantly higher in the subjects of control group before intervention. However, after intervention there was no significant difference found between the playtime of the subjects in the two groups.

A very small positive change was observed in the physical activity levels though these changes were not significant among the subjects of the experimental group.

Leisuretime (< 120 minutes/ day) was found to be significantly higher among the subjects of the control group after the study period. However, this could be attributed to the scheduled tests at the time of data collection.

Impact of CHALK Programme on the Self-perception of the subjects in the two groups– Post Intervention

As discussed before, the subjects were shown three figures and were asked to tick on the one they felt was like them. Table 4.4.4 shows the findings before and after the intervention related to their self perception. Before intervention 50% of the subjects who were severely underweight (<-3SD) believed themselves to be either normal or overweight while after intervention all the subjects who were severely underweight could correctly categorize themselves in the ectomorphic category. Half of normal subjects (BAZ <1to -1) considered themselves as underweight before intervention.

Overall 72% subjects in the experimental group showed incorrect self perception prior to intervention whereas post intervention 53% subjects had incorrect perception in the experimental group. In the control group subjects showing incorrect self perception remained almost the same with 57% and 58% subjects reporting incorrect perceptions pre and post intervention respectively. The improvement in the experimental group was found to be significant ($p<0.001$). Experimental group had a significantly higher number of subjects with incorrect responses related to self perception, before the intervention. However, there was no significant difference observed in the self perception of the two groups after the intervention (Table 4.4.5).

Table 4.4.3: Impact of the CHALK Programme on the Physical Activity Practices of the Subjects– Post Intervention

Physical Activity Practices (Reported/ Day)	Percent Response [%(n)]				Chi Square			
	EG (Pre) A	EG (Post) B	CG (Pre) C	CG (Post) D				
	(N=191)	(N=191)	(N=245)	(N= 245)	A v/s C	A v/s B	C v/s D	B v/s D
Playtime in school and home ($\geq$ 60 minutes)	53.4 (102)	58.1 (111)	67.8 (166)	66.5(163)	9.33***	0.86	0.08	3.26
Leisure time (<120 minutes)	85.3(163)	90.1 (172)	82.4 (202)	90.2(221)	0.66	1.97	6.24*	0.0
Studytime^ ($\leq$ 180 minutes)	44.5 (85)	46.1 (88)	46.1 (113)	45.7(112)	0.11	0.1	0.01	0.01

^Studytime excluding school time
*significant at p<0.05
**significant at p<0.01
***significant at p<0.005

Table 4.4.4: Self Perception of the subjects in the two groups:Pre and Post CHALK Programme Intervention

BMI for Age – Z score	Self Perception											
	Ectomorphic				Mesomorphic				Endomorphic			
	EG Pre (N=191)	EG Post (N=191)	CG Pre (N=245)	CG Post (N=245)	EG Pre (N= 191)	EG Post (N=191)	CG Pre (N=245)	CG Post (N=245)	EG Pre (N= 191)	EG Post (N=191)	CG Pre (N=245)	CG Post (N=245)
<-3	5 (6)	10.2 (10)	0 (0)	0 (0)	4.1(3)	0(0)	0 (0)	0 (0)	14.3 (1)	0 (0)	0 (0)	0 (0)
<-2 to -3	12.7 (14)	24.5 (24)	0 (0)	0 (0)	20.3 (15)	6.7 (6)	0 (0)	0 (0)	14.3(1)	0 (0)	0 (0)	0 (0)
-2 to <-1	30 (33)	32.7 (32)	0 (0)	0 (0)	75.7 (56)	67.4 (60)	0 (0)	0 (0)	71.4 (5)	50 (2)	0 (0)	0 (0)
-1 to <1	51.8 (57)	32.7 (32)	53.9 (48)	56.2(50)	0 (0)	25.8 (23)	77.4 (103)	76.6(98)	0(0)	50 (2)	87 (20)	82.1 (23)
1 to <2	0 (0)	0 (0)	33.7 (30)	32.6(29)	0 (0)	0 (0)	18.8 (25)	19.5(25)	0 (0)	0 (0)	13 (3)	14.3 (4)
2 to <3	0 (0)	0 (0)	11.2 (10)	10.1 (9)	0 (0)	0 (0)	3.8 (5)	3.9 (5)	0 (0)	0 (0)	0 (0)	3.6(1)
≥3	0 (0)	0 (0)	1.1 (1)	1.1(1)	0 (0)	0 (0)	0(0)	(0)	0 (0)	0 (0)	0 (0)	(0)
Total	57.6(110)	51.3 (98)	36.3 (89)	36.3(89)	38.7 (74)	46.6 (89)	54.3(133)	52.3(128)	7(3.3)	2.1 (4)	9.4 (23)	11.4(28)

Table 4.4.5 : Comparison of the Responses related to Self Perception between the Two Groups – Impact of the CHALK Programme

Self Perception	EG (N=191)		CG (N=245)					
	Pre Intervention A	Post InterventionB	Pre InterventionC	Post InterventionD	A v/s C	A v/s B	C v/s D	B v/s D
Incorrect	72 .3 (138)	53 (102)	56.7 (139)	57.9 (142)	11.15***	14.53***	0.08	0.9
Correct	27.7 (53)	47 (89)	43.3 (106)	42.1 (103)				

*significant at p<0.05 **significant at p<0.01 ***significant at p<0.005

This change can be attributed to the fact that Body Mass Index (BMI) calculations as well as interpretation of the same was covered under the Nutrition Communication Programme. Subjects in Standard Vth needed help for calculation while the others did it themselves. Also the reason can be that their knowledge levels showed an increase in the understanding of appropriate weight which could be attributed to the change observed in self-perception.

Impact of CHALK programme on the Food and Nutrient intake of the subjects: Pre v/s Post Intervention

Mean Food Group intake

The CHALK program was designed to cater to the gap in knowledge of the subjects mostly regarding healthy foods and healthy eating practices. An analysis of the mean food group intake revealed a significant increase in the consumption of grains, vegetables and edible oil, in the experimental group subjects, post CHALK programme intervention (Table 4.4.6). These findings are in line with the findings in the dietary practices earlier in this section. This shows a positive shift towards healthy eating practices while the only negative aspect is the increase in the intake of edible oil. This issue can only be addressed by improving the knowledge levels of the mothers who most of the time cook the meals.

There was a significant decrease in the mean intakes of grains, pulses and milk in the control group indicating faulty dietary practices amongst the subjects.

There was no significant difference prior to the intervention between both the groups. However, after the CHALK programme intervention the experimental group had significantly higher intakes of grains, vegetables and edible oil as compared to the control group.

Mean Nutrient intake

As expected a significant increase in all the nutrients was observed (Table 4.4.7) in the experimental group after intervention. This was mainly due to the increase in intake of foods during mid morning and breakfast. A significant improvement in the number of subjects consuming cereals and vegetables during mid morning in school as seen previously in this section on the dietary practices. Also the increase in the number of subjects consuming cereals and milk for breakfast would have led to the significant increase in the mean nutrient intakes for all the nutrients.

Table 4.4.6: Mean Intake of Food Groups in the Experimental Group subjects: Post Intervention

Food Groups	Mean intake (Mean ± SD)				't' value			
	EG (Pre) A	EG (Post) B	CG (Pre) C	CG (Post) D	A v/s C	A v/s B (Paired)	C v/s D (Paired)	B v/s D
Total Grains	193.2±39.6	207.1±37.0	196.9±41.1	195.5±42.7	0.95	7.06***	4.2***	2.99***
Pulses/ legumes	38.5±18.5	38.6±18.4	39±19.49	38.7±19.7	0.28	0.34	2.1*	0.1
Vegetables	185.2±100.2	205.5±93.6	178.58±82.24	177.8±83.2	0.76	6.90***	2.7	3.26***
Fruits	19.28±39.9	19.1±39.7	14.1±45.8	14.1±45.8	1.3	1	0.16	1.2
Milk	190.6±102.5	189.1±102.8	189.72±101.0	189.1±101.9	0.09	1.24	2.02*	0.00
Edible Oil	23.1±7.0	23.7±6.5	21.96±5.2	22.0±5.2	1.95	3.99***	1.09	3.09***
Sugar	11.7±5.6	11.7±5.6	12±5.5	11.9±5.5	0.42	0.25	1.63	0.37

*significant at p<0.05 **significant at p<0.01 ***significant at p<0.005

Table 4.4.7: Mean Nutrient Intakes of the subjects in the Experimental group: Pre and Post Intervention

Nutrients	Mean intake (Mean ± SD)				't' value			
	EG (Pre) A	EG (Post) B	CG (Pre) C	CG (Post) D	A v/s C	A v/s B	C v/s D	B v/s D
Energy(Kcal)	1474.63±326.1	1535.23±300.3	1468.7±280.2	1474.7±306.8	0.21	7.7***	1.7	2.06*
Protein (g)	43.06±11.1	45.06±10.5	43.3±11.2	43.9 ±12.9	0.19	7.5***	3.4***	1.0
Fat (g)	47.68±16.9	48.58±16.1	46.8±14.5	46.6 ±14.7	0.62	3.8***	1.9	1.33
Calcium(mg)	391.3±126.2	403.14±122.3	382.2±118.3	384.39±121.1	0.78	7.7***	3.5***	1.6
Iron (mg)	10.68±2.5	11.53 ±2.5	10.7± 2.6	10.7 ±2.6	0.03	8.0***	0.01	3.42***

*significant at p<0.05 **significant at p<0.01 ***significant at p<0.005

A 4% increase was observed in the energy intakes in the experimental group while there was a 0.4% increase observed in the control group after the intervention.

Mean protein intakes increased by 2g in the experimental group which accounts for a 5% increase. A significant increase of 1.4% was also observed in the control group after the intervention period, but the increase was much higher in the experimental group.

A significant increase in the mean fat intake was disturbing, as initial fat consumption was already higher than recommended amounts (Phase I). This could also be attributed to mid morning intake as the subjects started consuming more vegetables therefore, the fat intake was also higher as these vegetables were cooked in oil and instead of chapatti many subjects carried 'parathas' (Chapattis cooked with oil) in their tiffins as it was softer than chapattis.

Thus, alongwith the adolescents it is very important to create awareness among the mothers so that the improvement can be more towards a positive side.

Although there was no significant difference between the two groups before the intervention, a significant difference was observed in the mean energy and iron intakes of the subjects in the two groups, post intervention.

Mean Increment in nutrient intake of the study subjects - Post intervention

As shown above, the intake for most of the nutrients increased significantly. The magnitude of increase in nutrient intakes was calculated by age and sex. The mean increment for all the nutrients was highest in girls as compared to boys in the experimental group (Table 4.4.8).

In the control group the mean increments were found to be higher amongst the boys. Girls showed a negative increment in mean intakes for energy (-1.3kcal), fat (-0.39 g) and iron (-0.01g) while boys showed a positive increment for all the nutrients.

Mean increments in the intakes for all the nutrients in the experimental group were significantly higher than the control group amongst both the sexes.

An agewise analysis was carried out to see the impact of the CHALK programme on mean increment in nutrient intakes of the study subjects (Table 4.4.9). The youngest age group showed the maximum positive change in the experimental group. Age was found to be negatively correlated with mean increment in nutrient intake, however, the difference was not significant.

Table 4.4.8: Mean Increment in nutrient intake of the study subjects - Post intervention

Nutrient	Boys (EG)	Girls (EG)	Boys (CG)	Girls (CG)	't' value Boys	't' value Girls
Energy(Kcal)	54.28 ±111.4	75.25 ±104.66	10.39 ±63.8	-1.3 ±35.8	4.11***	6.51***
Protein (g)	1.67 ±3.8	2.54 ±3.51	0.75 ± 3.17	0.51 ±3	2.21*	4.0***
Fat (g)	0.88 ±3.7	0.98 ±2.33	0.01 ± 1.03	-0.39 ±1.49	2.80**	4.51***
Calcium(mg)	11.52 ±23.86	13.33 ±17.05	2.83 ±11.07	1.22 ±7.9	4.01***	6.0***
Iron (mg)	0.74 ±1.48	1.06 ±1.39	0.0 ±0.33	-0.01± 0.06	5.98***	7.32***

*significant at p<0.05 **significant at p<0.01 ***significant at p<0.005

Table 4.4.9: Mean Increment in Nutrient intake of the study subjects at different ages– Post Intervention

Age (Years)	Mean Increment in Nutrient Intake (Mean± SD)									
	Energy (Kcal)	**Energy (Kcal)**	**Protein (g)**	**Protein (g)**	**Fat (g)**	**Fat (g)**	**Calcium (mg)**	**Calcium (mg)**	**Iron (mg)**	**Iron (mg)**
	EG	CG	EG	CG	EG	CG	EG	CG	EG	CG
<9	167.61 ±163.29	9.29 ±46.8	5.52 ±5.45	0.39 ±1.13	2.01 ±3	-0.15 ±1.56	21.22 ±21.78	2.42 ±7.16	2.18 ±2.21	0.01 ±0.04
9-9.11	102.83 ±127.07	6.8 ±47.39	3.57 ±3.95	0.06 ±0.47	1 ±2.9	0.07 ±1.65	18.16 ±17.59	2.39 ±12	1.5 ±1.42	-0.06 ±0.26
10-10.11	72.42 ±96.44	23.55 ±102.32	1.87 ±3.18	1.65 ±4.67	1.2 ±5.28	-0.30 ±1.45	11.88 ±28.42	-0.04 ±0.28	0.86 ±1.07	-0.01 ±0.03
11-11.11	46.7 ±90.64	-2.2 ±8.99	1.36 ±2.75	0.69 ±3.67	0.81 ±3.22	-0.07 ±0.47	10.3 ±15.64	3.21 ±10.51	0.68 ±1.22	-0.0 ±0.02
12-12.11	22.57 ±61.87	5.95 ±44.5	0.76 ±2.18	0.21 ±1.52	0.49 ±1.26	-0.13 ±0.78	4.71 ±11.95	3.12 ±14.39	0.3 ±0.88	0.08 ±0.6
13-13.11	79.06 ±139.07	-7.58 ±27.41	2.55 ±5.15	0.05 ±1.11	1.67 ±2.83	-0.33 ±1.52	15.48 ±24.38	2.06 ±8.07	1 ±1.97	-0.04 ±0.13
14-14.11	53.22 ±111.0	0	2.12 ±3.82	2.57 ±6.12	0.15 ±3.24	0	14.7 ±27.69	4.26 ±14.12	0.92 ±1.63	0
≥15	0	0	0	0±0	0	0	0	0	0	0

*significant at p<0.05 **significant at p<0.01 ***significant at p<0.005

Analysis of variance revealed that age had no significant effect on the mean increments in the experimental group while there was a significant effect of age on mean increments in protein (p, 0.005), fat ($p<0.05$) and iron (p,0.001) intakes in the control group. Being in the experimental group had a significant effect on the mean increments of the nutrients ($p<0.001$). Mean increments in the nutrient intakes were significantly higher in the Experimental group as compared to the Control group.

Another important finding was observed on comparing the mean increments in nutrient intake with the stage of adolescence (Table 4.4.10). Pre-adolescents had significantly higher mean increments, as compared to early-adolescents, except for fat. As these subjects are younger to the others they are more receptive to learning and can be moulded more easily. Probably that is the reason why pre-adolescents showed a maximum positive change. Children in mid-adolescence also showed increments in nutrient intakes though not of the same magnitude as the younger children. This can be explained by the fact that these children have a better understanding of health. By mid-adolescence the children develop a sense of looking good and being healthy, therefore, a positive change can be brought about in them if strategic education is imparted to them at this stage, building upon their focus at this age.

Mid-adolescents, in the control group, showed negative increments in the mean intakes for energy fat and iron. These increments were found to be significantly lower as compared to the experimental group.

Mean Intakes as % Recommended Dietary Allowance (RDA) – Post Intervention

As shown in Table 4.4.11, mean intakes as percent RDA of the Experimental group showed significant improvements after the intervention through the CHALK programme. The difference in the mean RDA before and after intervention was found to be significant in case of the experimental group for all the nutrients. However, in the control group the difference was significant for protein and calcium after the intervention period

Table 4.4.10: Mean Increment in Nutrient Intake of the subjects according to Stage of Adolescence– Post Intervention

Nutrients	Mean Increment in Nutrient Intake (Mean± SD)						't value'†
	Pre - Adolescence (N=27) A	Pre - Adolescence (N=65) D	Early - Adolescence (N=100) B	Early - Adolescence (N=135) E	Mid - Adolescence (N=64) C	Mid - Adolescence (N=45) F	
Energy (Kcal)	112.43 ±131.49	7.68 ±46.84	45.96 ±85.36	9.06 ± 65.53	65.69 ±125.8	-5.39 ±23.27	Av/s B 3.17*** A v/s D 5.65*** B v/s E 3.75*** C v/s F 3.74***
Protein (g)	3.86 ±4.14	0.18 ±0.78	1.30 ±2.72	0.89 ±3.66	2.29 ±4.53	0.66 ±3.25	Av/s B 3.84*** Av/s D 6.94*** C v/s F 2.06*
Fat (g)	1.15 ±2.88	-0.01 ±1.6	0.82 ±3.5	-0.16 ±0.99	0.98 ±3.04	-0.24 ±1.29	A v/s D 2.46* B v/s E 3.11*** C v/s F 2.52 *
Calcium (mg)	18.61 ±17.83	2.40 ±10.47	8.86 ±19.35	2.05 ±10	14.67 ±25.38	2.51 ±9.61	Av/s B 2.36* A v/s D 5.43*** B v/s E 3.51*** C v/s F 3.06***
Iron (mg)	1.6 ±1.53	1-0.03 ±0.22	0.6 ±1.08	0.02 ±0.32	0.94 ±1.8	-0.03 ±0.11	Av/s B 3.88*** A v/s D 8.48*** B v/s E 5.9*** C v/s F 3.59***

†shows significant changes only *significant at $p<0.05$ **significant at $p<0.01$ ***significant at $p<0.005$

. Table 4.4.11: Mean Intakes as % Recommended Dietary Allowance (RDA) - Post Intervention

Nutrients	Mean % RDA Intake				Mean Increment in Nutrient Intake as % RDA		't' Value†
	Pre intervention		Post intervention				
	EG (A)	CG(C)	EG(B)	CG (D)	EG (E)	CG (F)	
Energy	67.37 ±15.84	71.4 ±15.69	70.28 ±15.57	71.71 ±17.01	2.91 ±5.18	0.31±2.7	Av/s B7.76*** E v/s F 6.76***
Protein	103.51 ±33.03	112.8 ±35.5	108.52 ±32.9	114.40 ±38.67	5.01 ±9.2	1.6±7.39	Av/s B 7.49*** C v/s D 3.4** E v/s F 4.28***
Fat	130.02 ±46.32	134.73 ±44.27	132.5 ±44.13	134.36 ±45.1	2.48 ±8.97	-0.37±3.67	Av/s B 3.82*** E v/s F 4.51***
Calcium	50.97 ±16.6	51.58 ±16.21	52.56 ±16.32	51.89 ±16.63	1.59 ±2.81	0.31±1.39	Av/s B 7.85*** C v/s D 3.45** E v/s F 6.25***
Iron	49.95 ±15.63	49.87 ±16.3	49.74 ±16.9	49.86 ±16.28	3.79 ±6.46	-0.01±1.33	Av/s B 8.1*** E v/s F 8.96***

† shows significant changes only

*significant at $p<0.05$ **significant at $p<0.01$ ***significant at $p<0.005$

Mean Nutrient intakes at various levels of RDA– Post Intervention

As seen in Figure 4.4.1, prior to intervention, 14% and 7% subjects consumed <50% of the RDA for energy in the experimental and control group respectively. After intervention there was reduction of 6% in the experimental group consuming < 50% of RDA for energy while there was no change observed in the control group. This was reflected as a 6% rise in the experimental group subjects consuming <75% of RDA for energy. A 5% rise was seen in the experimental subjects, consuming >75% of RDA for energy, against 1% increase in the control group.

Similarly a drop of 8% was observed in the experimental group subjects consuming <75% of the RDA for protein, resulting in an equivalent rise in the protein intakes of >75% of the RDA for protein. A 4% increase was observed, post intervention, in the subjects consuming >100% of the RDA for protein in the experimental group while the control group subjects showed no change in the same. An increase of 1% subjects in the control group, consuming <75 % of the RDA for protein after intervention (Figure 4.4.1).

An unexpected increase of 3.6% was observed in experimental subjects consuming >100% RDA for fat after the intervention, while the control group showed no changes before or after the intervention (Figure 4.4.1).

A small 2% rise was seen in the subjects consuming >50% of RDA for calcium in the experimental group after intervention while the control group showed an increase of 2% in the subjects consuming > 75% of the RDA for calcium (Figure 4.4.2). This could be attributed to no significant change in the milk and green leafy vegetable consumption pattern in the experimental group.

A significant improvement in the iron intakes was observed with an increase of 5% in the subjects in the experimental group while the control group subjects showed an increase of 0.5% in the subjects consuming >50% of the RDA for iron post intervention (Figure 4.4.2). Subject consuming >75% of RDA in the experimental group doubled after the intervention. This improvement can be attributed to an increase in cereal and vegetable intake of the subjects.

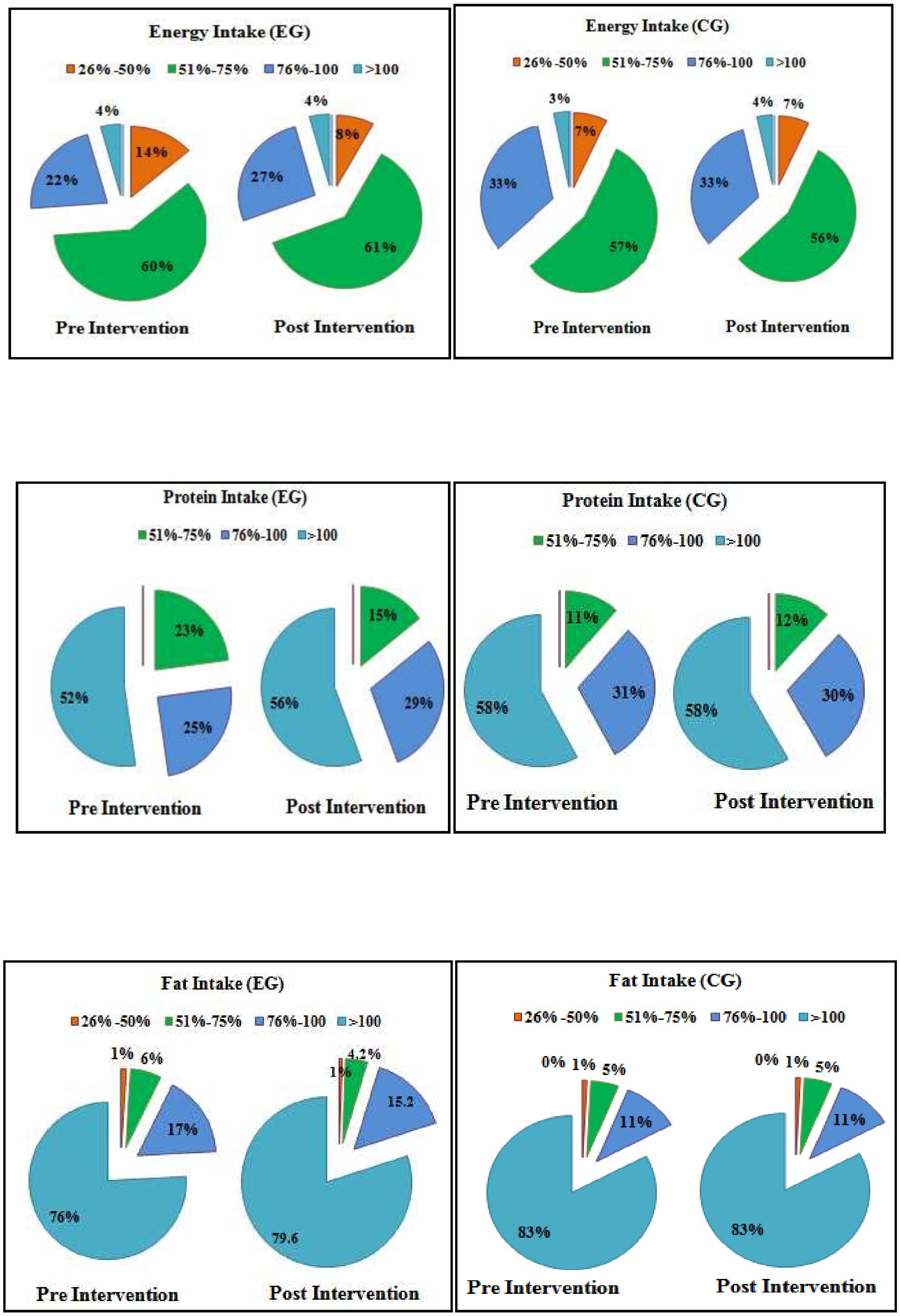


Figure 4.4.1: Mean Energy, Protein and Fat Intakes at Various Levels of RDA: Impact of the CHALK Programme (Percent Subjects)

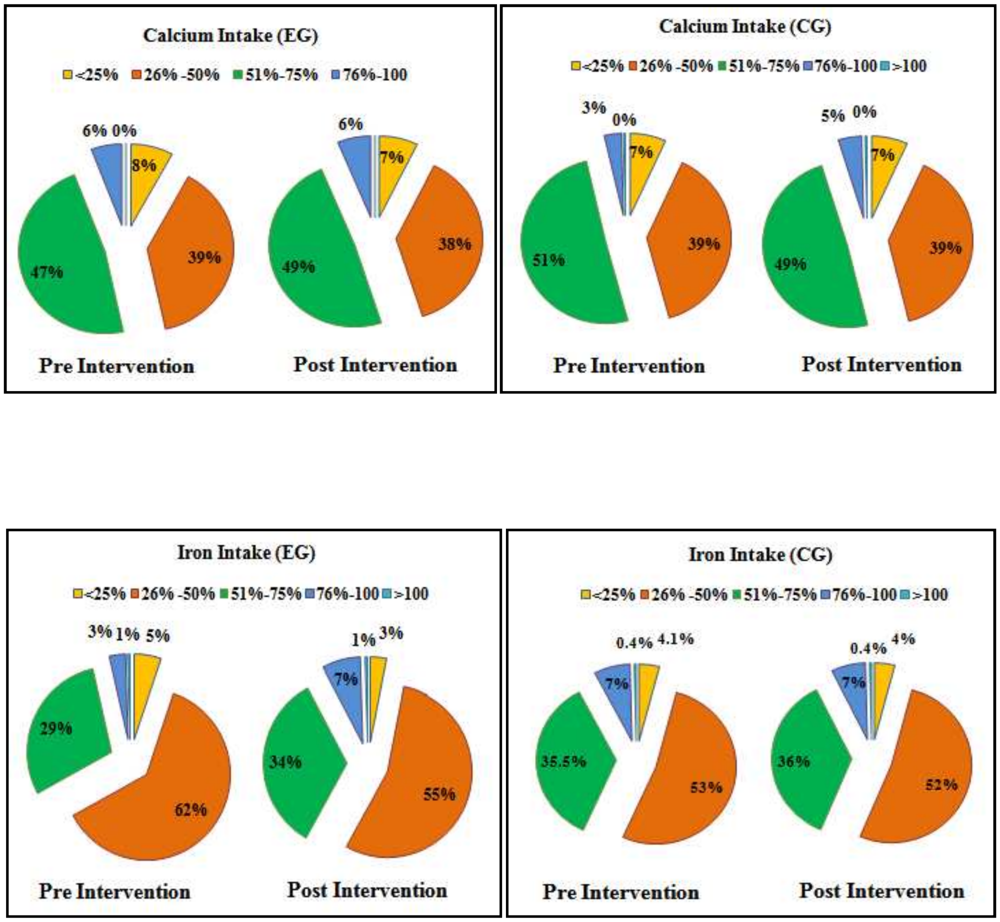


Figure 4.4.2: Mean Calcium and Iron Intakes at Various Levels of RDA: Impact of the CHALK Programme (Percent Subjects)

Impact of the CHALK Programme on the Frequency of Consumption of Healthy and Unhealthy Foods– Post Intervention

Table 4.4.12 shows the frequency of consumption of various foods in the two groups before and after the nutrition communication programme. An analysis of the frequency of food consumed showed a significant improvement in daily consumption of other vegetables like lady finger, cauliflower, brinjal etc in the experimental group. None of the foods showed an increase in daily consumption.

Daily consumption of fried foods went down significantly from 13.1% to 6.8% in the experimental group while a non significant rise of 2% was observed in the control group after the intervention programme.

Similarly a 6% reduction was observed in the experimental group as against a 2% increase in the control group regarding daily consumption of baked foods after the intervention. This indicates a healthier change in the food choices of the subjects which was also shown by the analysis of knowledge levels of these subjects when they were asked to choose foods they like from three different groups. Although majority of the subjects chose biscuits over chips yet the significantly lower frequency of consumption of baked foods shows that they could understand about the ill effects of baked foods. Another reason could be as the number of subjects who reported eating chapatti and vegetables during mid-morning increased, a concomitant fall was observed in consumption of bakery items which were sold in the school during recess.

Although insignificant, yet a decrease in consumption of unhealthy foods was seen in the experimental group subjects after the intervention. Consumption of sugary foods like sweets chocolates, candies, ice creams, accessories like jams, murabbas, pickle, chutneys, papads and aerated soft drinks remained significantly higher in the control group than the experimental group while consumption of fruits was significantly lower in the control group as compared to the experimental group.

Table 4.4.12: Impact on the Frequency of consumption of healthy and unhealthy foods (Daily) in the experimental group

Food items	Pre Intervention		Post Intervention		Chi square†
	EG (N=191) A	CG (N=245) C	EG (N=191) B	CG (N=245) D	
Pulses	69.6(133)	63.7(156)	70.7 (135)	64.9(159)	B v/s D 4.9*
Milk	84.3(161)	83.3(204)	85.3 (163)	84.1(206)	B v/s D 20.29***
Eggs	4.7(9)	3.3(8)	6.3 (12)	4.1(10)	NS
Green Leafy Vegetables	53.4(102)	47.3(116)	51.8 (99)	45.7(112)	NS
Yellow and orange Vegetables	15.2(29)	11.8(29)	20.9 (40)	14.7(36)	NS
Other Vegetables	52.9 (101)	49.4(121)	62.8 (120)	47.8(117)	Av/s B 3.88*
Roots and tubers	43.5(83)	44.1(108)	45.6 (87)	46.1(113)	B v/s D 5.71*
Fruits	65.4(125)	43.3(106)	62.8 (120)	43.7(107)	A v/s C 21.19***
Butter	19.9(38)	16.3(40)	18.9 (36)	18.4(45)	NS
Ghee	53.4(102)	58.4(143)	47.6 (91)	58(142)	B v/s D 21.28***
Fried Food	13.1(25)	16.7(41)	6.8 (13)	18.8(46)	Av/s B 4.21* B v/s D 13.14***
Baked Food	43.5(93)	46.1(113)	37.7 (72)	47.8(117)	Av/s B 4.7* B v/s D 4.42*
Fast Food	9.94(19)	6.5(16)	7.9 (15)	9(22)	NS
Accessories	38.7(74)	66.9(164)	37.2 (71)	64.5(158)	A v/s C 34.42*** B v/s D 32.12***
Fresh Fruit Juice	19.4(37)	22.8(56)	17.3 (33)	24.5(60)	NS
Tinned Fruit Juice	6.8(13)	7.8(19)	6.8 (13)	9.8(24)	NS
Aerated Soft Drinks	2.09(4)	6.9(17)	1.6 (3)	7.75(19)	A v/s C5.49* B v/s D 8.57***
Non Aerated soft Drinks	4.2 (8)	3.7(9)	3.1 (6)	4.5(11)	NS
Sweets, Chocolate, Candies and Ice creams	22.5(43)	47.3(116)	19.9 (38)	46.1(113)	A v/s C 28.57*** B v/s D 32.61***

† Shows significant changes only

*significant at p<0.05 **significant at p<0.01 ***significant at p<0.005

Key findings

- The knowledge levels of the subjects regarding healthy foods and healthy eating were quite low.
- Most of the subjects could state that soft drinks and fast foods were bad for health but were unable to give a reason for the same.
- A significant increase in the knowledge related to healthy foods, healthy eating, food groups, complete meals, importance of breakfast, appropriate weight etc. was observed in the experimental group while there was no change in the knowledge levels of the control group at the end of the CHALK programme intervention.
- Another important observation revealed a significant improvement in the daily consumption of breakfast, mid morning food and vegetables among the experimental subjects.
- Almost three fourth of the subjects in the experimental group had incorrect perceptions while at the end of the intervention which significantly improved after the intervention.
- No significant change was observed in the activity levels of the subjects in the experimental group.
- Mean food group intakes were significantly higher post intervention among the experimental subjects.
- Mean intakes of cereals, vegetables and oil was significantly higher in the experimental group at the end of the intervention.
- Mean intake all the nutrients improved significantly post intervention in the experimental subjects.

Discussion

Nutrition health education is an effective strategy for behavioral change to improve home diets. Nutrition health education is a process of formulating and disseminating messages that make individuals and communities aware about health and other related issues, strategies and behavior that enable them to make informed choices (Nandi, 2005).

Knowledge regarding healthy foods, food groups, balanced diet, benefits of eating fruits and vegetables, breakfast and appropriate weight in the present study was very low.This is corroborated with the findings of other studies carried out on adolescents (Vijayapushpam et al, 2003; Shariff et al, 2008; Singla et al, 2012; Lakshman et al, 2010; Saibaba et al, 2002; Kanani and Zararia,1996).

A significant change was observed in the knowledge regarding healthy foods among the subjects in the present study, which can be attributed to the CHALK programme intervention.Various studies on knowledge levels of the students before and after a nutrition communication programme have shown positive results at the end of the intervention

Vijayapushpam et al (2003) observed a significant improvement in the knowledge levels of the subjects post intervention regarding body building foods, protein rich foods and outside foods (street foods) amongst adolescents between 12-14 years of age.

A significant improvement in the knowledge, attitudes and practices related to food pyramid, functions of food, food choices, breakfast and snacks was observed in the experimental group amongst 335 primary students after nutrition education by trained school teachers (Shariff, 2008).

. A longitudinal study done on school going girls aged 8-13 yrs of urban Vadodara by Kanani and Agarwal (1998) resulted in a significant increase in the knowledge of experimental group than control group. A significant improvement in the nutrition knowledge amongst adolescents after nutrition education intervention has also been reported by several studies (Gupta &Kochar, 2009; Rao et al, 2007; Subbarao et al, 2006; Vijayapushpam et al, 2003; Lakshman et al, 2010)

Only a few subjects practiced healthy behaviour even though they had a considerably good knowledge about health and nutrition. Availability of unhealthy foods and physical activity levels affect the healthy behaviours (Shah, 2010). As seen in the present study although there were some significant changes related to healthy eating, there were no changes observed in the physical activity levels. One most important reason for this could be the increasing pressure of studies and competitions as these children grow up. Another reason could be the attitude of parents regarding physical activity.

Although the ability to choose healthiest foods did not change significantly in any of the groups, yet experimental group subjects did choose healthier foods post intervention from the same groups. Laksham (2010) also observed no increase in the ability to choose healthier foods in school going children after a nutrition education intervention programme.

Self perception or self concept is one of the deciding factors for dietary habits. The present study showed a significant improvement in the self perception of the subjects in the experimental group which could have also led to the positive changes in the practices. Several studies have shown effect of self-concept on eating behaviours of adolescents (Muir et al, 1999; Yang et al, 2010; Arora et al, 2012)

Mean intakes for all the nutrients increased significantly in the experimental group in the present study post intervention. Many studies have shown positive changes in the dietary intakes of the subjects after a nutrition communication program (Saibaba et al, 2002; Kaur et al, 2007).

Most of the subjects consumed snacks like namkeen, farsan and bakery items (mainly biscuits) as evening snacks before and after the intervention. Although there was a reduction in subjects consuming the same after the intervention but it was not significant. This can be attributed to the lack of knowledge and time on the part of the mothers to provide healthy snacks to their children. A significant reduction in the consumption of fried foods, junk foods and carbonated beverages was seen by Singla(2012) among adolescents in Punjab.

A review of 300+ studies by Contento et al (1992) found that short studies (< 15 weeks) have been shown to result in positive effect on cognitive outcomes such as nutrition knowledge, diet related skills, behavioural expectations and self-efficacy, however, the effects reported are inconsistent. Studies carried out for longer periods have reported to result in changes in dietary intakes and physiological parameters (Contento, 1992).

Children do not always choose what they eat, as their parents decide and prepare the food for them. Hence, there is a need to reach out to their mothers as they are the ones who are directly involved in the preparation of meals for the family.

SUMMARY AND CONCLUSIONS

‘Adolescence is an age of opportunity for children, and a pivotal time to build on their development in the first decade of life, to help them navigate risks and vulnerabilities, and to set them on a path to fulfilling their potential’ (UNICEF, 2011).

Healthy eating patterns in childhood and adolescence promote optimal health, growth, and intellectual development (SCN, 2006).

Most of the countries have developed or are developing National Food Based Dietary Guidelines (FBDG). In addition to the dietary guidelines, there has also been a call in the research and policy communities to develop simple indicators to measure diet quality. Simple dietary assessment tools like Healthy Eating Index (Kennedy et al, 1995) and Food Behaviour Checklist (Blackburn et al, 2006) can be used by the adolescents to assess their dietary intakes.

Additionally nutrition education should be provided to adolescents as ‘Nutrition education is an important measure to improve dietary habits and food choices of the adolescents, as poor dietary habits and ignorance are the main reasons for poor nutritional status of the adolescents’- (Gupta and Kochar, 2009).

Thus, in view of the above the present study was planned with the **Major Objective** of developing a Healthy Eating Index and Food Behavior Checklist for adolescents in Indian context and to implement a Nutrition Communication Programme to improve their dietary practices from three schools of urban Vadodara.

Methodology

The present study was conducted in 3 schools of urban Vadodara. The enrolled sample constituted of 1041 subjects between 7 to 18 years of age. Anthropometric data was obtained for all the subjects. Socio economic status; Food frequency; Food and Physical activity behaviour data was collected for 631 subjects studying in Std. V to Std. IX.

Data on Knowledge, Attitudes and Practices (KAP); Dietary intakes using 3- day 24 hour recall and Food frequency; Morbidity Profile; Cognitive development was obtained on 478 subjects from two schools. Biochemical estimations were carried out on a subsample of 61 subjects.

Two schools were allotted to the Experimental and Control group for the Nutrition Communication Program. The experimental group consisted of 212 subjects and in the Control group there were 266 subjects. However, due to dropouts from the study, Pre and Post data for impact evaluation was analyzed on KAP; Dietary intakes; Food and Physical activity behaviour for the 191 subjects in the Experimental group and 245 subjects in the Control group, who completed the study.

Data was analyzed using Microsoft excel (2010), Epiinfo Version 7 and Statistical Package for Social Sciences (SPSS) Version 17.

The salient findings of the present study are summarized below:

Phase I Formative Research

Socio Economic Status

Most (91%) of the subjects were Hindus and belonged to nuclear families (73%) with a mean family size of 4.71$\pm$1.56 members. Per capita income was between Rs 600-50,000 per month while mean per capita income was Rs. 5873.1$\pm$ 4.75. Most of the fathers (80%) were in service while 90% of the mothers were housewives. More than half of the subjects were vegetarians (57%).

Age and Sex Profile of the subjects

Mean age of the study subjects was 12.45$\pm$ 0.07 years. The study population consisted of 59% boys and 41% girls. Around 66% boys and 61% girls were between 10-13 years of age.

Growth Patterns among the study subjects

Mean Height of boys and girls was 153.53 and 150.76 cm respectively. Peak height velocity was observed in boys at 12 years and in girls at 11 years of age with an increment of 7 cm and 5.9 cm in boys and girls respectively. The difference in height amongst boys and girls were thus evident from 13 years onwards.

Mean weight of the subjects was 42.3 kg irrespective of the sex. Peak weight velocity was observed in girls at 11 years of age and in boys at 15 years with an increment of 5.04 kg and 7.98 kg in girls and boys respectively.

Overall scenario shows that girls had higher height and weight during pre-adolescent years as compared to boys, but by late adolescence, boys had better heights and higher weights as compared to girls.Girls had significantly higher mean BMI than boys (18.38 and 17.63 kg/m^2). Girls had higher values for BMI at all ages when compared to boys except between 15 to 19 years of age.

Comparison with other reference standards revealed that Height for age amongst boys in the present study was higher than the NCHS, WHO and Agarwal standards till 14 years of age, while for girls it was higher till 12 years of age. In case of weight for age the subjects had higher values for initial years till 11 years of age when compared to NCHS and Agarwal standards. BMI for age was lower than the NCHS and WHO standards at almost all ages. This clearly indicates the failure of the subjects to grow to their full potential.

Mean waist circumference was 65.5 and 64.2 cm in boys and girls respectively. Boys and Girls had lower values for WC at all ages when compared to NHANES III subjects. While boys had higher WC values till the age of 13 years, girls had lower WC values at all ages, when compared to an Indian study – The PEACH study.Mean Waist Hip Ratio (WHR) was 0.83 and 0.80 in boys and girls respectively. Mean Mid Upper Arm Circumference (MUAC) values were found to be 21.9 cm and 21.7 cm in boys and girls respectively. MUAC values at all ages were higher as compared to Agarwal standards in both boys and girls except at 17.5 years in boys and 15.5 to 16 years in girls. Mean waist stature ratio was found to be 0.43 in both the sexes.

Prevalence of Malnutrition

Prevalence of underweight (weight for age< -1 SD) was found to be 24.6%. Prevalence of moderate (WAZ <-2 SD) and severe (WAZ<-3SD) underweight was 4.8% and 0.9% respectively. Prevalence of stunting Height for age <-1 SD) was 14.3%. Moderate (HAZ<-2 SD) and severe (HAZ <-3 SD) stunting were 2.2% and 0.3% respectively. Prevalence of thinness (BMI for Age < -1 SD) was 33%. Moderate (BAZ <-2SD) and Severe (BAZ< -3SD) thinness were 7.9% and 2.2% respectively. Prevalence of overweight (>1 SD BAZ) and Obesity (BAZ> 2 SD) were 13.4% and 3.5% respectively.

Prevalence of dual burden of malnutrition (under and over) was highest during early and mid-adolescence.

Dietary and Nutrient Intakes

Mean intakes of all the food groups, except edible oil, was below 75% of the recommended dietary allowances (RDA). Boys had higher intakes of all the food groups, except grains and pulses, as compared to girls. Amongst boys, the youngest age group had highest consumption for grains and oil, while the eldest had highest consumption of milk and sugar. Girls showed a similar pattern, except the fact that milk consumption was lower among the oldest age group of girls.

Mean nutrient intakes of boys were significantly higher than girls. As age increased above 13 years a decline was observed in the mean nutrient intakes. Consumption of all the nutrients, except protein and fat, was below 84% of the RDA. Mean intakes of all the nutrients was lowest in the oldest age group irrespective of sex. More than half and one-third of the subjects reported intakes between 26% to 50% of the RDA for iron and calcium respectively.

A comparison of mean nutrient intakes with the nutritional status revealed that subjects with WAZ scores <-3, HAZ scores -2.99 to -2 and BAZ scores -2.99 to -2 had the lowest mean nutrient intakes.

Cereal consumption on a daily basis was reported by all the subjects, while 64% of the subjects consumed pulses on a daily basis. Daily milk consumption was reported by 84% of the subjects. Green leafy vegetables/ roots and Tubers / other vegetables like brinjal, ladyfinger, cauliflower etc. were consumed by around 50% of the subjects on a daily basis. Nearly 55% subjects consumed fruits daily.

Amongst unhealthy foods the most frequent consumption was observed for baked foods (42.5%) followed by accessories (42.3%) like jams, murabbas, pickle, papad etc. with meals on a daily basis.

Biochemical Estimations

Mean Hemoglobin level of the subjects was 11.9 g/dl. Forty one percent girls and 47% boys had hemoglobin levels between 11-11.9 g/dl and 12-12.9 g/dl respectively. Lowest hemoglobin levels in boys and girls were 8.6g/dl and 7.4g/dl respectively. Prevalence of anemia was found to be 42.6%,with most of the subjects having either mild anemia (65.5) or moderate anemia (30.8).Highest prevalence of anemia was seen among early adolescents. BAZ scores were found to be significantly associated with anemia.

Red cell morphology results revealed that 58% of the anemic subjects showed normocytic red cells. Microcytic hypochromic anemia was seen in 23% of the subjects.

Mean values of all the hematological indices were less than the International references. Hemoglobin showed a positive correlation with all the hematological indices ($p<0.01$). Serum total proteins and albumin levels of the subjects were found to be normal.

Morbidity Profile

Almost two thirds of the subjects reported to have experienced some or the other form of morbidity (ies). Nearly one-third of the subjects reported of experiencing cold, headache, stomachache and cough which were the most common morbidities. Most of the morbidities were experienced by early–adolescence group. One-fifth of the subjects had dental caries.

Physical Activity Profile

Boys were more active than girls in relation to previous day's physical activity pattern. Reported playtime in school, during recess and at home was similar in both the sexes. Two-third of the subjects reportedly slept forless than 8.5 hours daily. By the age of 10 years, number of subjects with sleep time of less than 8.5 hours started increasing. Most of the subjects spent less than an hour on leisure activities. Boys as compared to girls spent less time on leisure activities apart from their school time. One-third of the subjects reported a study time of >5 hours. Subjects spending more than 5 hours on studies started increasing from the age of 10 years. As age increased the duration of physical activity, playtime, leisure time and sleep time reduced.

Cognitive Abilities

Mean cognitive scores for girls in Digit span, Maze test and Overall class performance were higher than boys. Cognitive function test scores were positively correlated to age while class performance was negatively correlated with age. Undernourished subjects had lowest overall score in the cognitive tests performed by them.

Knowledge Attitude and Practices of the Subjects regarding Healthy Eating, Dietary Habits and Physical Activity

Lack of knowledge regarding healthy foods, healthy eating, food groups, functions of foods, benefits of eating fruits and vegetables, food pyramid, physical activity etc. was observed amongst the subjects. Half or more subjects failed to make healthy choices from the options given to them.

Around two-third (63%) of the subjects could not correctly respond on being asked about functions of food. A mere 7% could correctly state the functions of food. Almost all (94%) of the subjects did not know the names of food groups. Majority (95%) of the subjects were unable to define appropriate weight. Only 36% of the subjects were able to correctly perceive their body types when shown a picture with figures of three body types. Almost all of them (93%) stated that physical activity was important for them.

Although 71% subjects reported of consuming breakfast regularly, only 56% of the subjects actually consumed breakfast on all days in the past week. While eating out a majority of them had unhealthy choices. Half of the children spent their pocket money, fully or partly, on food. Apart from their pocket the subjects received money to eat out at times, half (49%) of the subjects spent it on purchasing bakery items from the shop near the school or tuition classes.Most of the subjects (84%) got packed lunch boxes (tiffins) from home while 8% of them bought food from the canteen.

Around half of them (47%) undertook some form of physical activity for more than an hour every day. Most common physical activity was playing outdoors (75%). Around 20% of children who were overweight or obese felt that they were ectomorphic (thin), while 36% of the subjects who were thin, reported themselves as mesomorphic (healthy person with healthy muscle mass).Two thirds of the subjects (64%) had incorrect perception regarding their body image.

Knowledge, Attitude and Perception of Teachers and Principals

Majority (80%) of the teachers were females. Sixty percent of the teachers had Grade I obesity. All of them stated that adolescents are children between 10-19 years of age, but they believed that age range of adolescent comes somewhere between 10-19 years. Some responded to 13-18 years or 12-16 years as range of adolescence. More than half (57%) did not know about BMI and only 7% could give the formula for same. Majority of them (93%) gave incorrect or partially incorrect responses regarding functions of food and food groups. Lack of awareness regarding health, foods to be given under various conditions etc. was observed amongst the teachers.

PhaseII Healthy Eating Index for Adolescents (HEIA)and Food Behaviour and Activity Checklist (FBACA) – Development, Assessment for Subjects and Validation

No tools to measure the dietary quality of adolescents have been developed in India. Indians have their own dietary guidelines and recommendations. It is time now to assess whether these guidelines are followed or not. New tools like Healthy Eating Index (Kennedy et al, 1995) and Food Behaviour checklist (Balckburn et al, 2006) have been developed in the United States of America and have been in use since 1989 (HEI was developed by USDA in 1989).

The present study aimed at developing new tools to assess dietary quality and also to evaluate the level to which the adolescent in urban Vadodara conform to the dietary guidelines for Indians.The new tools developed were named as Healthy Eating Index for Adolescents (HEIA) and Food Behaviour and Activity Checklist for Adolescents (FBACA).

Healthy Eating Index for Adolescents (HEIA) was developed in the present study to assess the dietary quality of the subjects. Except total vegetables, green/yellow/orange vegetables and Solid fat and added sugars (SOFAAS) each of the 7 components had scoring range of 0 to 10. SOFAAS had a maximum score of 20 while total vegetables and green/yellow/orange vegetables had a score range of 0 to 5. The overall HEIA score is a sum of the scores of each component. A total score of 80 indicated a “good” diet while a score between 51 and 80 implied “need for improvement” in the dietary quality. A score of $\leq$ 50 indicated a “poor” quality diet.

Total HEIA scores

Mean Overall HEIA scores were 63.34 $\pm$ 5.2 and were higher for boys as compared to girls. Oldest age group had lowest scores indicating a lower diet quality than the rest of the subjects.

Mean overall HEIA scores were significantly affected by religion and dietary habits. Christians had highest mean HEIA scores and vegetarians and non-vegetarians had significantly higher scores as compared to ovo-vegetarians.

HEIA increased with the increase in per capita income and years of education of both the parents, although the difference was not significant. Family size showed a negative association with HEIA scores. Assessment of the dietary quality of the subjects based on HEIA scores revealed that almost all the subjects (99%) needed improvement in their diets. Mean HEIA scores were significantly affected by the nutritional status of the subjects (WAZ and HAZ scores).

There was no significant difference between the HEIA scores for anemic and non-anemics. A possibility could be the small size of the subsample (n=61) on which biochemical estimations were conducted.

Individual HEIA Component Scores

Subjects received maximum scores for SOFAAS (19.8/20) followed by Total sugar (9.8/10) and Total oil (9.48/10). The lowest mean scores were of Total green/ yellow/ orange vegetables (0.5/5) and Total fruit (1.01/10) indicating lack of Variety in the diet and low intake of protective foods.Mean components scores were similar amongst boys and girls except Total Grains (Score higher in girls) and Variety (Score higher in boys). All the components except Total Oil, Total Sugar and SOFAAS showed significant positive correlation with overall HEIA scores.

Religion had a significant effect on mean Total Grains and Total Pulses/Meat/ Fish/ Poultry scores while type of family had significant effect on the total milk scores. Family size also had a significant effect on Total Milk scores. Education of parents had no significant effect on mean component scores. Mean scores for variety were significantly higher in subjects whose fathers were more educated. Children of well-educated mothers had significantly higher scores for SOFAAS.

Significantly higher scores for Total Grains and Total Milk were seen among vegetarians on comparison with ovo-vegetarians. Similarly, non-vegetarians had significantly higher scores for Total Green/Yellow/Orange vegetables and Total milk as compared to ovo-vegetarians.

A Food Behavior Checklist (FBC) was developed by Blackburn et al (2006)to evaluate the impact of nutrition education on fruit and vegetable intake in the Food Stamp Nutrition Education Program (FSNEP) and the Expanded Food and Nutrition Education Program (EFNEP). FBC was found to be a valid and reliable indicator of fruit and vegetable consumption.

For the present study a Food Behaviour and Activity Checklist for Adolescents was developed to assess the dietary and physical activity practice of the subjects. The maximum total FBACA score was 100. FBACA consisted of 20 practices related to diet and physical activity. Each FBACA component was allotted a maximum score of 5 and a minimum score of zero. Zero was given to the most undesirable action for any dietary component or activity pattern and a maximum score of 5 was given to the most desirable frequency of food item consumption or activity pattern (Appendix). A mean FBACA total of 80 points implied that the practices being followed are of a good quality. If the score ranged between 51 and 80 then the practices needed improvement and if the score was less than or equal to 50 then practices being followed were considered to be of a poor quality.

Total FBACA Scores

Mean Total FBACA scores were found to be higher for girls as compared to boys. An agewise analysis showed that the lowest mean FBACA score for girls was seen between 16-17 years of age while for boys it was seen between 9-10 years.However, there was no significant effect of age on Total FBACA scores. According to FBACA scores

Subjects with per capita income less than Rs 5000 had significantly lower mean Total FBACA scores as compared to those who had PCI above Rs 5000. Subjects with smaller family size, well-educated parents and working mothers had higher mean Total FBACA score as compared to others. However, these differences were not significant among the groups.

More females than males had ‘good’ dietary and physical activity practices (13% v/s 8%). Most of the subjects (89%) needed improvement in the practices. None of the subjects above 16 years had good quality of practice according to FBACA scores. There was no significant difference between the FBACA scores of well-nourished or undernourished subjects.

Individual FBACA Component Scores

The highest mean FBACA score was observed for vegetables (4.9), which indicates almost all the subjects consumed vegetables regularly. A further look into the type of vegetables revealed that the highest score was of roots and tubers indicating the highest consumption of roots and tubers among all the vegetables. The lowest scores were for evening snack item (0.97) indicating higher intakes of unhealthy foods as evening snacks.

Christians had significantly higher scores ($p<0.05$) for other vegetables and playtime. Scores for roots and tubers were significantly higher in nuclear families as compared to joint or extended families. Smaller families (< 5 members) had significantly higher scores for roots and tubers and evening snack.

Per capita income showed a significant positive association with mid-morning item, yellow orange vegetables and study scores of the subjects. A significant difference was observed amongst the subjects in relation to mid-morning item and parent's education. Children of well-educated parents had higher mid-morning scores in comparison to the others. Outside food score was significantly higher in vegetarians as compared to non-vegetarians.

Psychometric Properties of HEIA and FBACA (Validity and Reliability)

Content validity examines qualitatively the extent to which an index or scoring system represents the variety of attributes that make up diet quality in case of HEIA and the quality of practices in case of FBACA. All the components that relate to diet quality are reflected in HEIA. FBACA also covers the healthy dietary and the physical activity practices as given by the dietary guidelines of India. Thus, content validity was established for HEIA and FBACA in the present study.

Construct and criterion validity measures how well the index measures diet quality. This was done in four ways.

Four sets of menus for adolescents were chosen and scored according to HEIA. All the diets ranked as good quality, thus establishing construct validity for HEIA. Validity can also be established if the index is able to differentiate between groups of known differences, in this case undernourished and well-nourished. Mean total HEIA scores for undernourished subjects was significantly lower ($p<0.005$) as compared to well-nourished subjects (60.4 v/s 63.5). Total vegetables, Total fruits and Total milk scores were significantly higher in well-nourished subjects.

Correlations of Total HEIA, FBACA and their components were established in relation to energy intakes. It was observed that both HEIA and FBACA showed low correlations with energy indicating independence from FBACA intakes. Thus, it can be stated that both HEIA and FBACA were able to predict diet quality without being affected by the diet quantity.

Principal component analysis revealed that no single linear combination of components of HEIA or FBACA accounted for a significant proportion of variation in the dietary and Physical activity patterns of the subjects in the present study.

Thus, Content construct and criterion validity were established for both HEIA and FBACA.

Test retest reliability was already established as HEIA and FBACA were developed to be identical for identical diets or practices that are executed (recalled, recorded and coded) the same way. Inter rater reliability was not needed as there was no judgment required for scoring of the diets or practices.

Another form of reliability known as internal consistency was observed using Cronbach's coefficient alpha. For HEIA alpha was -0.17 and for FBACA it was 0.17. It was low as expected because diet quality or quality of practices is known to be multidimensional. As well there is no consistency in individuals meeting the standards which are used for assessing the diet or physical activity quality. Thus, internal consistency was not a necessary characteristic of HEIA or FBACA.

Phase III Planning, Development and Implementation of the Nutrition Communication Program for Adolescents - Creating Healthy and Active Learning Kids (CHALK) Programme

Phase I revealed a dual burden of malnutrition amongst subjects and a closer look into the practices showed unhealthy practices regarding diet and physical activity. Phase II showed that most of the subjects needed improvements in the diet quality and also in the quality of practices being followed. Subjects from two schools were allotted to two groups namely, Experimental Group (EG) and Control Group (CG).

Assessment of knowledge and practices was carried out in order to extract key messages for the development of the Nutrition Communication Programme (NCP) and was named as Creating Healthy and Active Learning Kids program – the CHALK Program.

Formative Research for the Development of CHALK Programme

Experimental group (EG) consisted of 212 subjects, comprising 134 boys and 78 girls while a total of 266 subjects constituted the Control Group with 166 boys and 100 girls. Most of the subjects were between 10-14 years of age.

Assessment of the knowledge levels regarding healthy eating and physical activity practices, followed dietary practices and food and nutrient intakes of the subjects

Subjects in EG had higher knowledge regarding healthy eating as compared to CG, while subjects in CG had higher knowledge regarding requirements of healthy growth and development. Around half of the subjects in both the groups considered breakfast as a very important meal. Although knowledge regarding functions of food, food groups, benefit of eating fruits / vegetables and appropriate weight was significantly higher in the experimental subjects, yet the number of correct responses was very low. Subjects in EG chose the most healthy choices out of the three options given, while, a significantly higher number in cg reported soft drinks and fast foods to be unhealthy. Subjects in both the groups had a very low knowledge level regarding healthy foods, healthy diet, food groups, food pyramid, number of complete meals, appropriate weight etc.

Assessment of the dietary practices followed by the study subjects in the two groups

A recall of the past 7 days showed that although many subjects reported of breakfast consumption on a daily basis yet the items consumed were not satisfactory. Almost half of the subjects consumed only milk for breakfast. A significant difference was observed in the mid-morning consumption between the two groups (EG 68% and CG 56%). The main reason for this was the canteen facility which was offered in the control group. A local vendor in the experimental group sold bakery items like vegetable puffs and muffins during recess. Possibly this was the reason why 30% of the subjects in EG reported irregular mid-morning food consumption. Daily vegetable consumption was reportedly high in both the groups but consumption of green leafy vegetables and yellow orange vegetables was very low.

Regular evening snack consumption was very high in CG. Consumption of unhealthy foods like Namkeen and farsan (both are deep fried dry salty snacks) was higher in EG. Around half of the subjects reported outside food consumption for >2 days in the past week.

Assessment of the daily physical activity practices of the study subjects

Playtime was significantly higher in CG with about 66% subjects in CG spending 60 minutes or more per day on playtime as against only 57% subjects in the EG.More than half of the subjects in both the groups reported > 180 minutes a day as their study time apart from the 5 hours of school time. Ninety percent subjects in both the groups spent < 2 hours on leisurely activities.

Assessment of the self-perception of the study subjects in the two groups

On showing a picture of three figures and asking the subjects to mark the figure that resembled them, the response showed that 72% in EG and 38% in CG had incorrect self-perception. Half of the subjects in EG who perceived themselves as underweight were normal, while out of the 36% subjects in CG who thought of themselves as underweight none were underweight. One fourth of the subjects in EG who thought they were normal, were actually underweight. None of the subject in CG thought of themselves as overweight and obese though 13% of them were overweight.

Assessment of the food and nutrient intakes of the subjects in the experimental and control group

Mean intakes of fruits was very low in both the groups. Mean intakes for energy, protein and iron were higher in CG while mean intakes for fat and calcium was higher in EG. However, there was no significant difference observed in the mean nutrient intakes of the subjects in both the groups. Around 85% subjects in both the groups reported consumption of milk daily although as observed by the mean food group intakes it was less than 40% of the recommended amount. Consumption of aerated drinks was significantly higher in CG (7.9%) as against 2.4% in EG. High consumption of various accessories like jams, murabbas, chutneys, pickles, papadetc.along with food was reported in the control group.

Selection of Key Messages and Development of the CHALK Programme

An assessment of knowledge and practices led to the selection of the following key messages for the NCP:

- Correct concept of Growth and Development of Adolescents
- Healthy food (Balanced diet) and Healthy Eating Behaviours
- Functions of foods and various food groups
- Meal Patterns and Breakfast consumption
- Dietary guidelines and Food Pyramid
- Healthy food choices (outside as well as at home)
- Fruit consumption
- Fast foods and soft drinks consumption
- Physical Activity
- Appropriate weight
- Self-perception

Based on the above concepts, a nutrition communication programme was developed. Seven sessions were conducted, which covered the concepts behind all the key messages for the subjects in the experimental group. The subjects in the control group received no intervention. The sessions were conducted on a weekly basis for boys and girls separately over a period of 3-4 months. Different communication methods like power-point presentations, posters, puzzles and video clips were used to communicate the information to the study subjects. Each session was planned for 45 minutes. These were followed by reinforcement sessions, which were conducted fortnightly for a period of 2 months. These reinforcement sessions were mainly a revision of the main sessions along with questions answer session.Average attendance for each session was 12 - 16 girls and 25-28 boys.

Phase IV Assessing the Impact of Nutrition Communication Programme (CHALK Programme) on the Dietary Practices of the Subjects

At the end of intervention data was collected on the knowledge, attitudes and practices followed (past 7 days), food and nutrient intakes for all the subjects excluding the dropouts. At the end there were 191 subjects in EG and 245 subjects in CG. There were 121 boys and 70 girls in the experimental group while the control group consisted of 154 boys and 91 girls. Therefore, assessment of the impact of the CHALK programme was limited to the subjects who completed the study.

Impact of the CHALK Programme on Knowledge Levels of the study subjects

Subjects in EG had significantly higher knowledge than the control group, before the intervention, regarding functions of foods, food groups, constituents of healthy breakfast, benefits of eating fruits and vegetables, healthy food choices, effect of TV viewing on growth and development, physical education and meaning of appropriate weight. The control group had significantly higher knowledge regarding the requirement of a healthy growth and development, importance of breakfast, unhealthy foods like soft drinks and fast foods prior to the intervention period.

Impact on knowledge regarding growth and development, healthy foods and healthy eating behaviours

Figure 5.4.1 shows a visual representation of changes in the knowledge and attitudes regarding growth and development, healthy foods and healthy eating behaviours after the intervention period. There was a significant difference in the understanding related to healthy growth and development between EG and CG (EG 39% and CG 19%). Prior to intervention CG had significantly higher knowledge regarding growth and development (EG 10% and CG 17%).

Knowledge regarding the concept of healthy foods was almost same between the two groups prior to intervention. A significant improvement in the experimental group was seen as compared to the control group (EG 58% and CG 6%) as well as in comparison with the knowledge levels prior to intervention in EG with regard to healthy food (EG pre 8% and EG post 58%).

Initially there was no significant difference between the two groups regarding healthy eating behaviours, while after the intervention, EG showed a ten times increase in knowledge while CG remained the same. The difference in both the groups after intervention was found to be significant regarding healthy eating behaviours.

Impact on knowledge regarding food groups, number of complete meals and breakfast consumption

EG subjects showed a 15 times increase in the understanding of food groups after the intervention. This was a significant increase in the knowledge in EG after the intervention. None of the subjects in CG could correctly respond on being asked about food groups. EG was significantly higher than CG before and after the intervention .

A significant difference between in the experimental group in relation to the concept of meals was observed post intervention (EG pre 7% and EG post 26%). There was no significant change in the control group (CG pre 9.4% and CG post 9.8%) after the intervention period. Initially there was no difference between the two groups regarding the concept of number of meals in a day but after the intervention EG was significantly higher than CG in the number of correct responses.

The number of subjects who reported breakfast as a very important meal was significantly higher in the experimental group after intervention (EG pre 50% and EG post 70%). CG was significantly higher than EG before intervention regarding the responses on importance of breakfast (EG 47% and CG 58%), while after intervention CG had significantly lower number of correct responses as compared to EG (EG 69% and CG 60%). There was no significant change regarding constituents of healthy breakfast among the subjects in EG before and after the intervention (Figure 5.4.2).

Impact on knowledge regarding healthy food choices, food pyramid and appropriate weight

There was no significant difference in EG regarding healthy food choices before and after the intervention.

No difference was observed in the two groups regarding correct response for food pyramid after the intervention. However, the number of partially correct responses related to food pyramid were significantly higher in the experimental group after the intervention (3.7% EG and 0.8% CG; $p<0.05$).

A significant three fold rise was observed in the number of subjects (31%) stating that appropriate weight is the weight according to age and sex, in the experimental group after the intervention (EG pre 11% and EG post 31%).

Impact of the CHALK Programme on the Dietary Practices of the Subjects – Post Intervention

Daily breakfast consumption showed a rise of 6% among the experimental group subjects. Daily consumption of only milk decreased while subjects consuming a combination of milk and cereals increased significantly in the experimental group. In the control group there was no significant difference observed related to breakfast consumption before and after the intervention.

Experimental group showed a significant rise in daily mid-morning food consumption after the intervention. However, there was no significant change observed in the control group. This positive change in the dietary practice of the subjects can be attributed to the CHALK intervention (Figure 5.4.3).

Daily vegetable consumption improved significantly in the experimental group after the intervention and could be attributed to the increase in the consumption of a cereal vegetable combination for mid mornings, while there was no significant change in the control group. There was no significant change in both groups regarding fruit intake.

There was no significant change in the consumption of evening snacks, outside food and water intake in both the groups before and after the intervention.

Impact of the CHALK Programme on the Physical Activity Practices of the Subjects– Post Intervention

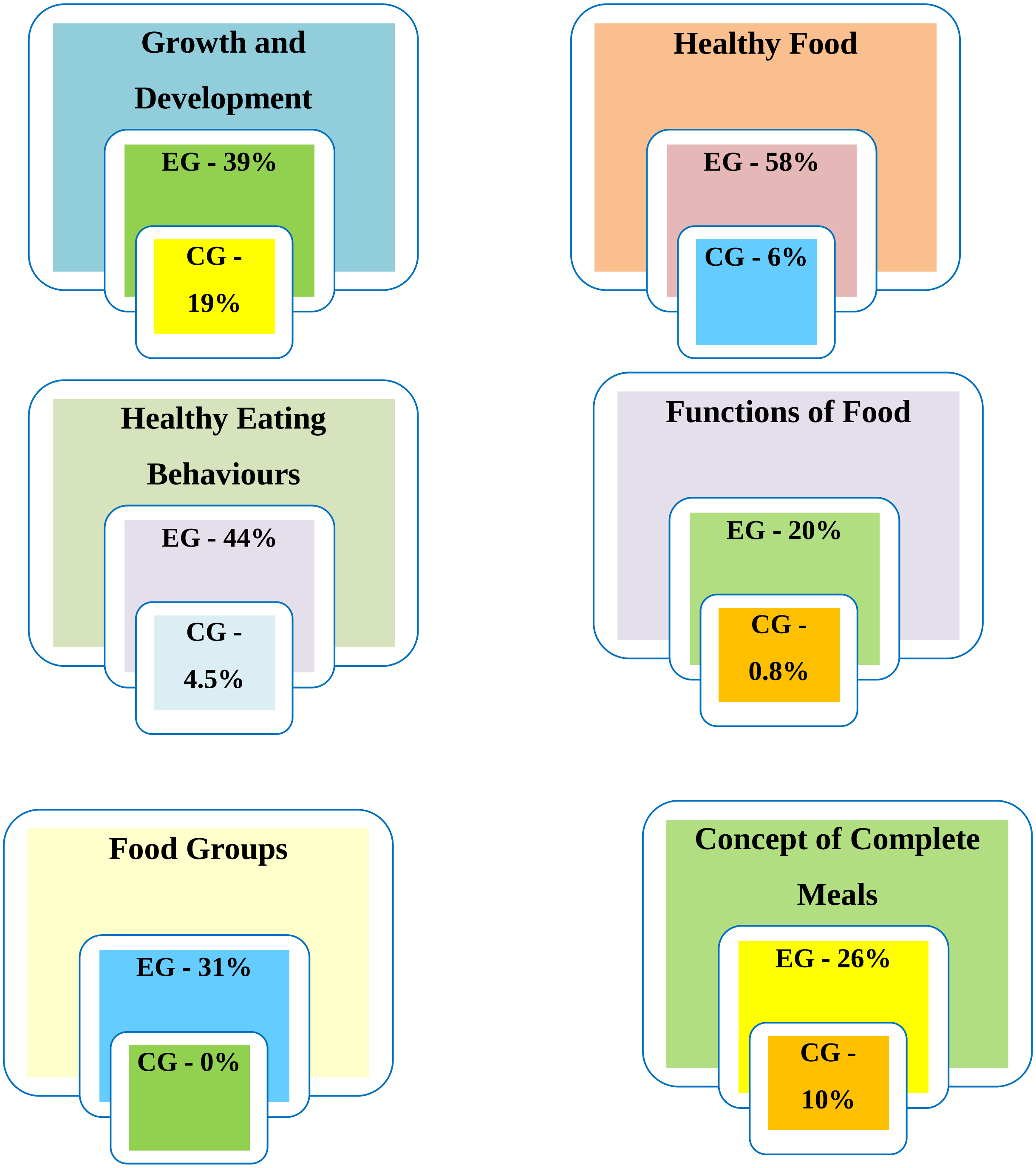
Playtime (>60 minutes / day) was significantly higher in the subjects of control group before intervention. However, after intervention there was no significant difference found between the playtime of the subjects in the two groups.

A very small positive change was observed in the physical activity levels though these changes were not significant among the subjects of the experimental group.

Impact of CHALK Programme on the Self-perception of the subjects in the two groups– Post Intervention

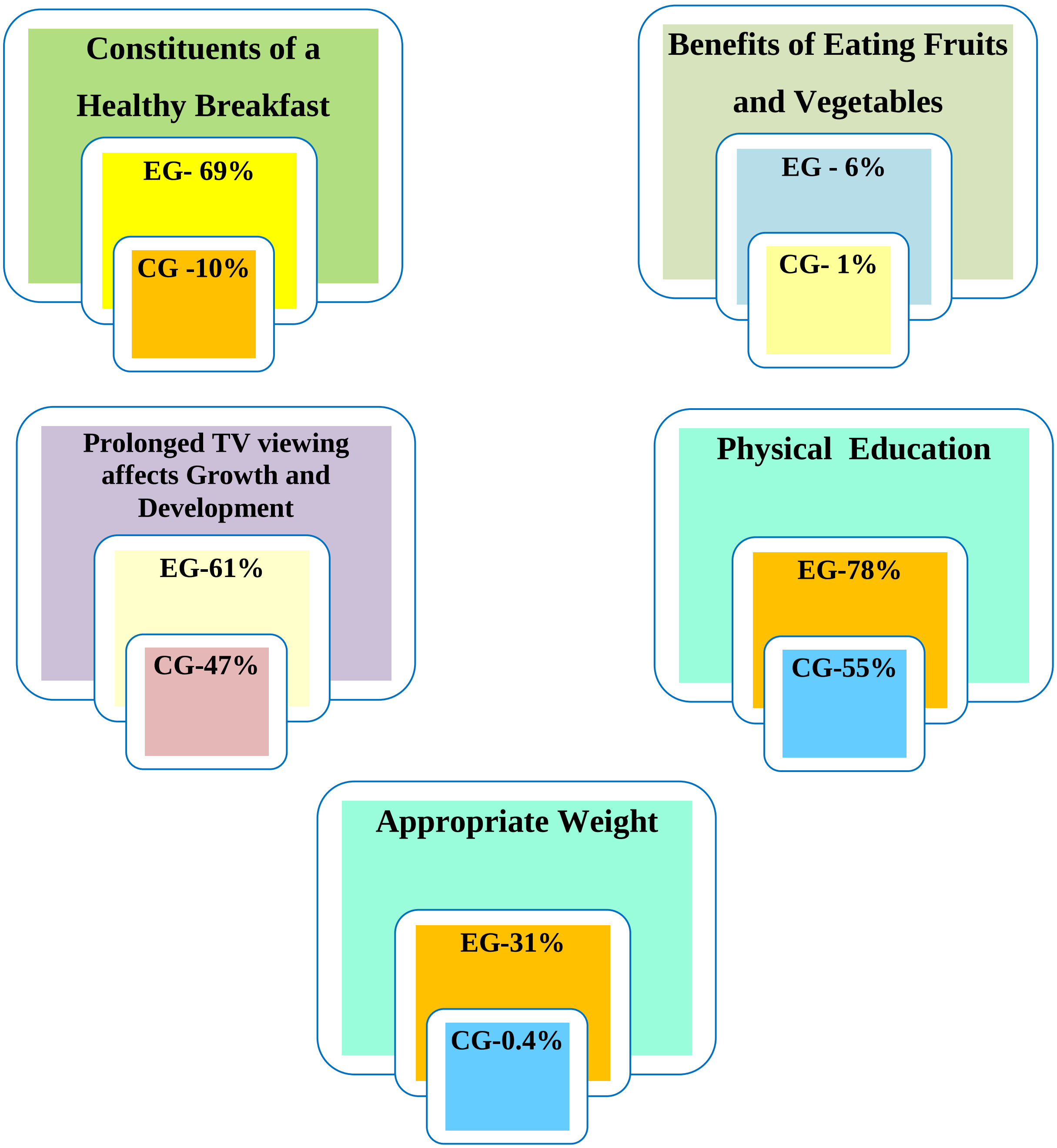
Around 72% of the subjects in the experimental group showed incorrect self-perception prior to the intervention, while after intervention 53% subjects had incorrect perception regarding themselves, this was a significant change in the group. Control group on the other side did not show any significant change in self-perception of the subjects after the intervention period (CG pre57% and CG post 58%).

Figure 5.4. 1: Overview of the Impact of the CHALK Programme on increase in Knowledge levels of the study subjects*



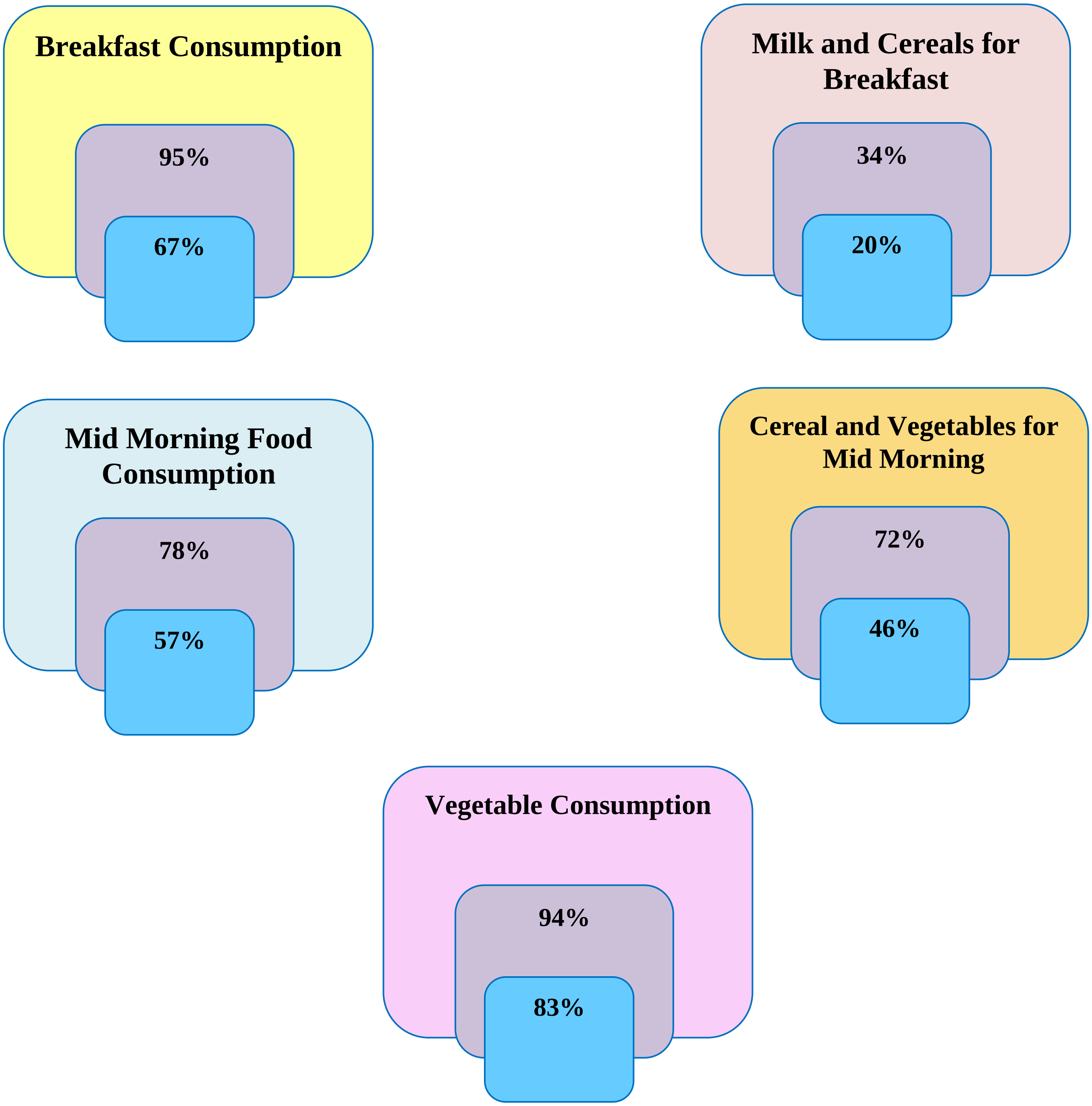
*Visual Representation (Not to Scale)
EG – Experimental Group
CG - Control Group

Figure 5.4. 2: Overview of the Impact of the CHALK Programme on the Knowledge Levels of the study subjects*



*Visual Representation (Not to Scale)
EG – Experimental Group
CG - Control Group

Figure 5.4. 3: Overview of the Impact of the CHALK Programme on the Dietary Practices of the study subjects



*Visual Representation (Not to Scale)
Represents – Experimental Group
Represents - Control Group

Impact of *CHALK* programme on the Food and Nutrient intake of the subjects

There was a significant increase in the mean food group intakes of grains, vegetables and edible oil in EG after the intervention while, a significant decrease in the mean intakes of grains, pulses and milk was observed in the control group. After the *CHALK* programme intervention the experimental group had significantly higher intakes of grains, vegetables and edible oil as compared to the control group.

A 4% increase was observed in the energy intakes in EG while there was a 0.4% increase observed in CG after the intervention. Mean protein intakes increased by 2g in EG which accounts for a 5% increase which was significant. A significant increase of 0.9 g in fat intakes was seen in the experimental group after the intervention.Although there was no significant difference between the two groups before the intervention, a significant difference was observed in the mean energy and iron intakes of the subjects in the two groups, post intervention.

Mean increments in the nutrient intakes were significantly higher in the experimental group as compared to the control group.The mean increment for all the nutrients was highest in girls as compared to boys in the experimental group, while in the control group the mean increments were higher in boys as compared to girls.Mean increments in the intakes for all the nutrients in the experimental group were significantly higher than the control group amongst both the sexes.The youngest age group showed the maximum positive change in the experimental group. Analysis of variance showed that being in the experimental group had a significant effect on the mean increments of the nutrients ($p<0.001$).

Analysis according to the stage of adolescence showed that pre-adolescents in EG had significantly higher mean increments, as compared to early adolescents, followed by mid-adolescents. Mid-adolescents, in the control group, showed negative increments in the mean intakes for energy fat and iron. These increments were found to be significantly lower as compared to the experimental group.

The difference in the mean RDA before and after intervention was found to be significant in case of the experimental group for all the nutrients. A 5% rise was seen in the experimental subjects, consuming >75% of RDA for energy, against 1% increase in the control group. A drop of 8% was observed in the experimental group subjects consuming <75% of the RDA for protein, resulting in an equivalent rise in the protein intakes of >75% of the RDA for protein. An increase of 1% subjects in the control group, consuming <75 % of the RDA for protein after intervention. An increase of 3.6% was observed in experimental subjects consuming >100% RDA for fat after the intervention, while the control group showed no changes before or after the intervention. A significant improvement in the iron intakes was observed with an increase of 5% in the subjects in the experimental group while the control group subjects showed an increase of 0.5% in the subjects consuming >50% of the RDA for iron post intervention.

Impact of the CHALK Programme on the Frequency of Consumption of Healthy and Unhealthy Foods

An analysis of the frequency of food consumed showed a significant improvement in daily consumption of other vegetables like lady finger, cauliflower, brinjaletc in the experimental group. Daily consumption of fried foods went down significantly from 13.1% to 6.8% in the experimental group while a non-significant rise of 2% was observed in the control group after the intervention programme. A 6% reduction was observed in the experimental group as against a 2% increase in the control group regarding daily consumption of baked foods after the intervention.

Consumption of sugary foods like sweets chocolates, candies, ice creams, accessories like jams, murabbas, pickle, chutneys, papads and aerated soft drinks remained significantly higher in the control group than the experimental group while consumption of fruits was significantly lower in the control group as compared to the experimental group after the intervention.

Conclusion

Several major conclusions emerge from the present study. Firstly, the study clearly demonstrates that in middle income group urban school going children (Pre-adolescents and Adolescents), dual burden of malnutrition exists. However, the problem of undernutrition is higher than overnutrition. Two out of three schools used to check height and weight of the subjects once a year, still prevalence of undernutrition was very high in these schools, as it was done only for the school records. Therefore, growth monitoring and promotion should be a regular practice in all the schools, the students should be taught to read and prepare their own growth charts and also to calculate their BMI (A point to note here is that almost all the subjects in the present study except the V standard students were able to calculate their BMI). Parents should be informed regarding the nutritional status of their child.

Secondly, self-perception of the child leads to a healthy or unhealthy behaviour. Many subjects in the present study had incorrect perception about their body types. An increase in the awareness regarding ‘healthy weight and unhealthy weight’ would help adolescents to perceive themselves more clearly which in turn, would lead to improved healthy behaviours.

Thirdly, Healthy Eating Index for Adolescents (HEIA) was found to be a valid and reliable tool in assessing the dietary quality of the subjects. Similarly, Food Behaviour and Activity Checklist for Adolescents (FBACA), was a short, valid and reliable tool for assessing the quality of practices being followed by the school children. Tools like HEIA and FBACA should be developed for other age groups.

Fourthly, simple Behaviour Change Communication (BCC) messages can be designed and imparted to adolescents and their parents, especially mothers in order to bring about long term changes in their behaviour.

Policy Implications for Healthier Dietary and Physical Activity Practices

Advocacy is required at all levels right from the students, their parents, teachers and even the Principals, regarding health and healthy eating behaviours. There is a need to change the existing policies in schools regarding health of the school children. Schools can be accredited for initiating healthy canteen facilities, health education, growth monitoring etc. This would motivate the school authorities to generate new ways of health improvement amongst the students.

Also there is need to develop new tools like HEIA and FBACA for all age groups and implement it at population levels, to see the degree of conformation to the dietary guidelines. These tools are simple, yet valid and reliable for populations.

Another implication to be drawn from the present study is that with a little information general population can also be trained to evaluate the quality of their own diets using HEIA and FBACA. Steps should be made in this regard as to make these tools more accessible to the population.

Thus, to conclude simple dietary tools like HEIA - to assess the diet quality and FBACA - to assess quality of dietary and physical activity practices, should be used in conjunction with simple BCC messages to bring about positive behavioural changes amongst populations.

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APPENDIX- I

SOCIO ECONOMIC STATUS

Background Information

1. Date of Birth ______________________________
2. Sex : 1) Male 2) Female
3. Religion: 1) Hindu 2) Muslim 3) Sikh 4) Christian 5) Parsi 6) Others ☐
4. Type of Family: 1) Joint 2) Nuclear 3) Extended ☐
5. Family Size : Total _______ Adults _______ Children ($\leq$ 18 yrs) ________
6. Father's Occupation : Actual ______________________________________
7. Father's Education : 1) Elementary 2) High School 3) Diploma 4) Graduate 5) Post Graduate 6) PhD (Write **actual** also) ☐ _________________________
8. Mother's Occupation : Actual ______________________________________
9. Mother's Education : 1) Elementary 2) High School 3) Diploma 4) Graduate 5) Post Graduate 6) PhD (Write **actual** also) ☐ _________________________
10. Approximate Family Income : Rs. ____________________/Month
11. Per capita Income/month : _____________________________________
12. Dietary Habits 1) Vegetarian 2) Non-Vegetarian 3) Ovo-vegetarian ☐
13. Is anyone Overweight or Obese in your family? 1) Father 2) Mother 3) Both the parents 3) Siblings ☐

APPENDIX - II

Proforma for 3 Day 24 – hour Dietary Recall

Name : **Class:** **School:** **Sibling in school: Yes / No**
If yes which class: **Address:**

Meal	Date & Time	Food Item	Ingredients	Raw amounts (g/ml)	Total cooked quantity (g/ml)	Consumption of food by subject (g/ml)	Intake of raw ingredients (g/ml)

APPENDIX –III

Proforma for Food Frequency

Name:_________________________Class:__________________________School____________

Food item	Daily	Alternate days	Twice a week	Once a week	Twice a month	Once a month	Rarely	Never
Chapati								
Phulka								
Bhakri/ paratha								
Puri								
Bread								
Rice								
Pulav								
Khichdi								
Dals								
Whole legumes								
Milk								
Curd/buttermilk								
Cheese								
Eggs								
Chicken/chicken products								
Meat/products								
Fish /products								
Green leafy vegetables								
Cauliflower, beans ladyfinger, brinjal, cabbage, peas, tomato, cucumber								
Beetroot,onion,potato, radish, sw.potato,yam								
Yellow &orange veg. pumpkin and carrot								
Fruits								
Apple,banana,cheeku, custard apple, guava								
Yellow-orange fruits								
Amla								
Butter								
Ghee								
Instant noodles								
Instant soups								
Cream biscuits								
Plain biscuits								
Salted biscuits								
Cakes								

Food item	Daily	Alternate days	Twice a week	Once a week	Twice a month	Once a month	Rarely	Never
Pastries								
Pavbhaji								
Burger								
Pizza								
Milk shakes								
Tinned fruit juices								
Fresh fruit juice								
Aerated soft drinks								
Non aerated soft drinks								
Chocolates								
Candies/ sweets								
Mithai								
Ice creams								
Jams/murabba								
Pickles/sauces/ketchup								
Papad								
Fried snacks(wafer/ samosa/ kachori etc.)								

APPENDIX- IV

Food Behaviour Checklist

Name: **Std:** **School:**

Sr. no.	**Food & life style pattern**	Day(0- 7) (specify)
1.	**Breakfast:** (1) Yes (2) No	
2.	**Breakfast Options:** milk, tea, milk/cereal, cereal/veg, milk/cereal/veg etc.	
3.	**Mid morning:** (1) Yes (2) No	
4.	**Mid morning Options:** cereal, cereal/veg, cereal/pulse/milk product, etc.	
5.	**Vegetables:** (1) Yes (2) No	
6.	**Vegetables:** GLV'S,	
7	**Vegetables:** Yellow and Orange veg. like pumpkin, carrot	
8.	**Vegetables:** Roots & tubers like potato, onion etc.	
9.	**Vegetables:** Other veg. like lady finger, cauliflower, brinjal, bottle gourd(doodhi) etc.	
10	**Fruits:** (1) Yes (2) No	
11	**Local fruits:** wood apple, guava, bor, etc.	
12	**Evening Snacks**: (1) Yes (2) No	
13	**Evening Snacks options:** namkeen and farsan	
14.	**Evening Snacks options:** Biscuits and bakery products like bread, puff etc.	
Sr. no.	**Food & life style pattern**	Day(0- 7) (specify)

Sr. no.	**Food & life style pattern**	Day(0- 7) (specify)
15.	**Outside foods:** Pav bhaji, Punjabi, Chinese, fast foods etc.	
16.	**Carry lunch to school:** 1) Yes (2) No	
17	**Have MDM :** 1) Yes (2) No	
18	**Water Intake (Frequency)**	____________ glasses.
19	**Activity: Playtime in school and home (Daily):**	____________ minutes
20	**Activity: Leisure time (watching TV, computer games, video games etc.) (Daily)**	____________minutes
21	**Activity: Study time (Daily)**	____________minutes

APPENDIX V

DIGIT SPAN

Digits Forward	Score	Digits Backward	Score
3-8-6	3	2-5	2
6-1-2	3	6-3	2
3-4-1-7	4	5-7-4	3
6-1-5-8	4	2-5-9	3
8-4-2-3-9	5	7-2-9-6	4
5-2-1-8-6	5	8-4-9-3	4
3-8-9-1-7-4	6	4-1-3-5-7	5
7-9-6-4-8-3	6	9-7-8-5-2	5
5-1-7-4-2-3-8	7	1-6-5-2-9-8	6
9-8-5-2-1-6-3	7	3-6-7-1-9-4	6
1-6-4-5-9-7-6-3	8	8-5-9-2-3-4-2	7
2-9-7-6-3-1-9-4	8	4-5-7-9-2-8-1	7
5-3-8-7-1-2-4-6-9	9	6-9-1-6-3-2-5-8	8
4-2-6-9-1-7-8-3-5	9	3-1-7-9-5-4-8-2	8

APPENDIX-VI

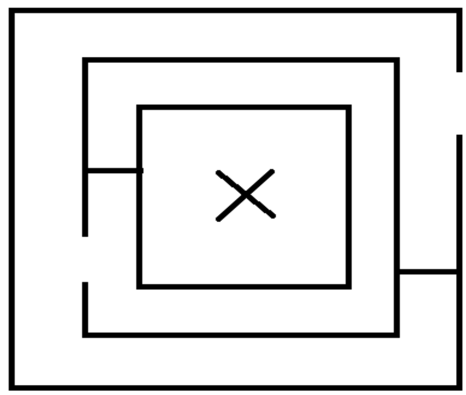
List of Items Kept for Observation During Visual Memory Test

1. Pen
2. Pencil
3. Sharpner
4. Rubber
5. Ruler
6. Comb
7. Mobile
8. Clip
9. Stapler
10. Brush
11. Crayon
12. Chalk
13. Chocolate
14. Scissors
15. Coin

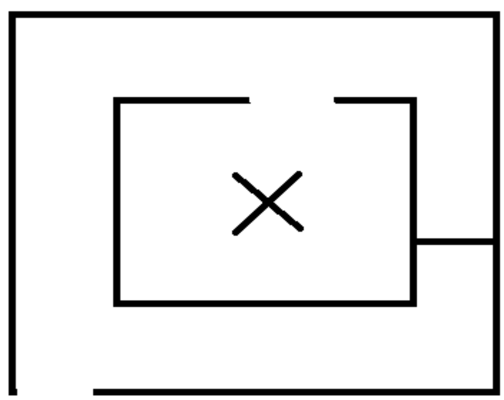
APPENDIX – VII

MAZE TEST

SAMPLE :

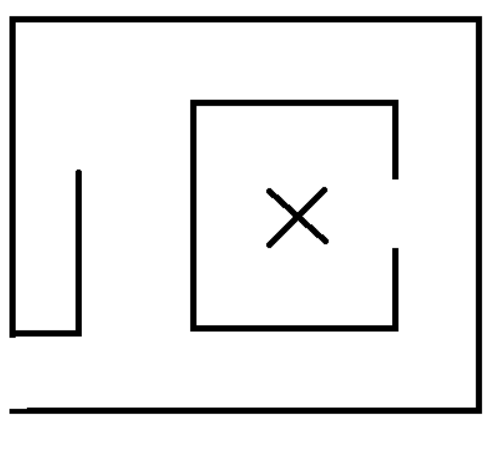


MAZE : A



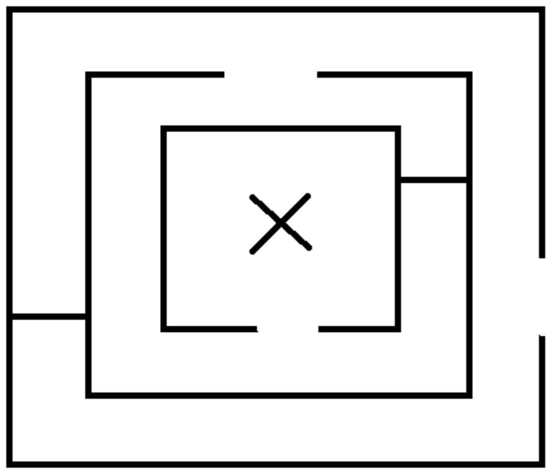
ERROR : _______ POINTS : ________

MAZE : B



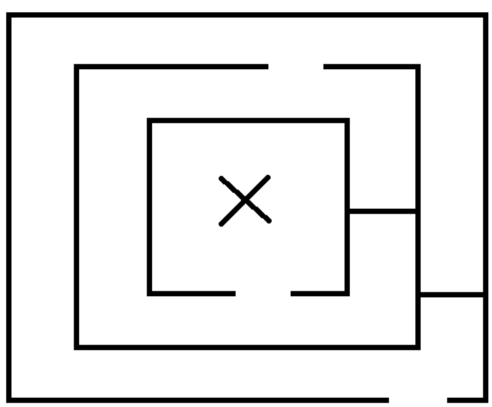
ERROR : _______ POINTS : ________

MAZE : C



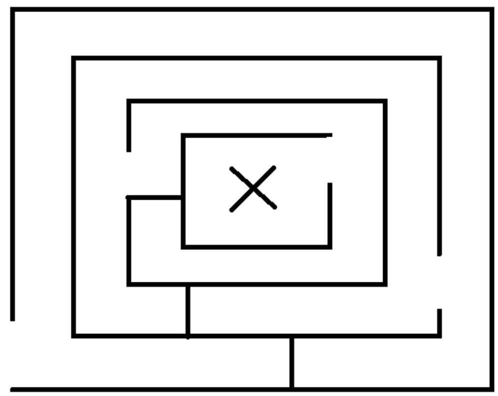
ERROR : _______ POINTS : ________

MAZE : 1



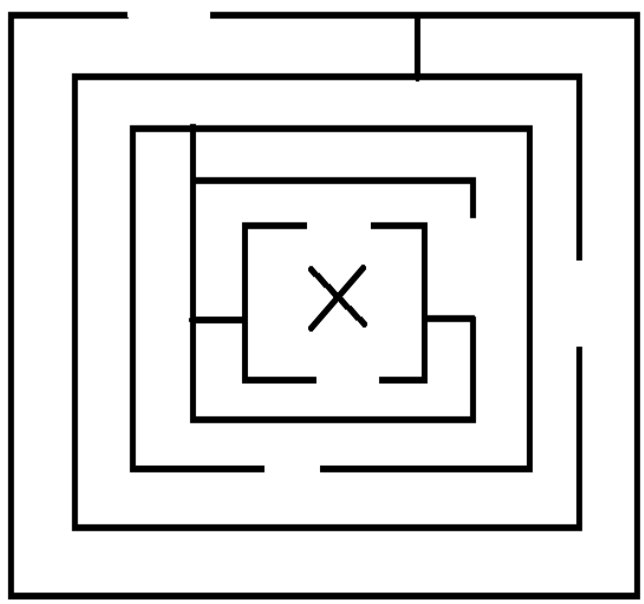
ERROR : _______ POINTS : ________

MAZE : 2



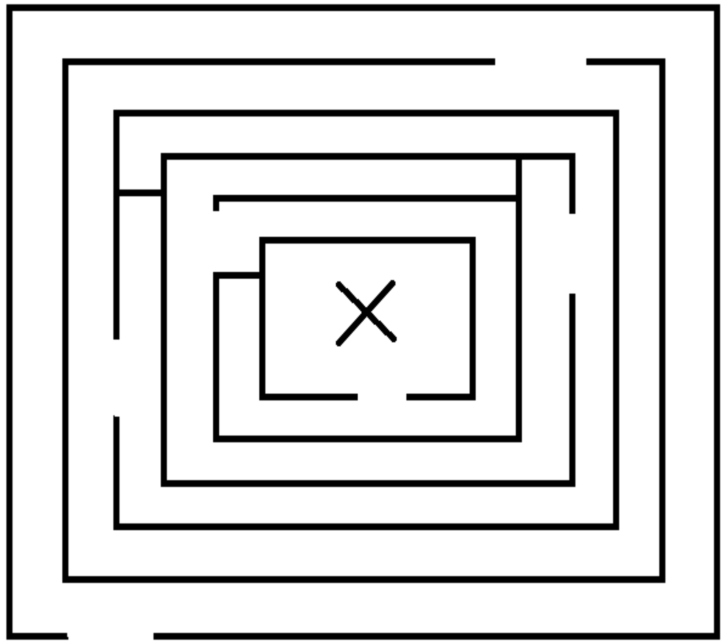
ERROR : _______ POINTS : ________

MAZE : 3



ERROR : _______ POINTS : ________

MAZE : 4



ERROR : _______ POINTS : ________

APPENDIX – VIII

Scoring for the Maze Test

Maze	Errors allowed	Time limit	Points		
			0 Error	1 Error	≥2 Error
Maze A	2	30 sec	2	1	0
Maze B	2	30 sec	2	1	0
Maze C	2	30 sec	2	1	0
Maze1	3	30 sec	3	2	1
Maze 2	3	45 sec	3	2	1
Maze 3	5	60 sec	3	2	1
Maze 4	6	120 sec	3	2	1

APPENDIX -IX

Knowledge Attitude and Practices Questionnaire for children

Healthy eating and dietary habits

1. What is important for growth and development?

2. What according to you is healthy food?

3. What according to you is healthy eating?

4. Since last year, have you being taught about healthy eating?
1) Yes 2) No

5. If yes, how many times have you been taught in school about healthy behaviours and healthy eating?
1) Never 2) Once 3)Twice 4)Three or more class lessons
e) Any other (specify) ______________________

6. If yes, what were you taught about healthy eating?

7. Give the different functions of foods.
8. Name the different food groups.
9. Name at least 3 foods that help you grow.
10. According to you, what is the number of complete meals you should have in a day?
1) 1 2)2 3) 3
4) 4 5.)5 6) More than 5
11. Is breakfast an important meal?
1) Very important 2) As important as other meals
3) Not very important 4) Not at all important
12. What do you think constitutes a healthy breakfast?
1) Only milk
2) Milk and cereal (bread/ chapatti/cornflakes/parantha)
3) Milk, cereal and some vegetable (excluding potato)
4) Milk, cereal and fruits 5) Milk, cereal, fruits and nuts.
6) All the above 7) Any other, specify_________________
13. Do you have breakfast?
1) Yes 2) No
14. If yes, do you have it on a regular basis?
1) Yes 2) No

15. During the past 7days, how often did you eat breakfast before you left for school ?
    1) Less than 2 days   2) 2-4 days   3) More than 4 days   4) 7 days
    (If the option you have selected is “4”, then do not attempt the next question)

16. If you skip your breakfast, mention the reason for it?
    1) I do not have time for breakfast   2) I cannot eat early in the morning
    3) There is not always food in my home   4) Some other reason

17. What do you usually consume for breakfast?

1)Pohe	2)Upma	3)Idli	4)Dosa
5)paratha	6)Bread	7)Cornflakes	8)Daliya
9)Egg	10)Milk	11)Fruits	12)Biscuits
13)Maggi	14) pasta	15)Any other (Please specify)	

18. Do you generally eat after going home from school?
Yes / no

19. If yes, what do you generally eat?

1) Bread	2)pastries	3)biscuits	4)Chiwda
5) farsan	6)Milk	7)Soft drinks	8) pohe
9) upma	10) fruits	11)Lunch	12)Any other (please specify)

20. If lunch, what do you have?

1) Chapatti	2)Phulka	3)bhakri	4)paratha
5) Rice	6)Usals	7)Dals	8)Salads
9) Chicken	10)Meat	11) Fish	12)Sweets
13) vegetables	14) Any other (please specify)		

21. When you are very hungry, what do you normally eat at home?

22. How many meals did you have yesterday?

Breakfast		Midmorning		Lunch	
Evening		Dinner		Bed time	

23. Since last year, were you taught in any of your classes the benefits of eating more fruits and vegetables?
    1) Yes   2) No

24. If yes, how many times have you been taught in school about the benefits of eating more fruits and vegetables?
    1) Never   2) Once   3)Twice   4)Three or more class lessons

5) Any other (specify)____

25. What was taught about eating fruits and vegetables in school?
26. How many servings of fruits should you have in a day?
27. Define one serving of fruit?
28. In what form do you consume fruits?

1) Whole fruits peeled 2) Whole fruits unpeeled 3) Fruit juice
4) Do not consume

29. Reasons for not consuming fruits?

1. I do not have time 2.There is not always fruit in my home
3. I don’t like fruits 4. Some other reason

30. Since yesterday at this time, how many glasses of water did you drink?
1 glass=200ml

31. If you were given a chance to choose your food, which ones from the following would you select? (please select one food from each group of foods)

<u>Group A</u>	<u>Group B</u>	<u>Group C</u>
Potato	Chips	Pastries
Green leafy vegetables	Pohe	Ladoos
Cauliflower	Biscuits	Fruit salad

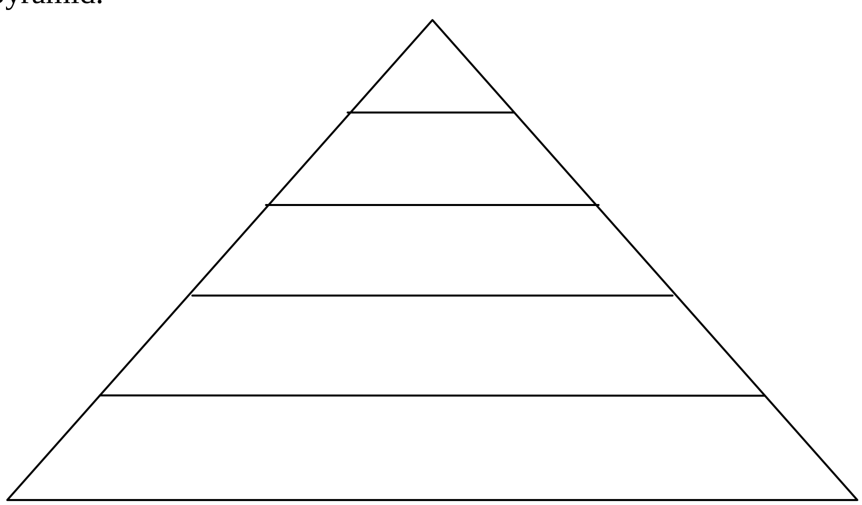
32. Do you add extra salt to the food at the dining table?

1. Yes 2. No

33. What accessories do you consume with your meals?

1) Curd 2) Chutney 3)Papad
4) Pickles 5) Jams/ Murabbas 6) Any other

34. Fill in the food pyramid given below. The foods that you can consume in maximum amount should come at the bottom, and those to be had in the least amount should be at the top of the pyramid.



Fast-food and soft-drink intake

35. Do you think soft drinks can impart any health benefit to you? Explain
    1. Yes 2.No

36. Do you think fast foods can impart any health benefit to you? Explain
    1. Yes 2.No

37. How many times in a week do you eat out? Actual ______
    1) Less than once a week 2) Once a week 3) 2-3 times a week or more

38. In the past 7 days how often have you eaten out (outside your home) with your Family/friends?
    1) 0 days 2) 1 day 3) 2 days 4) 3 days
    5) 4 days 6) 5 days 7) 6 days 8) 7 days

39. When you go out to eat, what are the foods that you like to have? (Name at least three foods)
40. Do you get any pocket money?
    1. Yes 2.No
41. If yes, mention the average amount you get per week?
42. How much of it do you spend on food?
43. What kind of food do you purchase?
44. What do you purchase from street vendor/ shop outside the school?
    1) Biscuits and confectionaries 2) Fried foods
    3) Cold drink 4) Fruits
    5) Bakery items (puff, biscuits, cream rolls etc. 6) wafers/ fryums
    7) any other

Food consumption pattern in the school

45. Mention what you usually eat during your recess?
    1. I get my own packed lunch from home
    2. I consume MDM provided by school
    3. I buy food from outside (street)
    4. All of the above
    5. I go home for having lunch 6. None

46. Do you carry your lunch to the school?
    1. Yes 2. No

47. What do you usually carry for lunch?

48. During the past 7days, how often did you bring your lunch to school?

1) 0 days 2) 1 day 3) 2 days 4) 3 days

5) 4 days 6) 5 days 7) 6 days 8) 7 days

49. Mention the average amount of money you spend on food in school per week?

50. Does your teacher check or evaluate the Tiffin that you carry?

1. Yes 2. No

Oral Health.

51. I brush my teeth (tick the appropriate answer)

1. Once a day 2. Twice a day

52. Do you have cavities in your teeth?

1. Yes 2. No

If yes how many cavities do you have?_______________

Physical activity and T.V watching.

53. What time do you get up every day? _______________

54. What time do you go to sleep? _______________

55. Do you think it is important for you to be physically active?

1. Yes 2. No

56. What is the minimum level of physical activity that you should undertake in your view?

1. Should not undertake at all 2. ½ hour 3. 1 hour

4. 1-2 hours 5. More than 2 hours

57. How much time on an average do you undertake physical activity in a week?

1. ½ hour 2. 1 hour

3. 1-2 hours 4. More than 2 hours

58. What type of physical activity do you undertake?

59. Do you get involved in any kind of physical activity / games during leisure or free time in school?

1. Yes 2. No

60. Does prolonged T.V viewing can have an effect on your growth and development?

1. Yes 2. No

If yes, what?

61. Since last year, how many times have you been taught in school to do physical activity or exercise at Home?

1. Never 2. Once
3. Twice 4. Three or more class lessons

62. Since yesterday at this time, how many minutes of physical activity did you do at home?

63. How do you pass your leisure time?

Sr. no.	Activity	Frequency				Duration
		Daily	Weekly	Sometimes	Never	
1	TV viewing					
2	Video games					
3	Computer games					
4	Listening to music					
5	Dance					
6	Karate					
7	Reading					
8	Swimming					
9	Conversing with friends on phone					
10	Cricket					
11	Others specify ________________					

Physical education

64. According to you what is physical education?

65. According to you is physical education important?

1. Yes 2. No

66. Do teachers teach you about any physical education?

1. Yes 2. No

67. Since last year, on how many days did you go to physical education class each week?

1. 0 days 2. 1 day 3. 2 days 4. 3 days
5. 4 days 6. 5 or more days

Physical activity and Behavioural pattern

68. How long does it take for you to reach school from your house?

1. < 5 mins 2. 5 – 15 mins 3. 15 – 30 mins 4. 30 mins

69. What is your mode of transportation to and from school?

1. Walking 2. Bicycle
3. Public transport / school transport 4. Own Automated vehicle

70. During the past 7 days, on how many days did you walk or ride a bicycle to and from school?

1. 0 days 2. 1 day 3. 2 days 4. 3 days
5. 4 days 6. 5 days 7. 6 days 8. 7 days

71. What according to you is appropriate weight?

72. How important is it for you to have appropriate weight?

1. Not At All Important 2. Slightly Important
3. Moderately Important 4. Very Important
5. Extremely Important

73. How long should you exercise daily in order to stay healthy?________

74. Do you tire easily after playing for 5-10 minutes?

1. Yes 2. No

75. Do you avoid playing with your friends because you cannot keep up with them?

1. Yes 2. No

76. Do you feel tired after walking up the stairs?

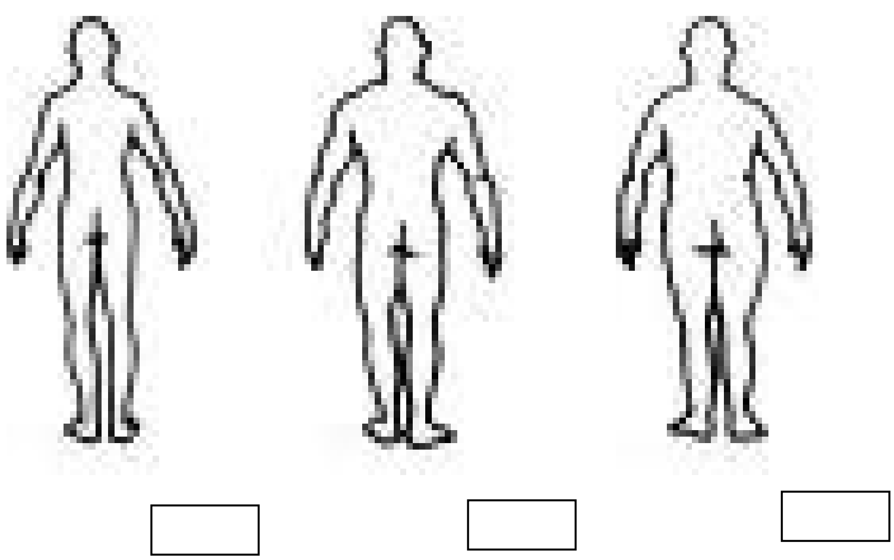
1. Yes 2. No

77. I Fall ill

1. Often 2. Sometimes 3. Rarely

Self- Perception

78. What do you think you look like?



APPENDIX- X

Knowledge Attitude and Practices Questionnaire for Teachers

1. Name:
2. Class:
3. School:
4. Date of Birth:
5. Weight:
6. Height:
7. BMI
8. Waist:
9. Hip:
10. WHR:
11. Muac:
12. Wrist:
13. What age group does Adolescent period cover?
    a) 0-5 years b) 6-9 years c)10-19 years d) 19 years and above
14. What according to you is important for Growth and development?
    a) Food b) Exercise c) Both d) Any other
15. According to you what are the steps that should be taken to address the nutritional requirements of a child in this age group?
    a) Health check ups
    b) Monitoring the dietary intake of the child at home
    c) Restricting the child from eating out not more than twice a week
    d) Restricting the intake of fast foods, soft drinks to not more than twice a week
    e) Restricting the child not to purchase unhealthy snacks (samosas, puffs, French rolls etc.)
16. Any other
17. Do you know what 'Malnutrition' is? 1. Yes 2. No
18. Which age group does it affect?

a) 0-5 years b) 6-9 years c) 10-19 years d) 19 years and above

19. Do you think it is important to get a child's nutritional status assessment done from time to time? 1. Yes 2. No

20. Do you know what is the most relevant method used to assess the nutritional status (normal weight, underweight, overweight, obesity) of adolescents? 1. Yes 2. No If yes name the method.

21. Do you know what Body Mass Index (BMI) is? 1. Yes 2. No

if yes give the formula:

22. Do you know what the causes of under nutrition (Underweight and anemia) are? 1. Yes 2. No

If yes, then what

a) Skipping breakfast

b) Unhealthy dietary practices

c) Consumption of aerated drinks

d) Unhealthy school meal

e) Any other

23. What according to you is Healthy Food?

24. What according to you is Healthy eating?

25. Give the different functions of food?

26. Name the different food groups?

27. Name at least 3 foods that help a child grow.

28. What is the number of complete meals a child should have in a day?

1) 1	2) 2	3) 3
4) 4	5) 5	6) more than 5

29. Do you think soft drinks can impart any health benefit to children? 1. Yes 2. No

Explain

30. Do you think Fast foods can impart any health benefit to children? 1. Yes 2. No

Explain

31. Do you think it is important for children to be physically active? 1. Yes 2. No

32. If yes for how many days do you think they should exercise in a week?

a) Everyday b) 3-4 times a week c) Twice a week d) Any other

33. What kind of exercise should they undertake?

Exercise	Time

34. Do you know the calories in the foods you eat regularly? 1. Yes 2. No

35. Do you limit the portion size of the foods you tend to overeat? 1. Yes 2. No

36. Do you use whole legumes instead of dals regularly 1. Yes 2. No

37. Peel the skin of fruits like apple and chickoo? 1. Yes 2. No

38. Know what affects the nutritional needs of individual?

    1. Age 2. Sex 3. Activity 4. Any other

39. Give two benefits of giving fruits and vegetables to children?

    a. b.

40. What are the benefits of giving green, yellow and orange vegetables and fruits to children?

41. Growing children should eat a lot of fat (ghee/oil). Is this true?

42. Have you anytime made decisions to purchase or consume certain foods based on information or advertisements from newspapers, magazines or television? 1. Yes 2. No

If yes, which foods and why?

43. Do you believe in the concept of hot and cold foods? 1. Yes 2. No

If yes give examples of some <u>Hot foods</u> <u>Cold Foods</u>

44. Should mothers make restrictions for the above mentioned foods in a child's diet?

    1. Yes 2. No If yes, when and why?

45. What are the foods that you would serve A child recovering from illness

46. What are the foods that you would serve After a child comes back from play

47. What are the foods that you would serve A child for breakfast

48. What are the foods that you would serve A child for evening snacks

49. What are the foods that you would serve A child for Tiffin

APPENDIX- XI
Observational Checklist for Schools

1. Are there any street vendors/shops found outside the school?

1. Yes		2. No

2. If yes, how many were found?

1. 1	2. 1 – 3	3. > 3

3. What do these vendors sell?

1. Biscuits & confectionaries	2.Fried food	3. Cold drinks
4. Fruits	5. Wafers/fryums	6. Bakery items

4. What do children buy from vendor/shop outside the school?

1. Biscuits & confectionaries	2.Fried food	3. Cold drinks
4. Fruits	5. Wafers/fryums	6. Bakery items

APPENDIX –XII

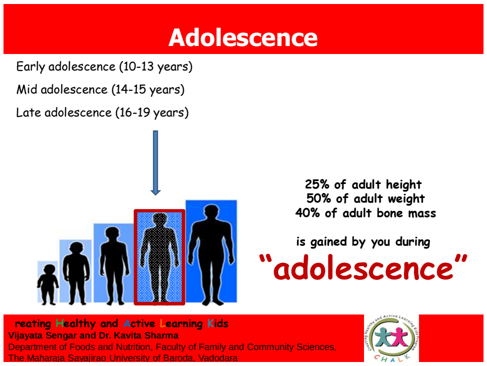
SCORE GUIDE FOR INDIVIDUAL COMPONENT

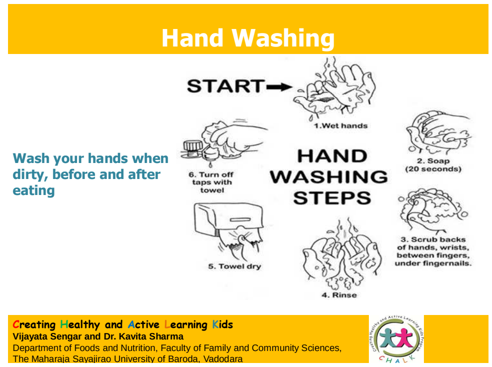
S. No.	Component	OPTIONS	SCORES
1	Breakfast	None	0
		1-4 Days	1-4
		≥ 5 Days/Week	5
2	Breakfast Food Item	None	0
		Tea/Coffee+ Biscuits ≥5 Days/ wk	1
		Milk Alone ≥5 Days/ wk	2
		Milk+Biscuit ≥5 Days/ wk	3
		Milk +Cereal ≥5 Days/ wk	4
		Milk+Cereal+Veg ≥5 Days/ wk	5
3	Mid Morning	None	0
		1-4 Days/ wk	1-4
		≥ 5 Days/ wk	5
4	Mid Morning Food Item	None	0
		Cereal Alone ≥5 Days/ wk	1
		Cereal+Veg ≥5 Days/ wk	3
		Cereal+Pulse+Milk/Veg ≥5 Days/ wk	5
5	Carry Lunch To School	None	0
		1-4 Days/ wk	1-4
		≥ 5 Days/ wk	5
6	Vegetable	None	0
		1-4 Days/ wk	1-4
		≥ 5 Days/ wk	5
7-10	Component	Roots & Tubers ≥ 5 Days/ wk	1
		Other Veg ≥ 5 Days/ wk	2
		Glv's / Other Veg/ Yellow & Orange Veg+ Roots & Tubers ≥ 5 Days/ wk	3
		Glv+Yellow & Orange Veg /Other Veg/ Roots & Tubers ≥ 5 Days/ wk	4
		Glv+Yellow & Orange Veg +Other Veg+Roots & Tubers ≥ 5 Days/ wk	5
11	Fruits	None	0
		1-4 Days/ wk	1-4
		≥ 5 Days/ wk	5
12	Any Fruit	None	0
		1-4 Days/ wk	1-4
		≥ 5 Days/ wk	5
13	Local Fruit	None	0
		1-4 Days/ wk	1-4
		≥ 5 Days/ wk	5

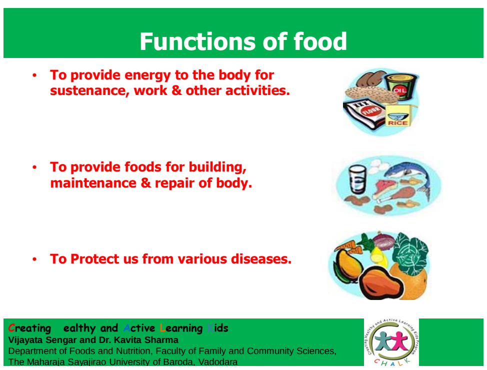
14	Evening Snacks	None	0
		1-4 Days/ wk	1-4
		$\geq$ 5 Days/ wk	5
15	Evening Snacks Food Item	Milk +Cereal+ Fruits $\geq$5 Days/ wk	5
		Milk + Fruits $\geq$5 Days/ wk	4
		Milk Only $\geq$5 Days/ wk	3
		Milk & Biscuits $\geq$5 Days/ wk	2
		Milk + Namkeen/ Farsan /Bakery Items $\geq$5 Days/ wk	1
		Namkeen & Farsan $\geq$5 Days / wk	0
		Biscuits & Bakery $\geq$5 Days / wk	0
16	Outside Food	None	5
		1-4 Days / wk	4-1
		$\geq$5 Days / wk	0
17	Water Intake (Daily)	None	0
		1 Glass	1
		2-3 Glass	2
		3-5 Glass	3
		6-7 Glass	4
		$\geq$ 8 Glass	5
18	Activity : Playtime (Daily)	< 20 Min	0
		20-30 Min	1
		30-40 Min	2
		40-50 Min	3
		50-60 Min	4
		$\geq$60 Min	5
19	Activity: Leisure time (Daily)	>2 Hrs	0
		11/2 – 2 Hrs	1
		1-11/2 Hrs	2
		½-1 Hrs	3
		0-1/2 Hrs	4
		0	5
20	Activity: Study time (Daily)	>11 Hrs	0
		>10-11 Hrs	1
		>9-10 Hrs	2
		>8-9 Hrs	3
		>7-8 Hrs	4
		6-7 Hrs	5

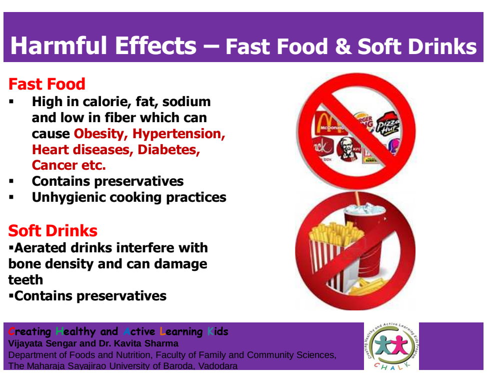
APPENDIX -XIII

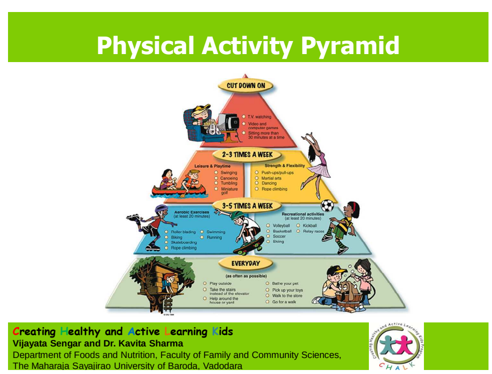
Posters for the *CHALK* Programme







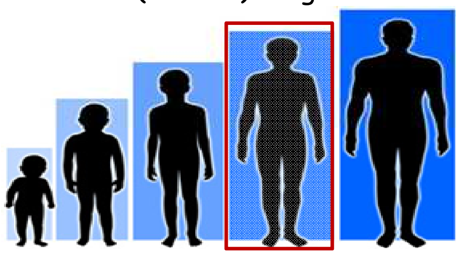




APPENDIX – XIV

PowerPoint Slides Used for the Sessions

Create Healthy Active Learning Kids (CHALK) Program



Vijayata Sengar & Dr. Kavita Sharma
Department of Foods and Nutrition, Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda, Vadodara

Adolescence

Adolescence is a transitional stage between childhood and adulthood

Main stages of Adolescence

- Early adolescence (10-13 years)
- Mid adolescence (14-15 years)
- Late adolescence (16-19 years)

How does it affect you???

25% of adult height
50% of adult weight
40% of adult bone mass

is gained by you during

"adolescence"

What is important for growth and development????

A nutritionally adequate diet (that consists of healthy foods) and regular physical activity is essential for optimal growth and development

 + 

Why should you care for nutrition??

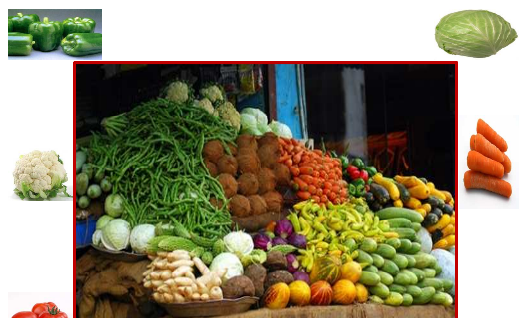
- Physical Growth
- Body image
- Brain Development
- Daily activities
- Sports performance
- Prevention of diseases

What are Healthy Foods?

Foods that provide good amount of carbohydrates, proteins, vitamins and minerals are healthy foods.

Eat more healthy Carbohydrates and whole grains

Have good amount of Proteins

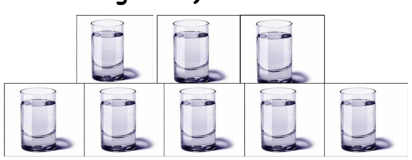


Choose from a wide variety of vegetables

Water

Building material : About 50 to 70 percent of the body's weight is water.

Daily Requirement: About (2.5 liter i.e. 8-10 glasses)



Hygienic Habits

- **Maintain hygienic habits**
- **Do not cough or sneeze into your hands**
- **Do not put your fingers in eyes, nose or mouth**

Wash your hands when dirty, before and after eating

- ❖ **Hand washing (Show video)**

Eating Habits

- **Eat slowly, chew properly**
- **Never skip meals, specially breakfast**
- **Have small frequent meals**
- **Don't overeat**

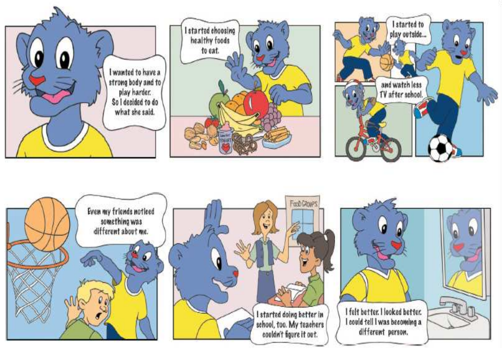
Environment while eating

- Avoid reading while you eat
- Sit in a quiet place without distractions, avoid TV viewing while eating
- Make meal time a family time (if possible)

CHALK Program Sengar V. & Sharma K.

CHALK Program Sengar V. & Sharma K. 6

CHALK Program Sengar V. & Sharma K. 7



CHALK Program Sengar V. & Sharma K. 8

CHALK Program Sengar V. & Sharma K. 9

Functions of food

- To provide energy to the body for sustenance, work & other activities.

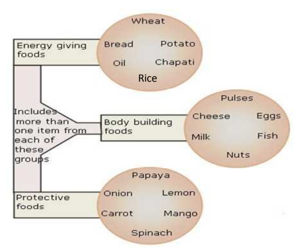
Functions of food

- To provide foods for building, maintenance & repair of body.

Functions of food

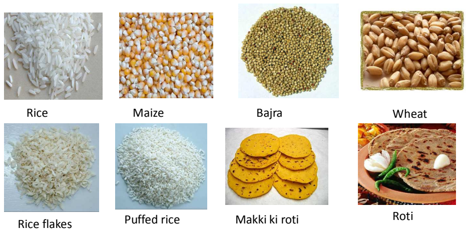
- To Protect us from various diseases.

Functions of food



Food groups

- Cereals Grains and products



Food groups

- Pulses and legumes

Food groups

- Milk and Milk Products

Food groups

- Vegetables and fruits

•Are rich sources of vitamins and minerals
•Atleast 150 gms of veg (GLV: 40 g; other veg: 60g; roots and tubers: 50g) in a day. In addition fresh fruits (100g) should be consumed in a day.

Food groups

- Fats and Sugars

Should be consumed in restricted amounts

Food groups

- Meat and products

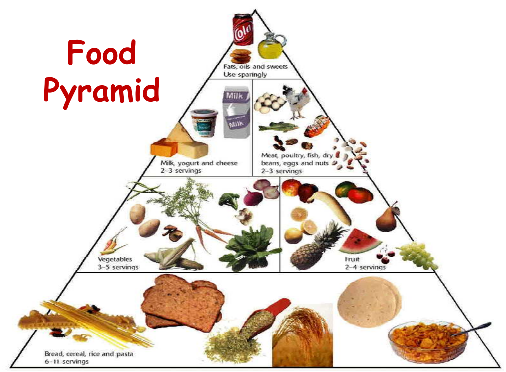
Food groups

- Nuts and oilseeds

Three foods that help you grow??

- Milk
- GLVs
- Pulses
- Meat
- Eggs
- Fruits
- Juices

Food Pyramid



No. of meals in a day??

- Have small and frequent meals
- Have at least four to six meals in a day
- Eat three well-rounded meals (with vegetables, proteins, and carbohydrates) and one or two healthy snacks at regular times throughout the day.

Breakfast: The most important meal

- Fuels your empty tank
- Brain Food
- Improves physical activities
- Keeps you healthy
- Skipping breakfast associated with overweight and obesity

Breakfast: The most important meal

- High sugar breakfast causes a high sugar level which dips fast making you more hungry and you eat more sugary food
- Ideal foods for breakfast are eggs, cheese, curd, apples or bananas, sprouts, carrots, sweet potatoes, nut butters, whole grain breads, oatmeal

Breakfast: The most important meal

- Should provide at least 25% of daily requirements of nutrients.
- Should include foods from all the food groups
- This can be obtained by having different combinations of milk, cereals, fruits and nuts

Why is Fast Food unhealthy ?

- High in calorie, fat, sodium and low in fiber which can cause
  - Obesity, Hypertension, Heart diseases, Diabetes, Cancer etc.
- Contains preservatives
- Unhygienic cooking practices

Soft Drinks are Unhealthy..

- *Aerated drinks interfere with bone density and can damage teeth*
- *Contains preservatives*

Are there healthy snacks???

Yes! There are plenty of them….

- Fresh fruits
- Sprouted beans
- Nuts Like almonds, Cashew, Walnuts etc.
- Fruit shakes

…..are nutritious and healthy.

Types of physical activity

- Daily Chores: walking, climbing stairs, cycling, household activities, etc.
- Exercise: planned & structured subset of leisure time physical activity undertaken for improving or maintaining physical fitness.
- Sports: involves competition. It may become an occupation.

Physical activity

- It is recommended to have 30-60 min. moderate physical activity on weekdays, four days a week

"My doctor told me to keep in shape.
Well, this is my shape and I'm keeping it!"

Physical activity

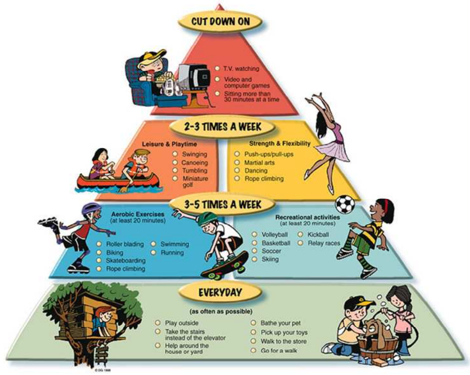
- It is not necessary to exercise continuously
- Can be divided into 10 -15 mins of activities several times through the day

Physical activity

- Helps build and maintain healthy bones and muscles.
- Helps reduce the risk of developing obesity and chronic diseases such as diabetes and cardiovascular (heart) disease.
- Reduces feelings of depression and anxiety and promotes psychological well-being.

Physical activity

- Overweight and obesity, influenced by physical inactivity and poor diet, are significantly associated with an increased risk of diabetes, high blood pressure, high cholesterol, asthma, arthritis, and poor health status.
- Physical inactivity increases the risk of dying prematurely, dying of heart disease, and developing diabetes, colon cancer, and high blood pressure.



Television

- *Excessive TV watching is associated with weight gain specially when associated with increased snacking with junk food and aerated drinks*
- *Affects vision*

Television

- *Combine TV watching with physical activity like stationary bicycling, or spot jogging*