RESULTS AND DISCUSSIONS

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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± 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 ± 1.20cm at age <9 years to 177 ± 0 cm at 18 years (Figure 4.1.2).

Figure 4.1.1: Population Pyramid (N=1041)

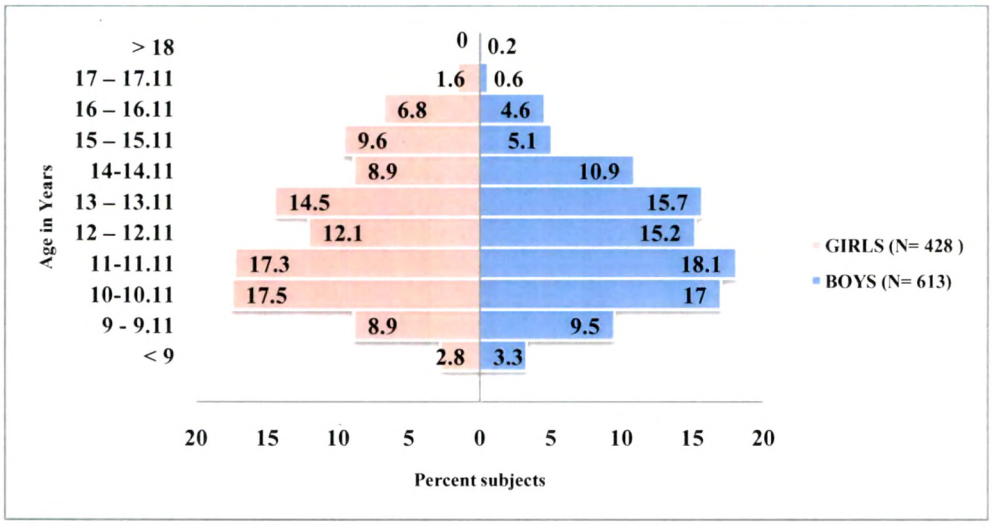


Figure 4.1.2: Growth Pattern in Boys at Different ages (N=613)

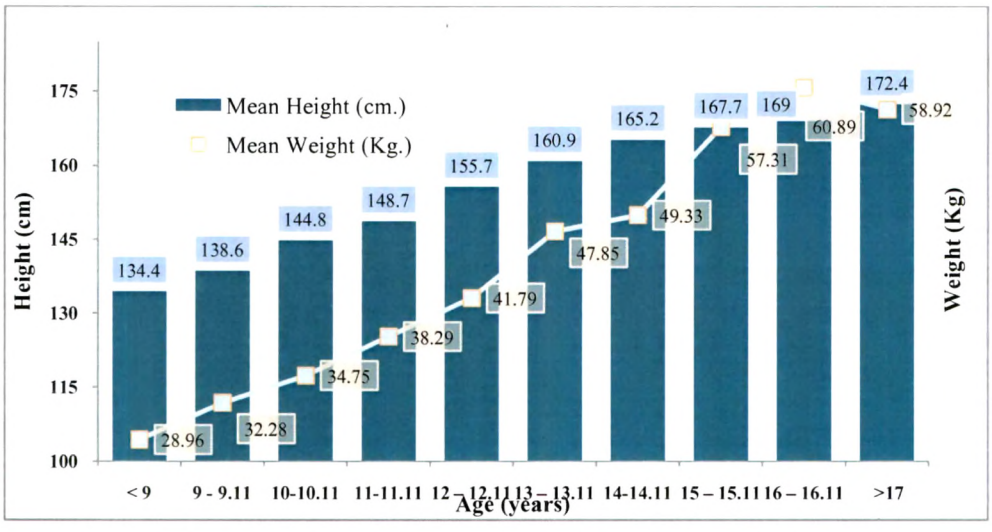


Table 4.1.3: Growth Parameters of the study subjects

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 ± 2.97 cm at age <9 years to 158.88 ± 2.13 cm at 17 years age (Figure 4.1.3). The mean height of boys at 17 years was 171.25 ± 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 ± 2.1 kg while for boys it was comparatively lower (28.96 ± 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 ± 8.42kg) than girls (54.43 ± 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 ± 0.51kg/m^2) was lower than girls (16.48±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)

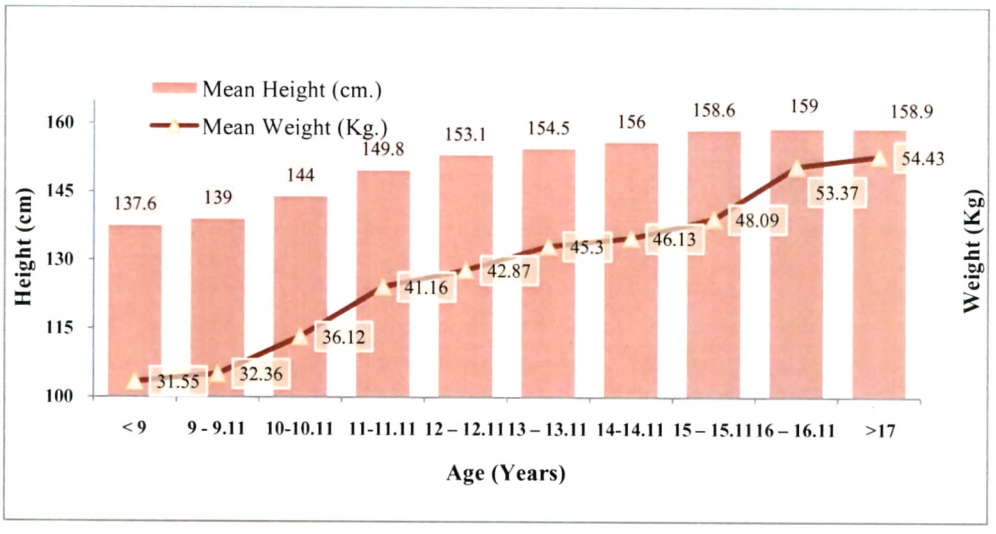


Figure 4.1.4: Peak Height Velocity of the Study Subjects (N=1041)

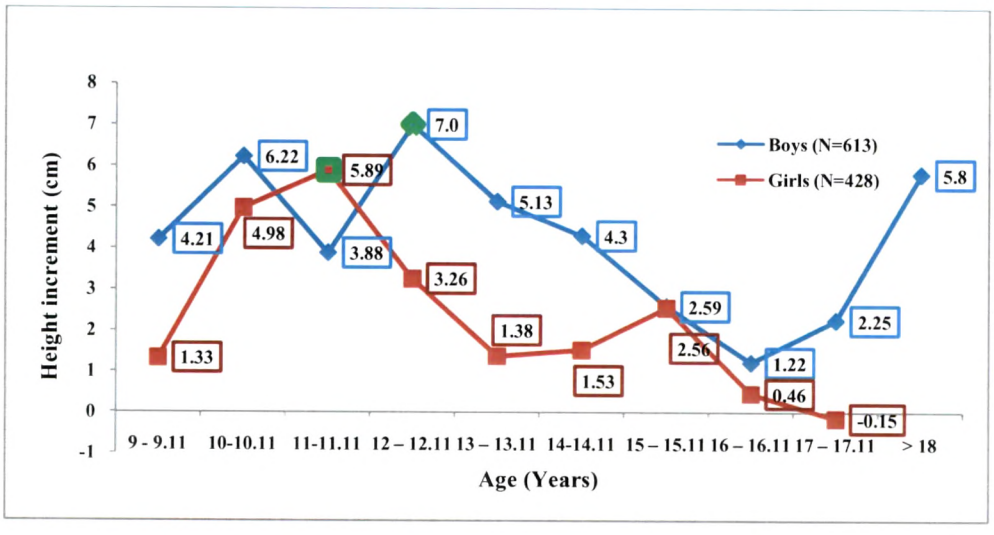


Figure 4.1.5: Peak Weight Velocity of the Study Subjects (N=1041)

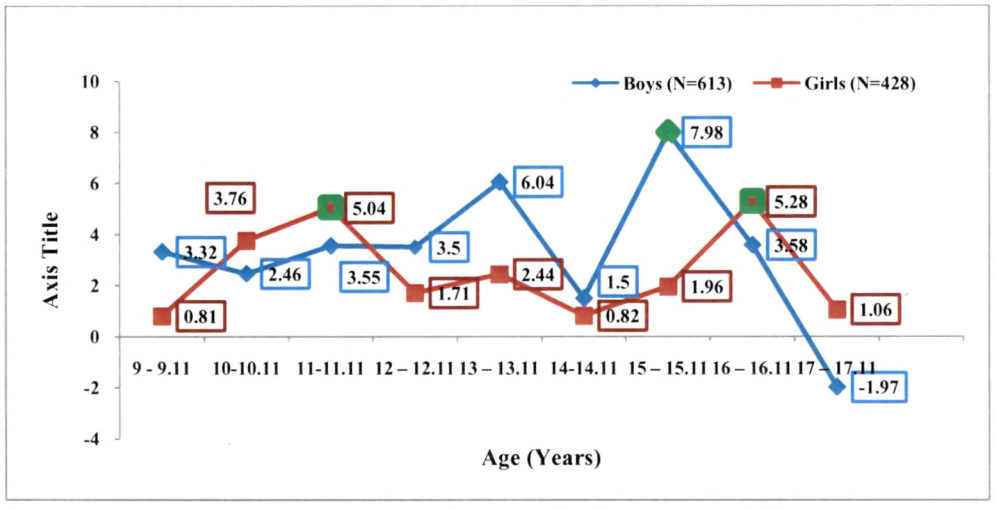
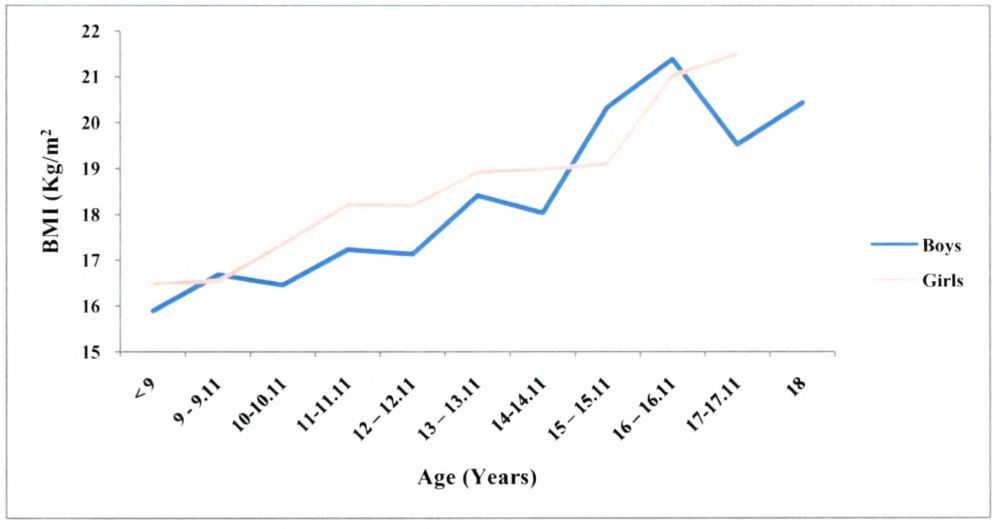


Figure 4.1.6: Growth Pattern (Mean BMI) Boys V/s Girls at different ages (N=1041)



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)

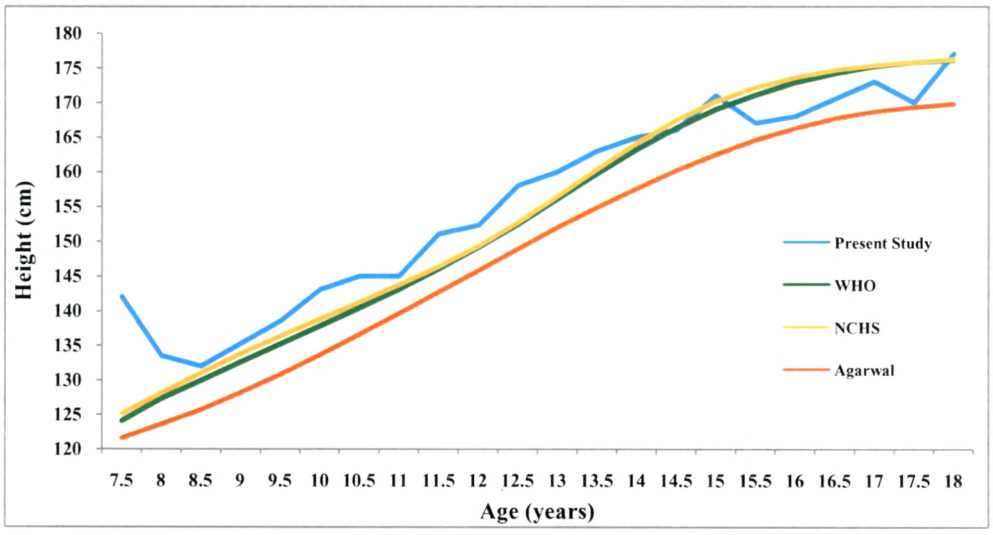


Figure 4.1.8: Comparison of Height for Age with other Reference Standards – Girls (N=428)

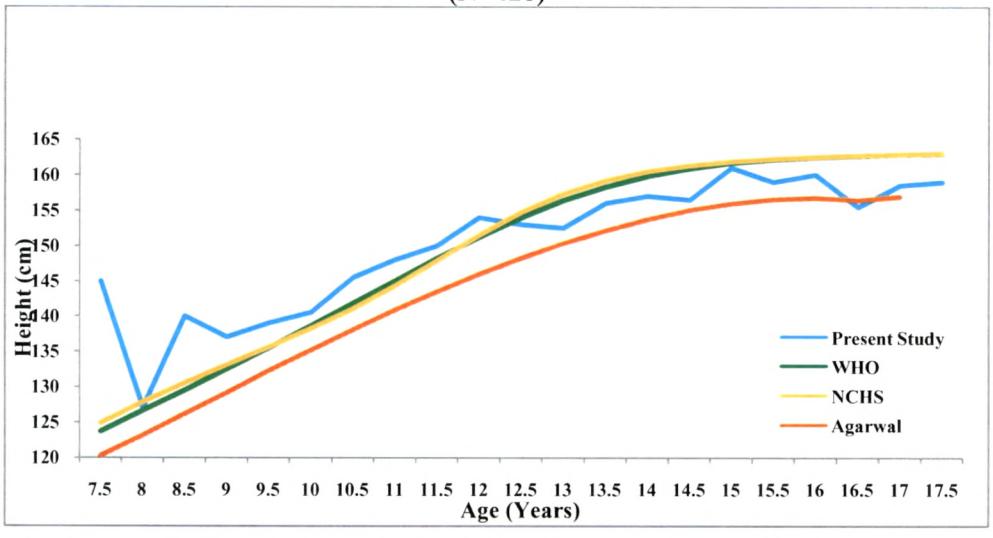


Figure 4.1.9: Comparison of Weight for Age with other Reference Standards – Boys (N=613)

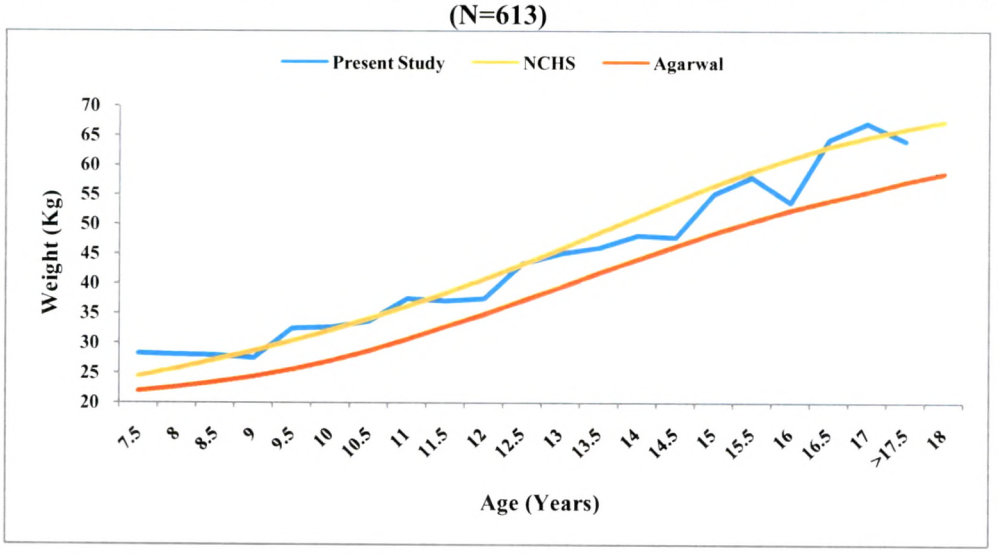


Figure 4.1.10:Comparison of Weight for Age with other Reference Standards – Girls (N=428)

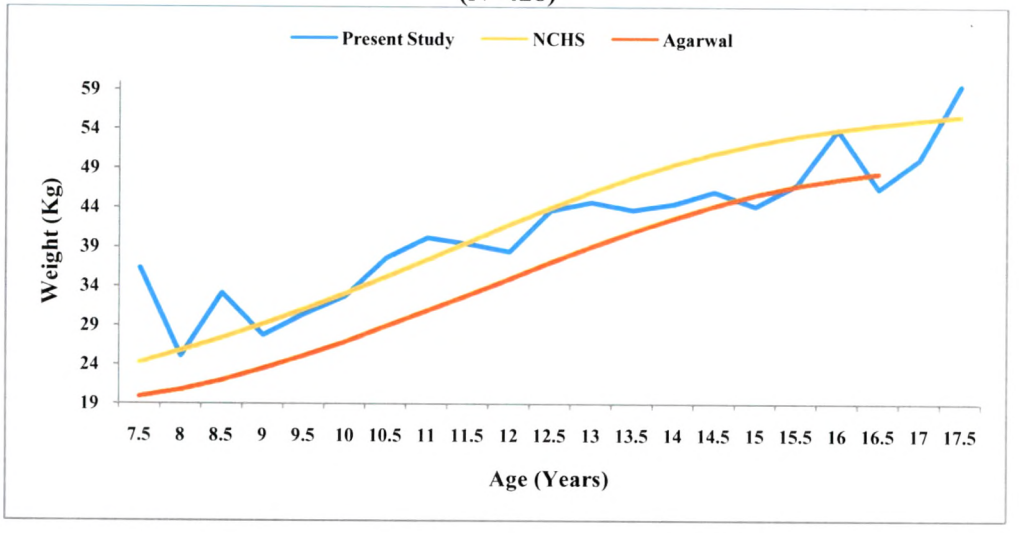


Figure 4.1.11: Comparison of BMI for Age with other Reference Standards – Boys (N=613)

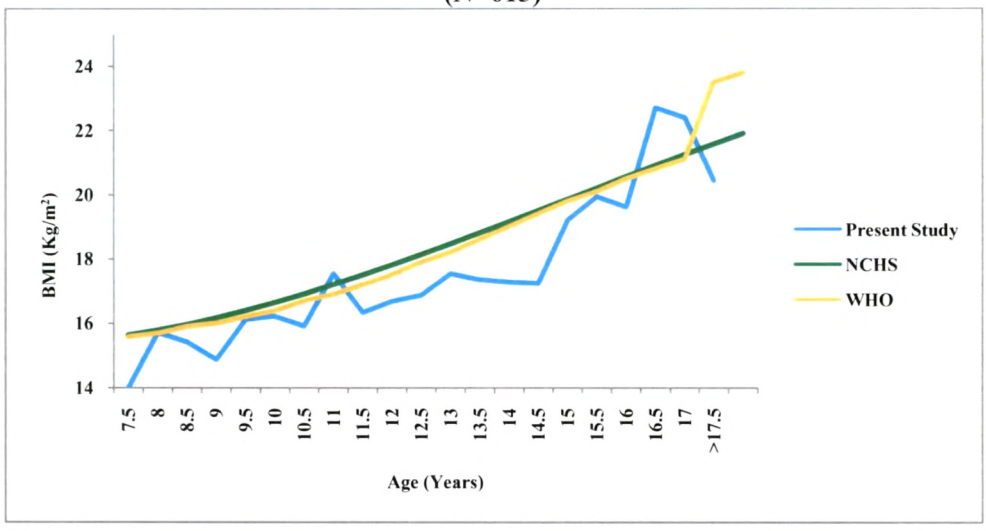
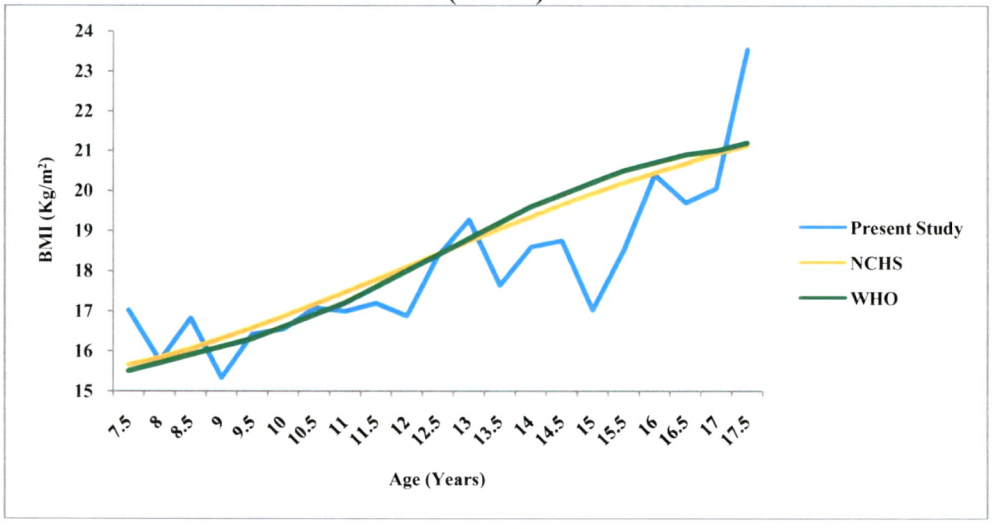


Figure 4.1.12: Comparison of BMI for Age with other Reference Standards – Girls (N=428)



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 (≤94 cm men, ≤ 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 (≤ 90 cm for men and ≤ 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)

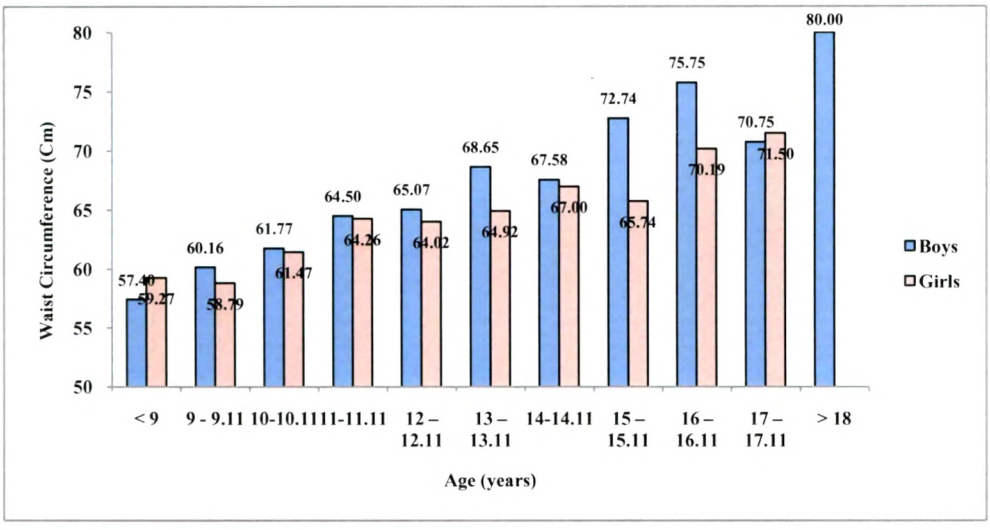


Table 4.1.4: Waist Circumference values - Comparison with other Reference standards

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)

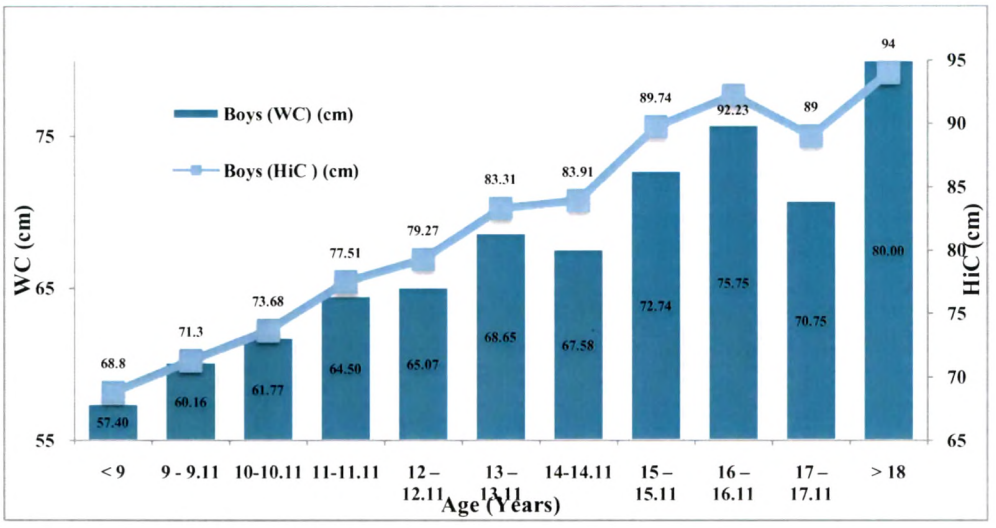


Figure 4.1.15: Waist and Hip Circumference at Different Ages- Girls (N=428)

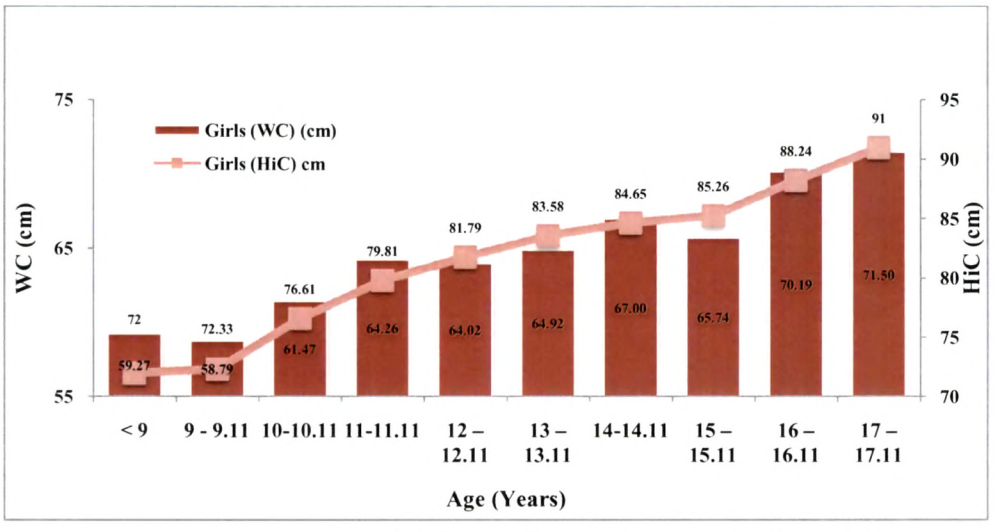


Figure 4.1.16: Waist Circumference and Waist Hip Ratio at Different Ages - Boys (N=613)

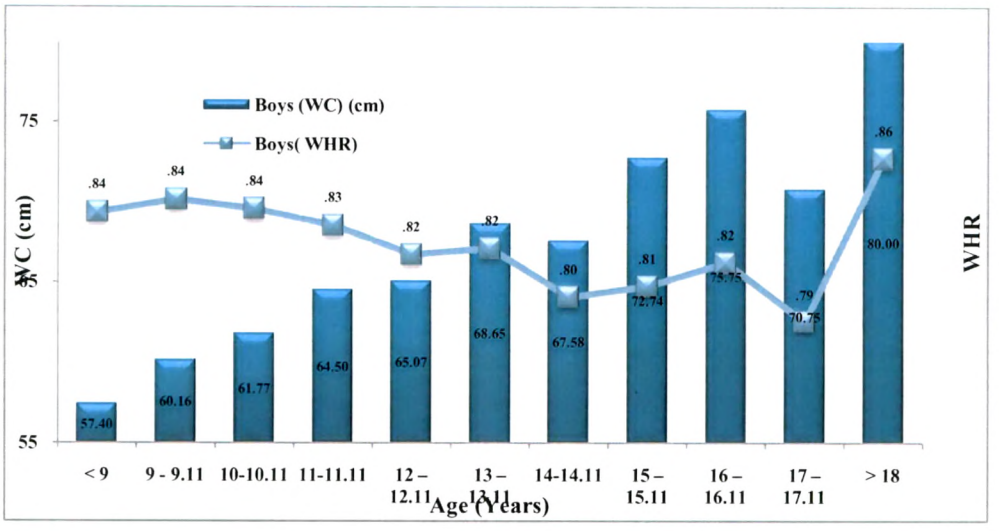
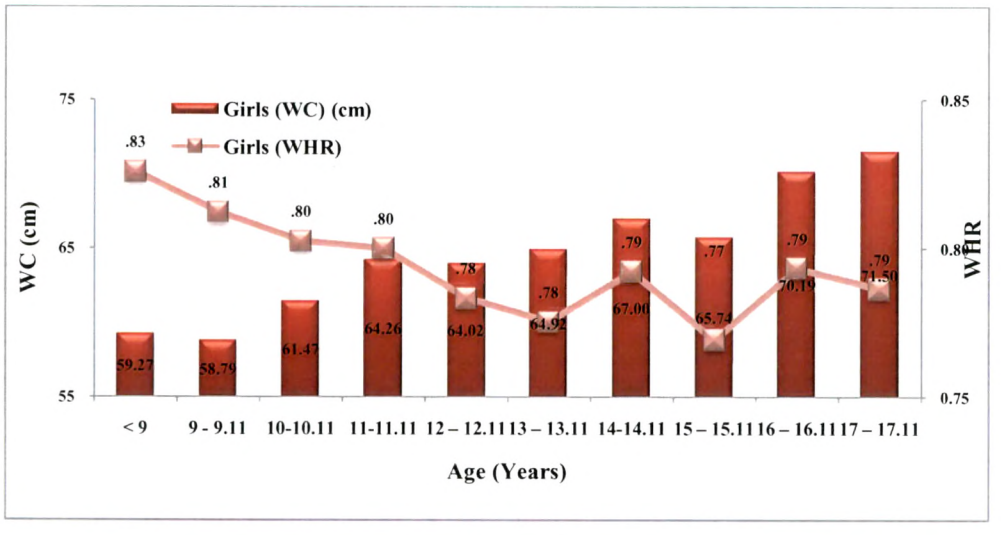


Figure 4.1.17:Waist Circumference and Waist Hip Ratio at Different Ages - Girls (N=428)



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)

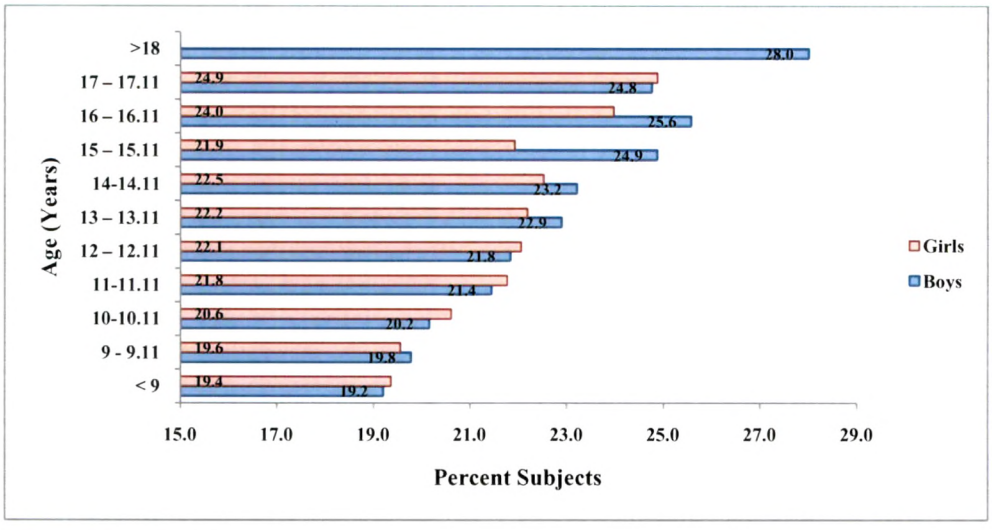


Figure 4.1.19: Comparison of MUAC with Different Standards – Boys (N=613)

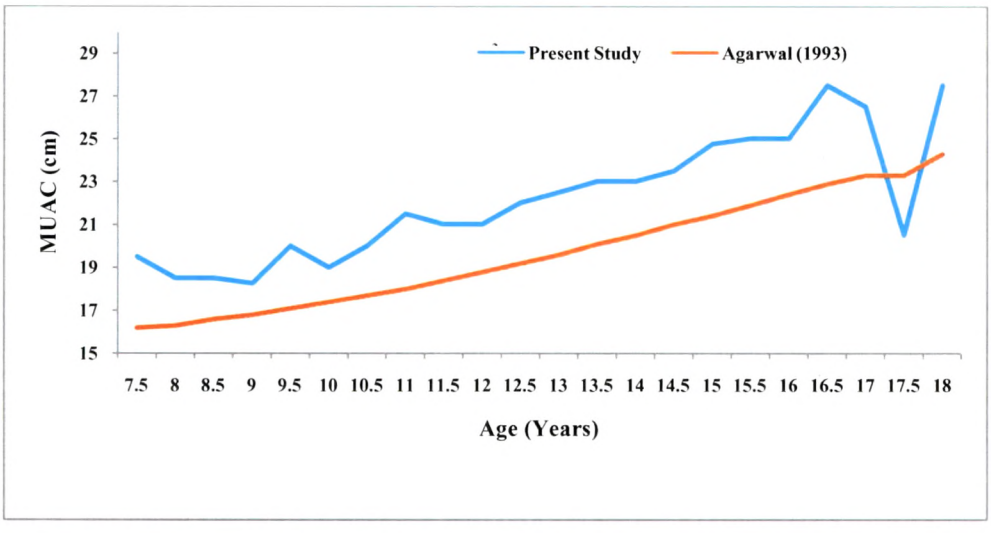
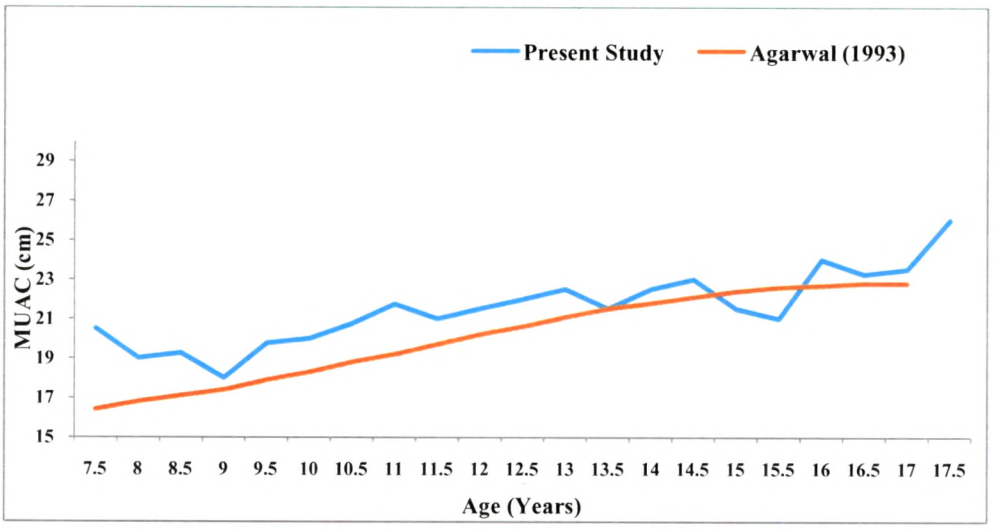


Figure 4.1.20:Comparison of MUAC with Different Standards – Girls (N=428)



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± 0.36 kg. while mean weight for age Z score was found to be -0.26 ± 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± 0.36 cm. and 0.12 ± 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)

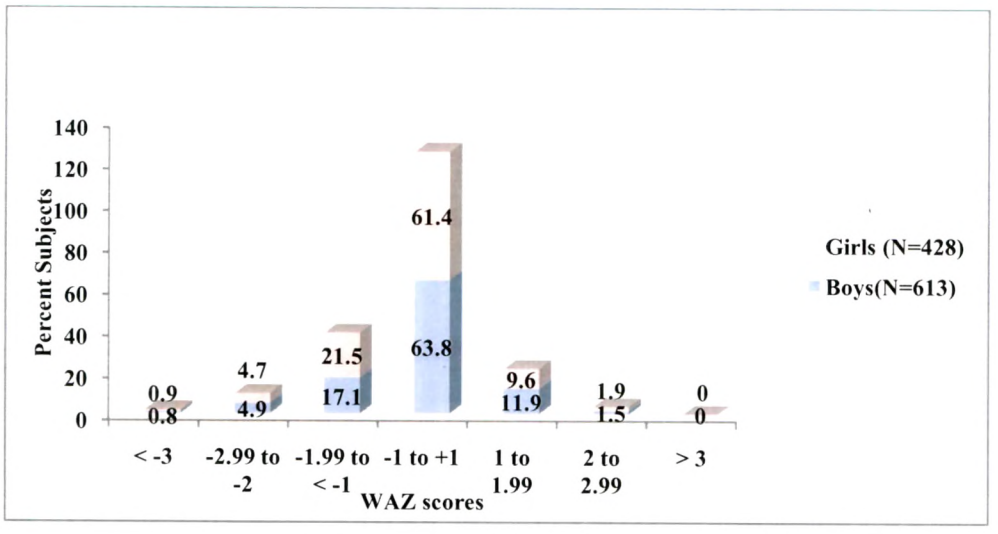


Figure 4.1.22: Prevalence of Underweight according to the Stage of Adolescence

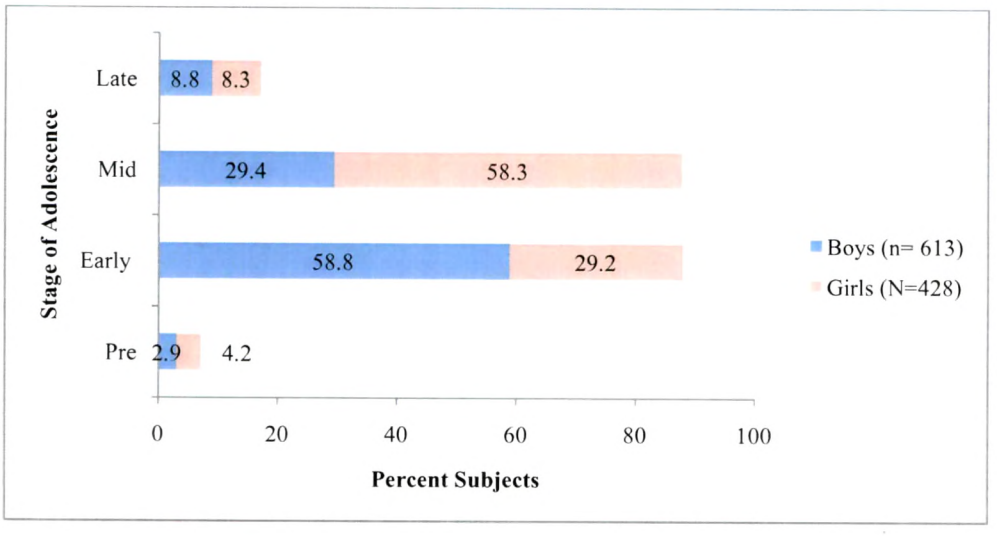


Figure 4.1.23: Prevalence of Stunting (N=1041)

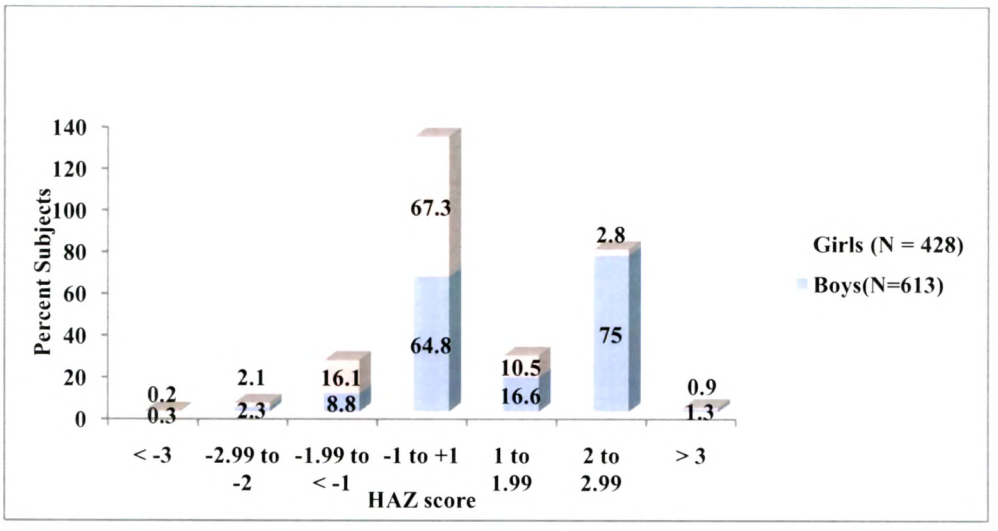
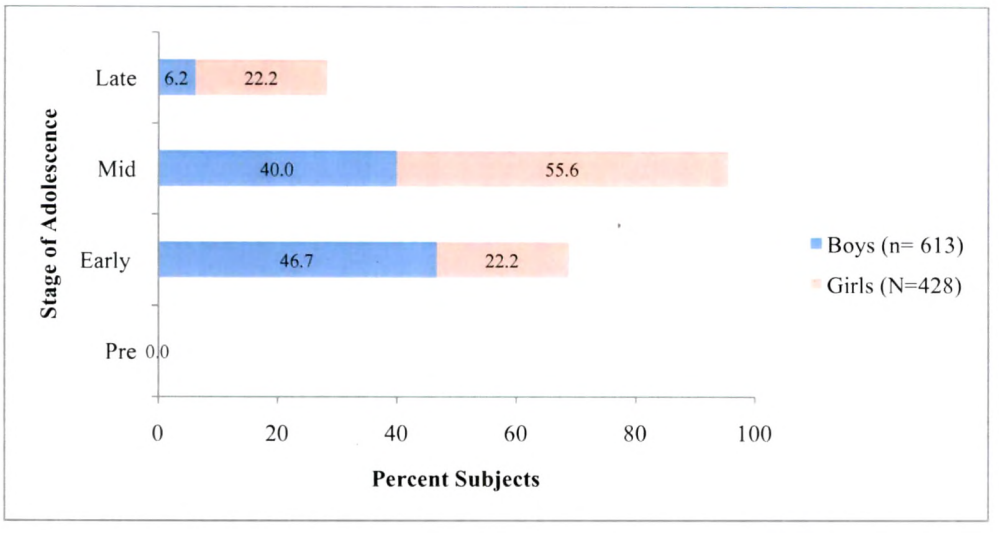


Figure 4.1.24: Prevalence of stunting according to the Stage of Adolescence (N=1041)



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)

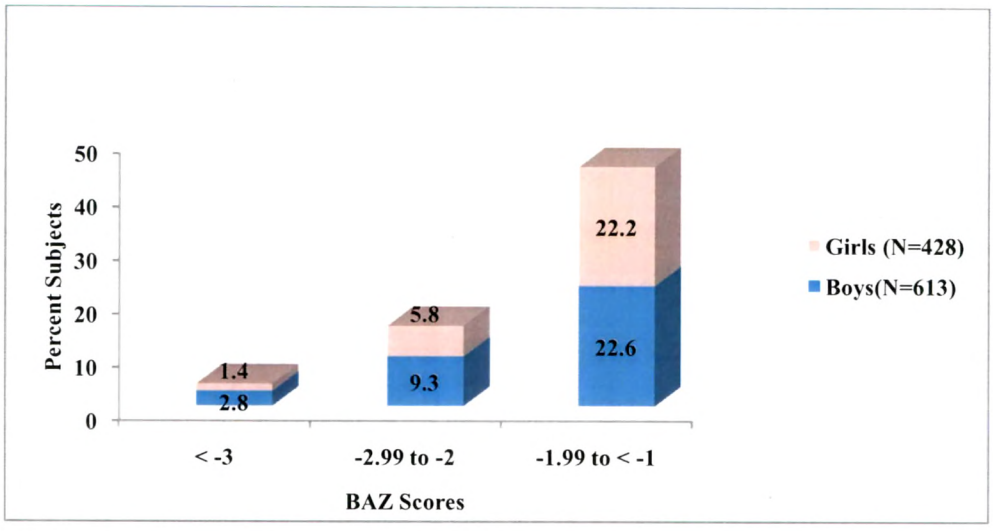


Figure 4.1.26: Prevalence of Thinness According to the Stage of Adolescence (N=1041)

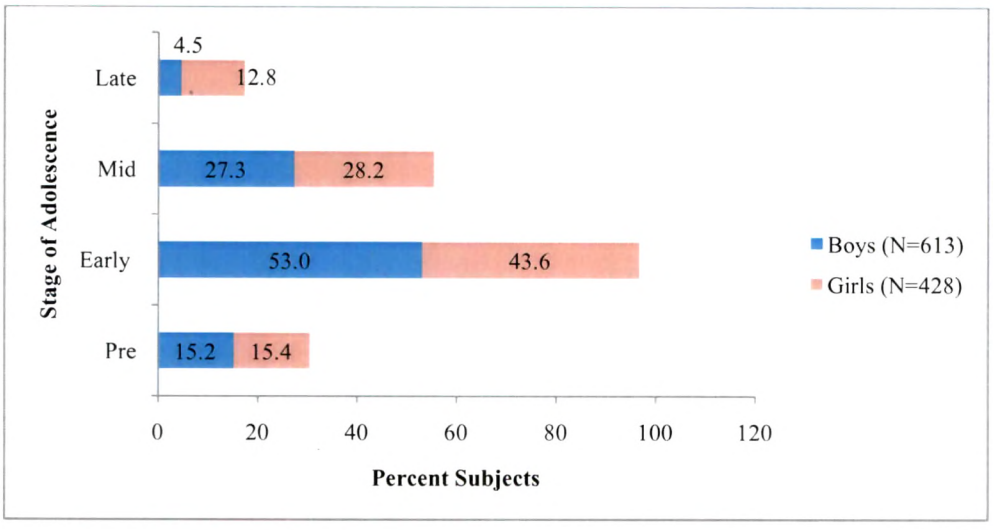


Figure 4.1.27: BAZ scores (Present study) in comparison to WHO 2007 BAZ scores

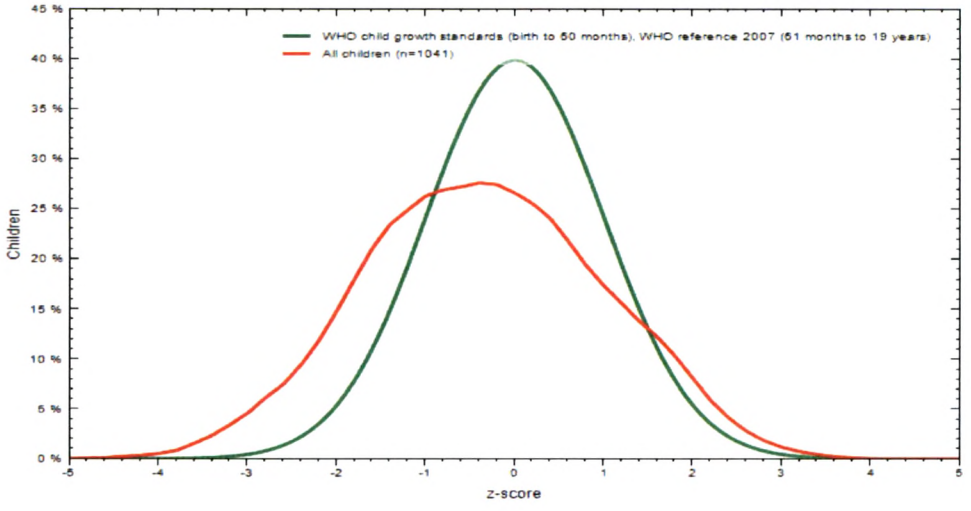


Figure 4.1.28: Prevalence of Overweight and Obesity (N=1041)

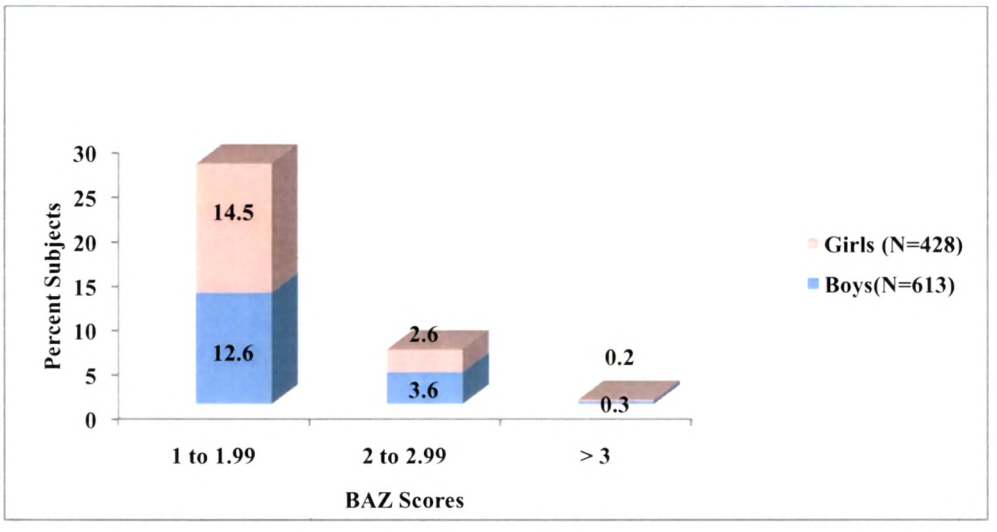


Figure 4.1.29: Prevalence of Overweight and Obesity According to the Stage of Adolescence

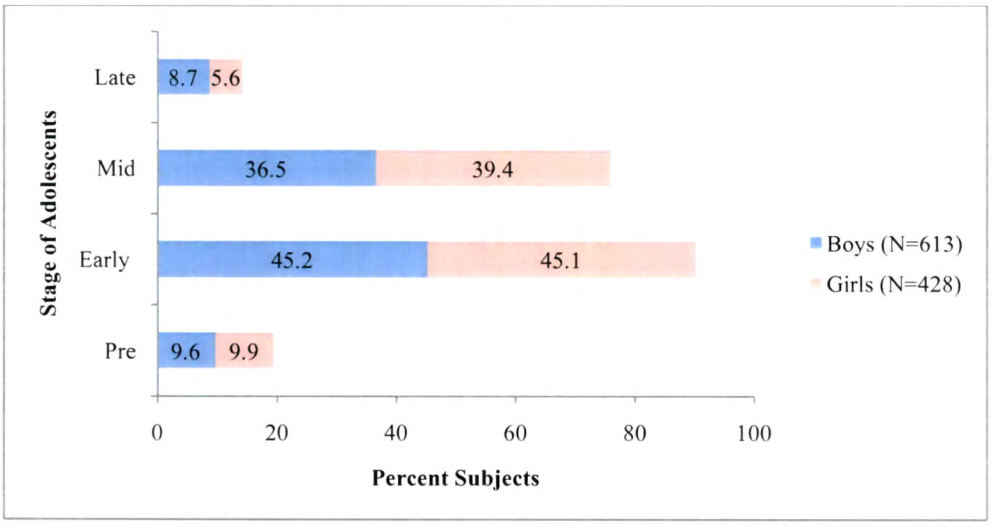


Figure 4.1.30: Prevalence of Dual Burden of Malnutrition – Boys (N=613)

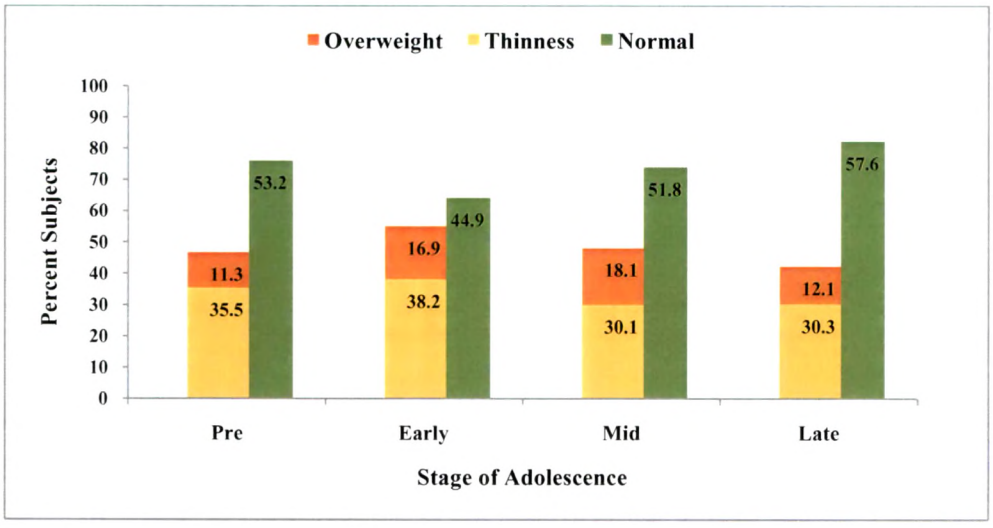
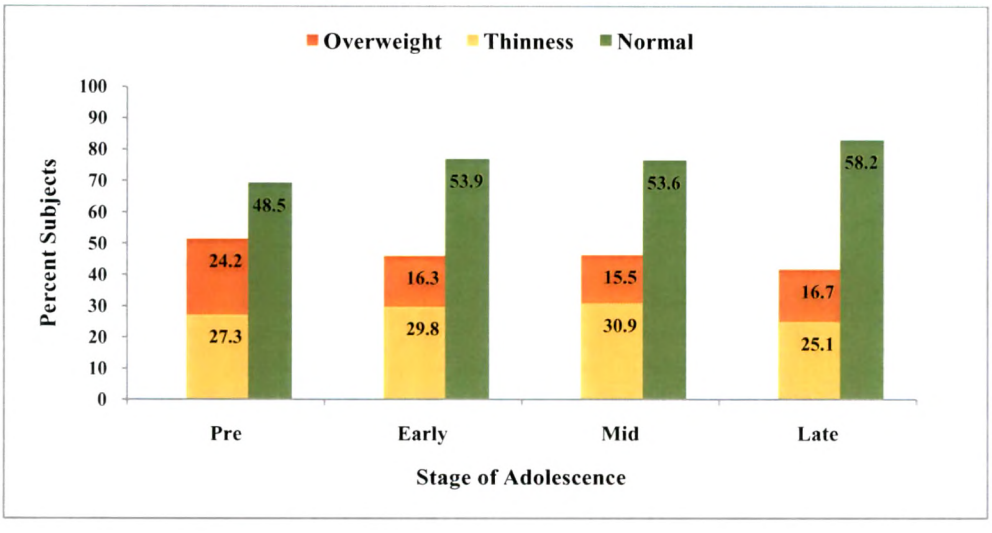


Figure 4.1.31: Prevalence of Dual Burden of Malnutrition – Girls (N=428)



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

SD ? Mean

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

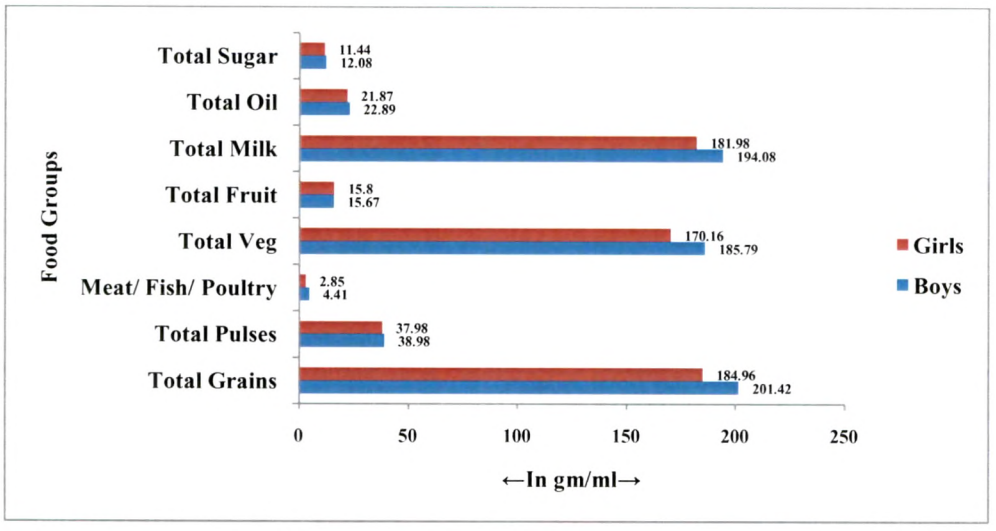
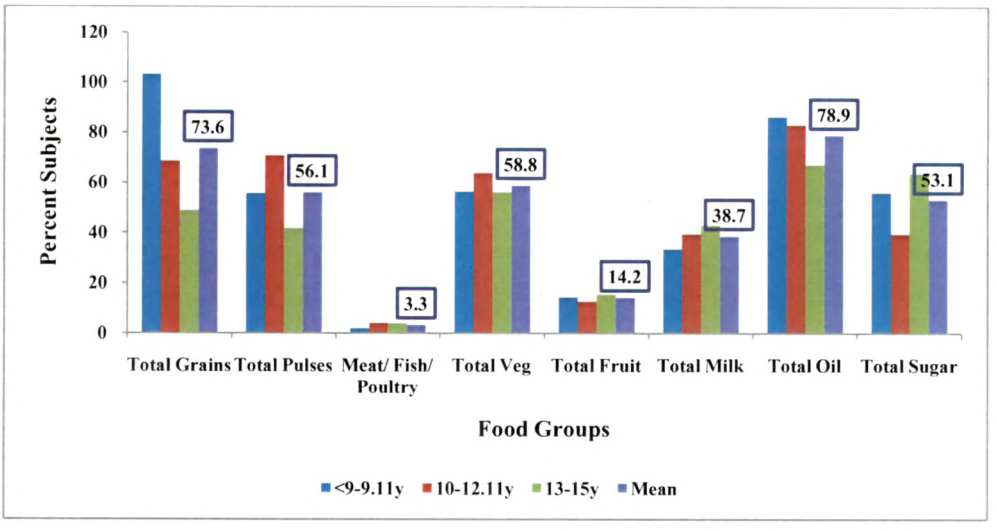


Figure 4.1.33: Mean Intake of Food Groups as % RDA – Boys (N=300)



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)

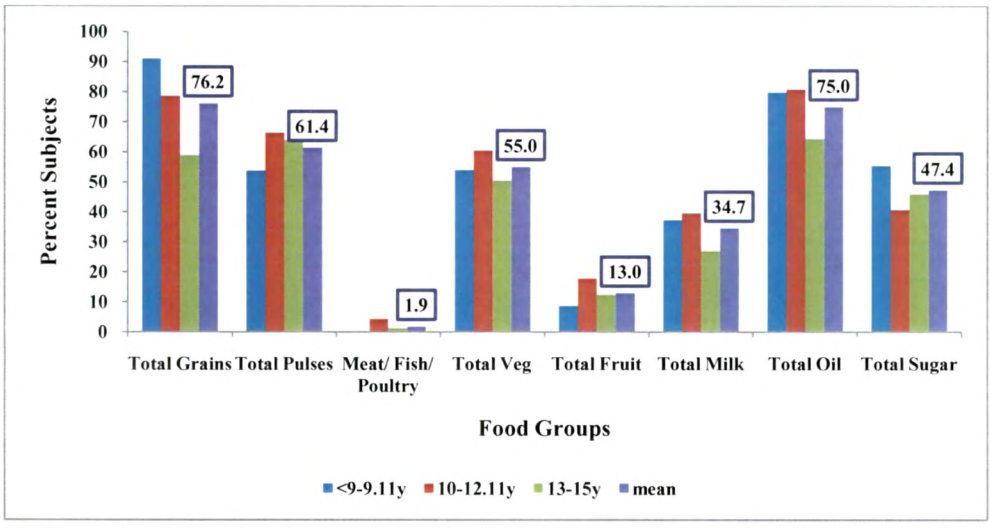
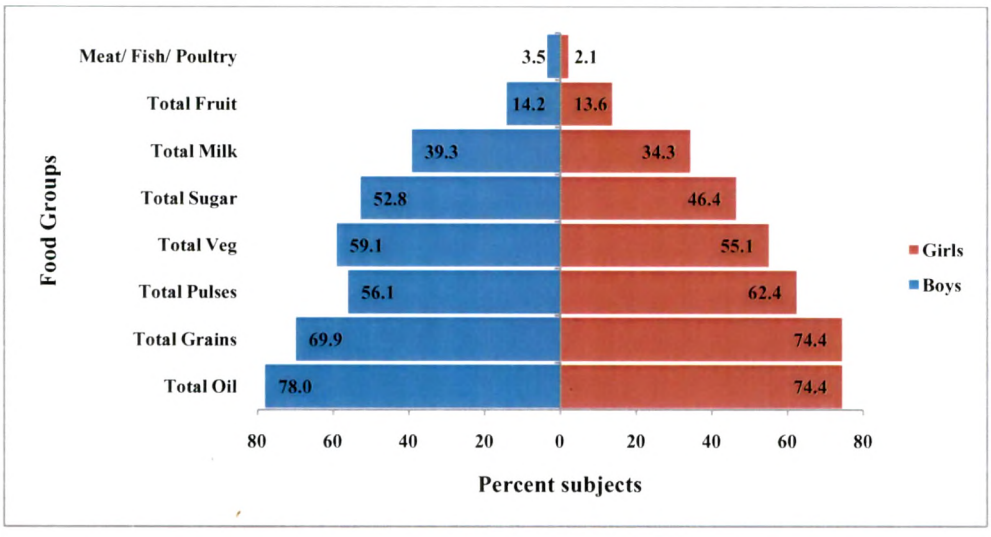


Figure 4.1.35: Food Pyramid Based on the Intakes of the Subjects - Present Study (N=478)



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)

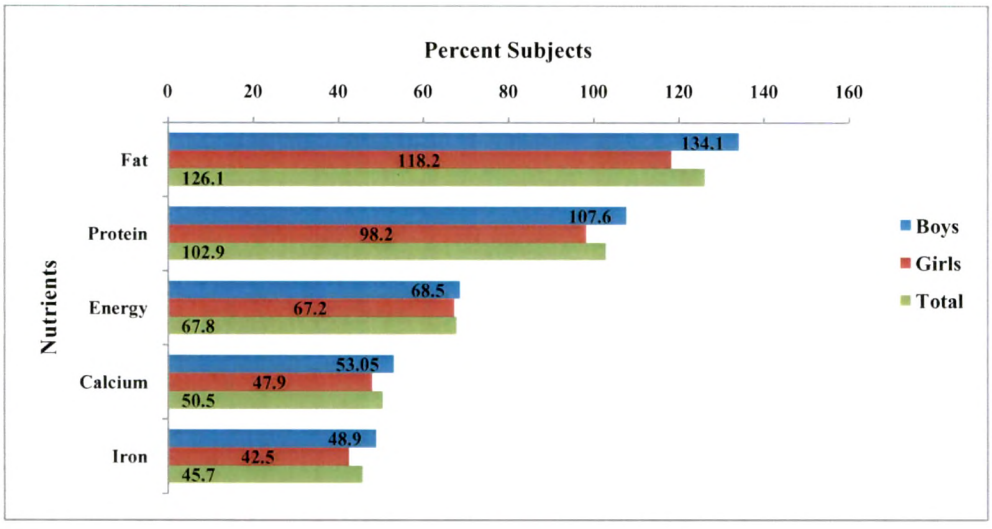


Figure 4.1.37: Nutrient intakes at various levels of RDA

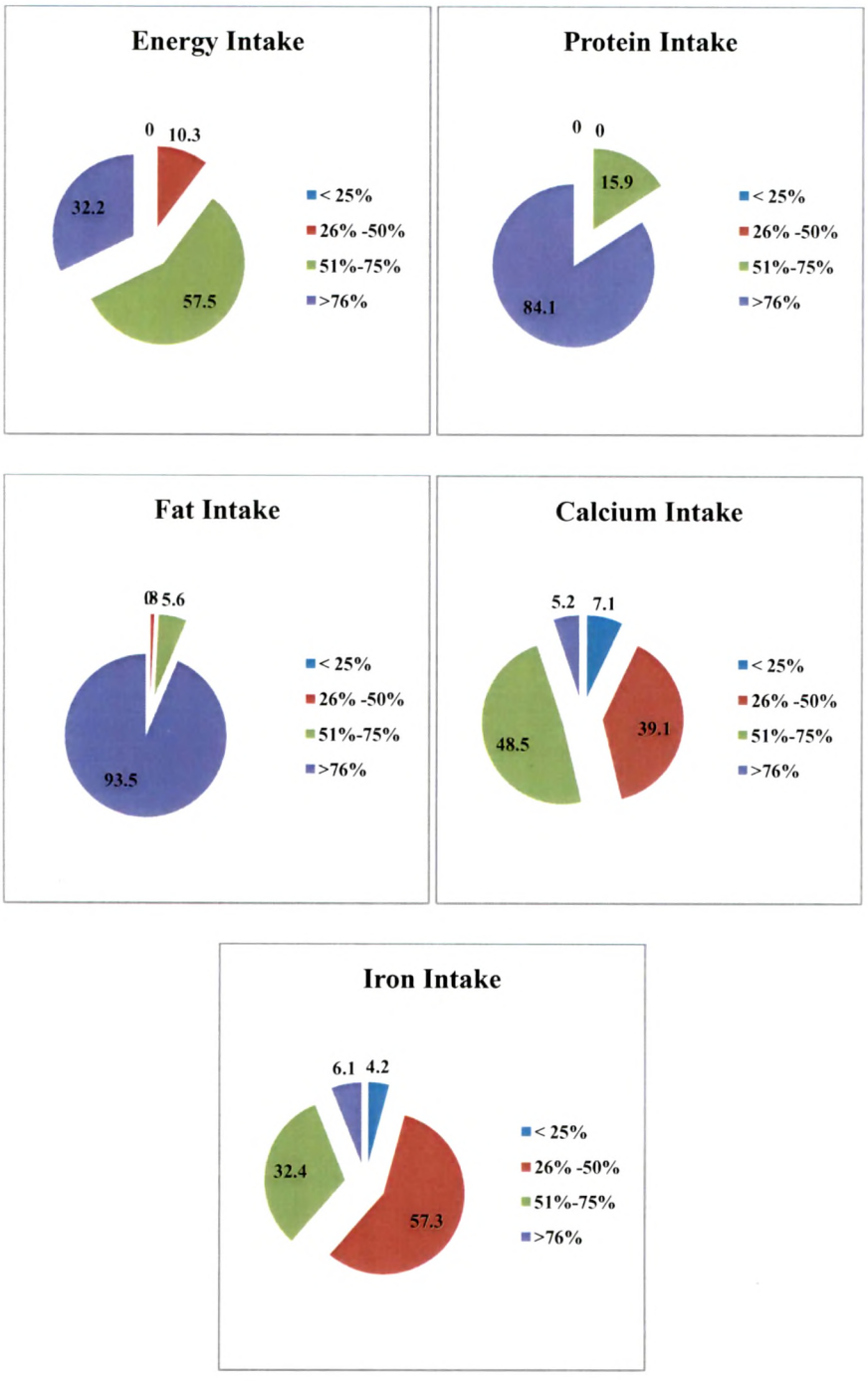


Table 4.1.20: Nutrient Intakes as % RDA- Agewise (N=478)

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

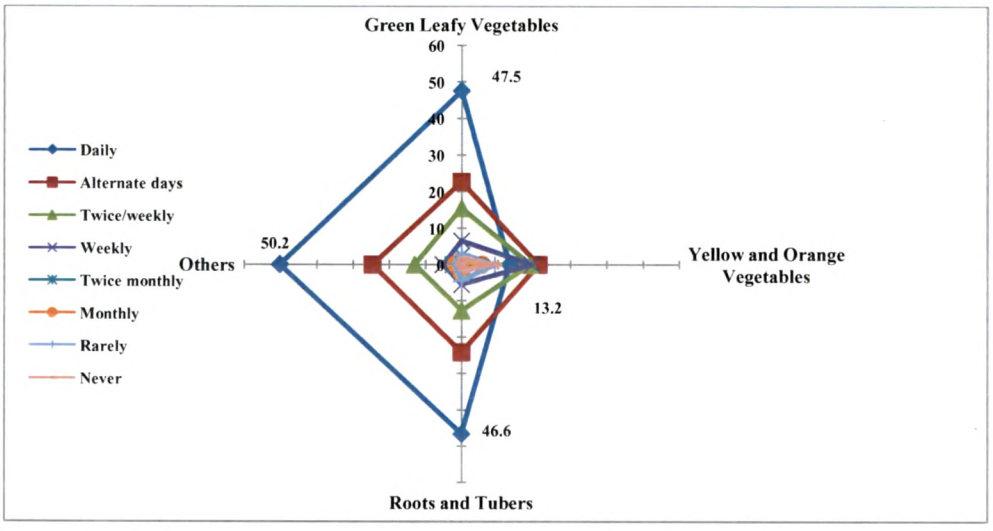


Table 4.1.23: Frequency of Consumption of Processed / Fast Foods (N=631)

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)

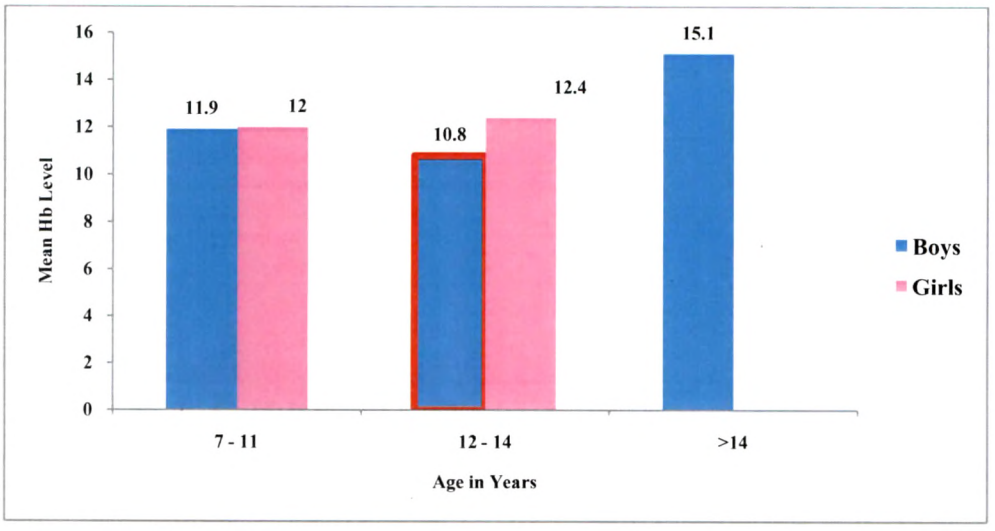
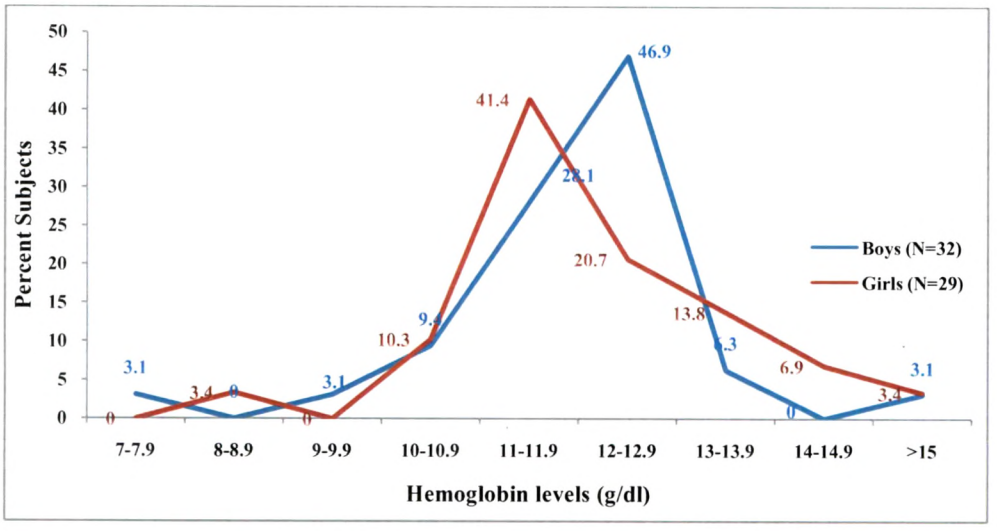


Figure 4.1.40: Frequency Distribution of the Hemoglobin Levels of the Study Subjects (N=61)



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)

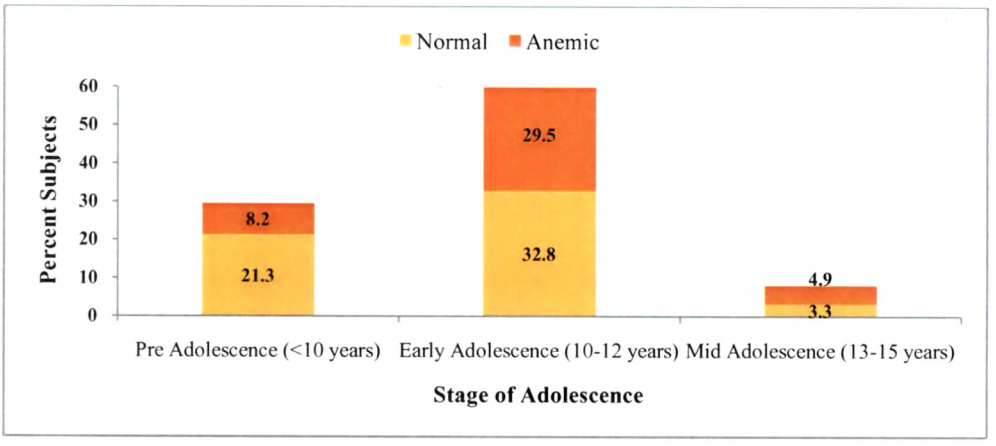


Table 4.1.26: Red Cell Morphology in Anemic and Non Anemic Subjects

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)

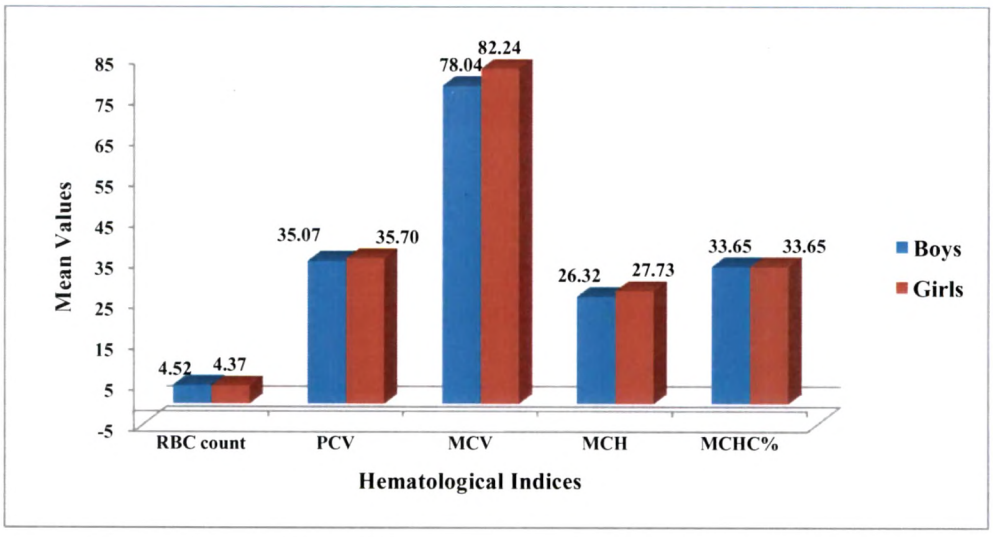


Figure 4.1.43: Mean Serum Total Protein Levels According to the Stage of Adolescence

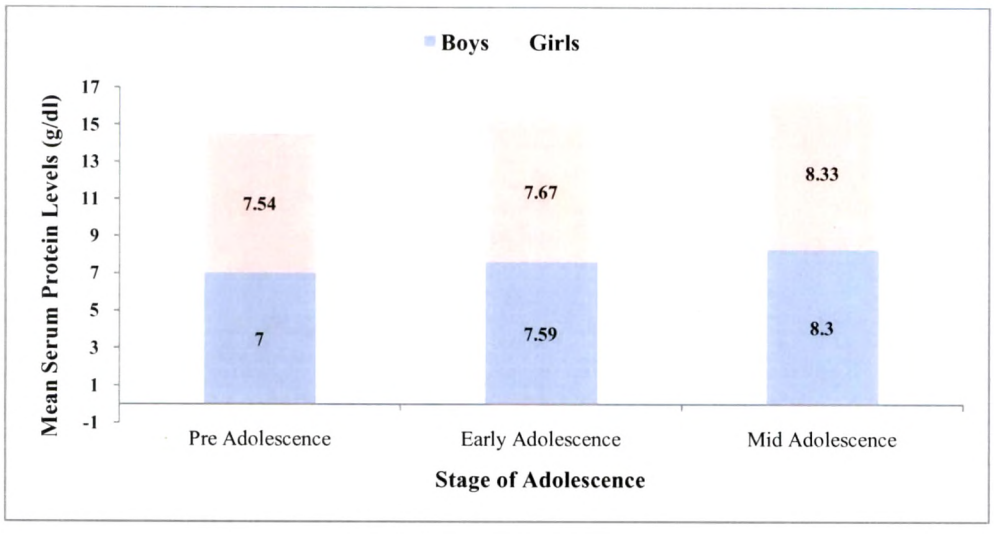


Table 4.1.28: Mean Hematological Indices Age and Sexwise

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± 0	4.45± 0.48	4.31± 0.18	4.69± 0.66
MCV (fl)	81.7±0	79.68±8.61	85.88±3.23	81.46±9
MCH (pg)	27.4±0	26.99±3.36	28.71±1.39	26.97±3.74
MCHC (g/l)	33.5±0	33.8±1.08	33.45±0.58	32.98±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 ± S.D			't' value
	Boys (N=32)	Girls (N=29)	Total (N= 61)	
< 9	6.93 ± 0.20 N= 3	7.45 ± 0.23 N= 2	7.14 ± 0.33 N=5	3.18^{NS}
9 - 9.11	7.27 ± 0.56 N=7	7.58± 0.27 N=6	7.41 ± 0.46 N=13	2.2^{NS}
10-10.11	7.54 ± 0.44 N=10	7.79 ± 0.29 N=6	7.63 ± 0.40 N=16	2.14^{NS}
11-11.11	7.3 ±0.59 N=6	7.52 ± 0.56 N=9	7.48 ± 0.55 N=15	2.16^{NS}
12 – 12.11	7.95 ± 0.53 N=4	7.77 ± 0.42 N=3	7.87 ± 0.45 N=7	$2:57^{NS}$
13 – 13.11	7.5 ± 0 N=1	8.33 ± 0.31 N=3	8.13 ± 0.49 N=4	4.3^{NS}
14-14.11	9.1 ± 0 N=1	--	9.1 ± 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)

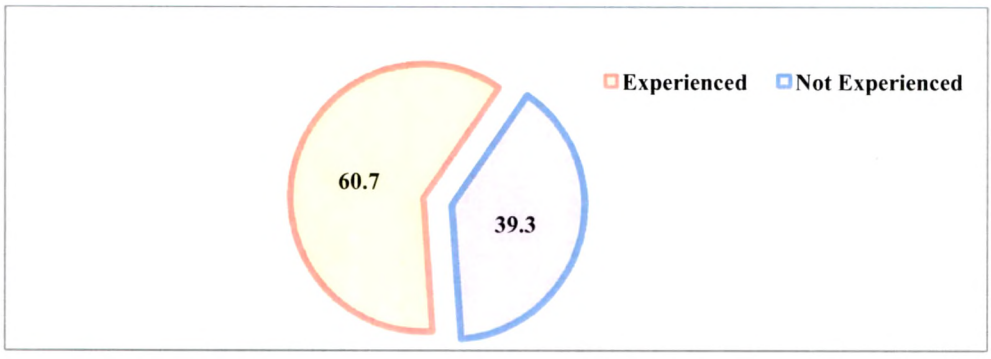


Figure 4.1.45: Morbidity (ies) Experienced - Agewise (N=478)

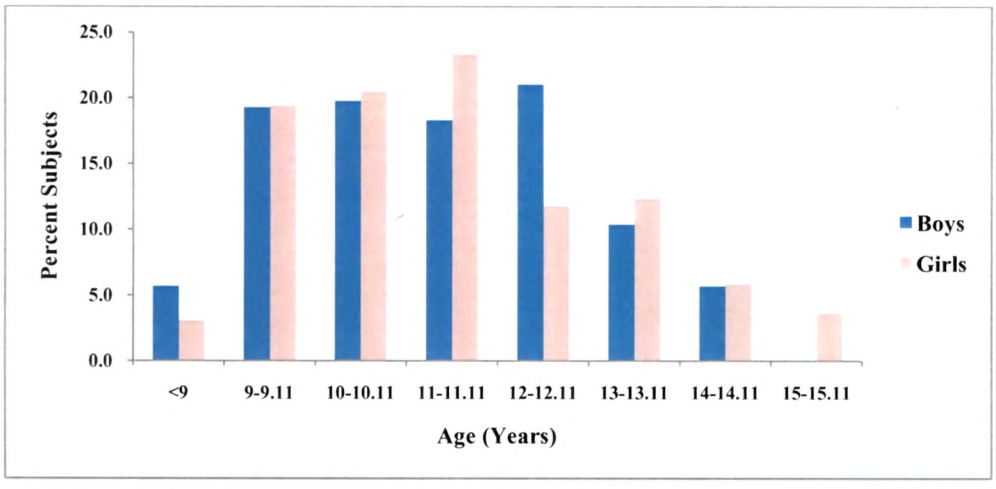


Figure 4.1.46: Morbidities Experienced According to the Stage of Adolescence(N=478)

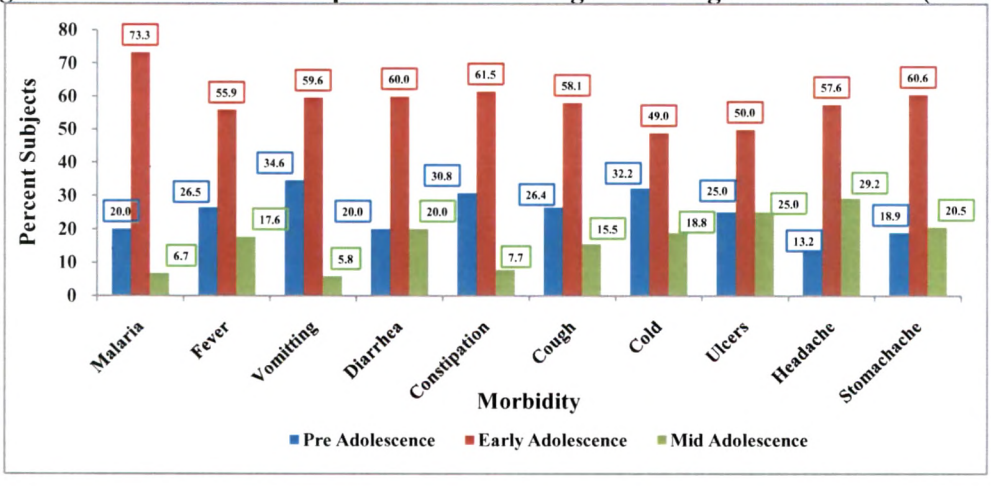


Table 4.1.30: Morbidities Experienced – Sexwise (N=478)

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 ± 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)

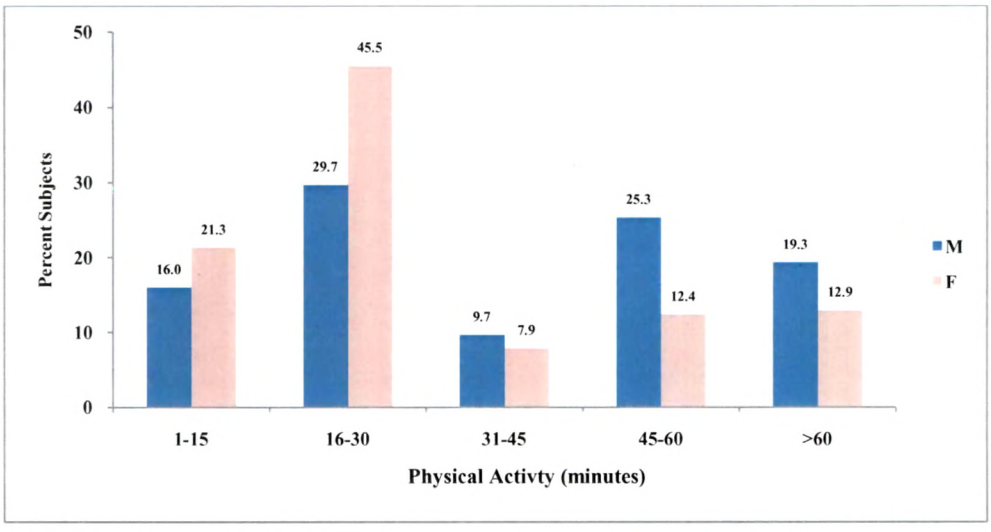


Figure 4.1.48: Physical Activity Performed by the Subjects on the Previous Day –Agewise (N= 478)

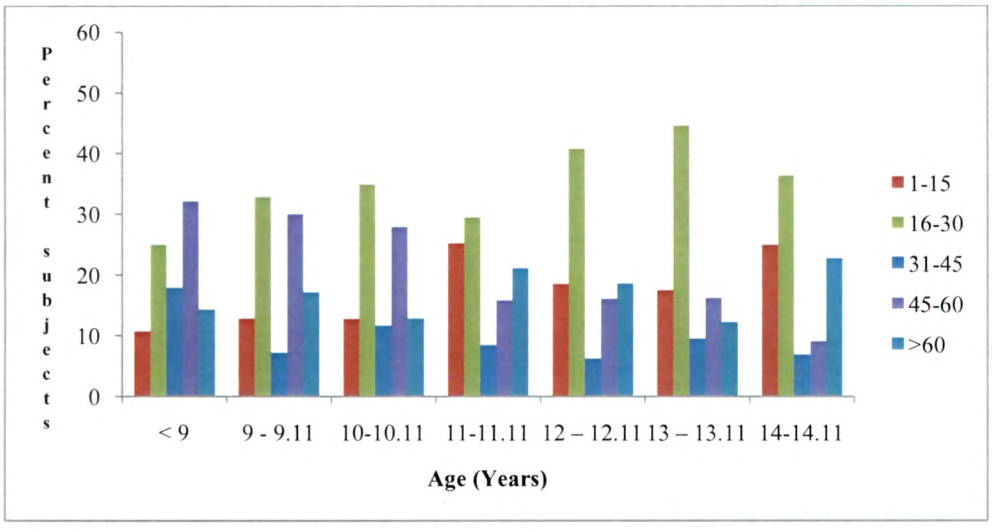


Figure 4.1.49: Reported Playtime at Home and at School –Sexwise (N=478)

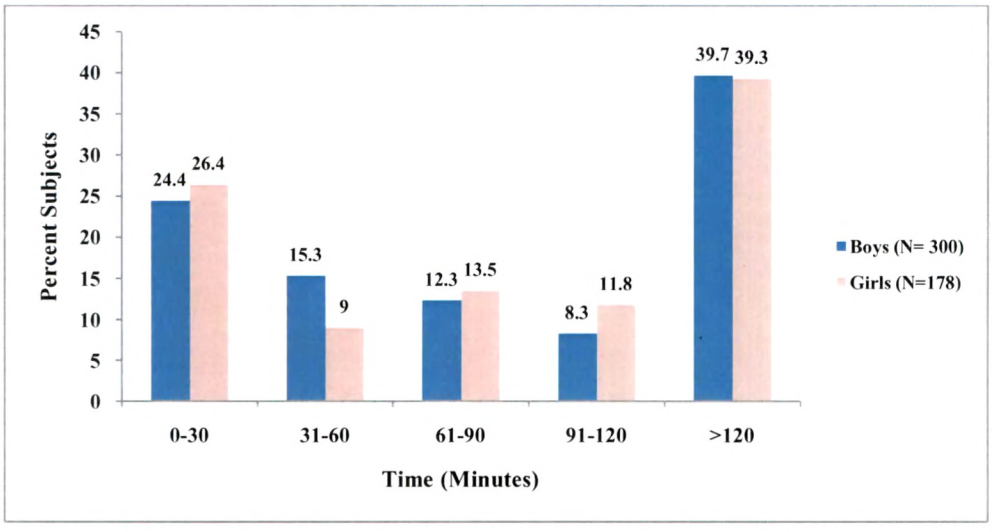


Figure 4.1.50: Reported Playtime at Home and at School –Agewise (N=478)

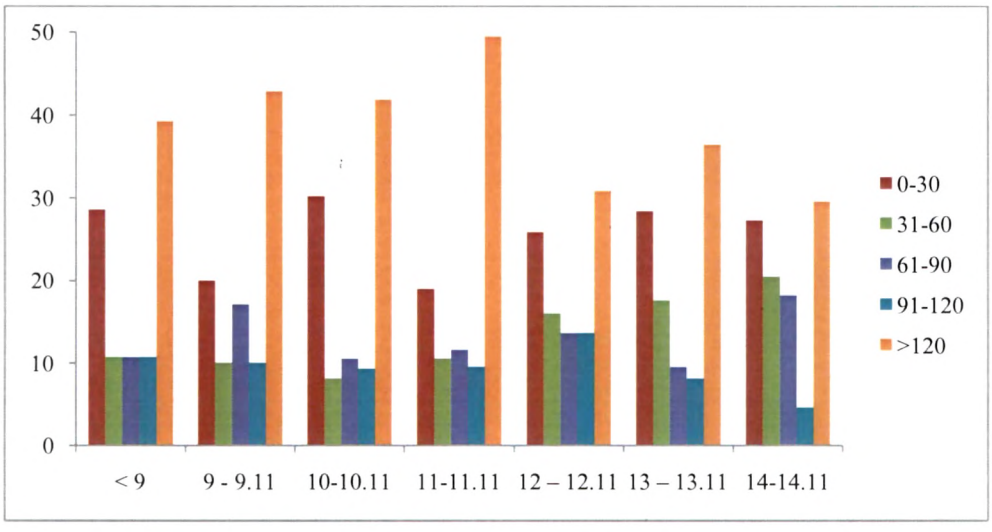


Figure 4.1.51: Reported Sleeptime of the Study Subjects – Sexwise (N=478)

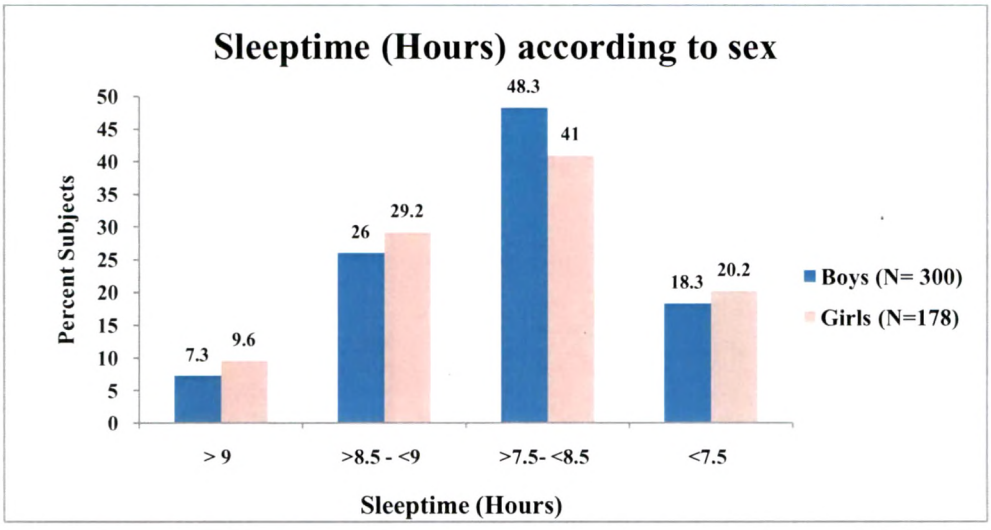
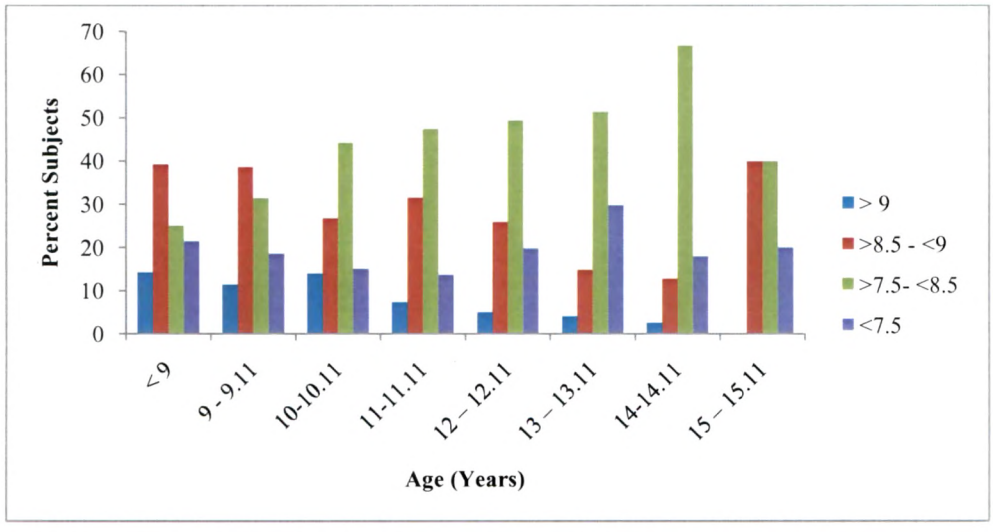


Figure 4.1.52:Reported Sleeptime of the Study Subjects – Agewise (N=478)



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)

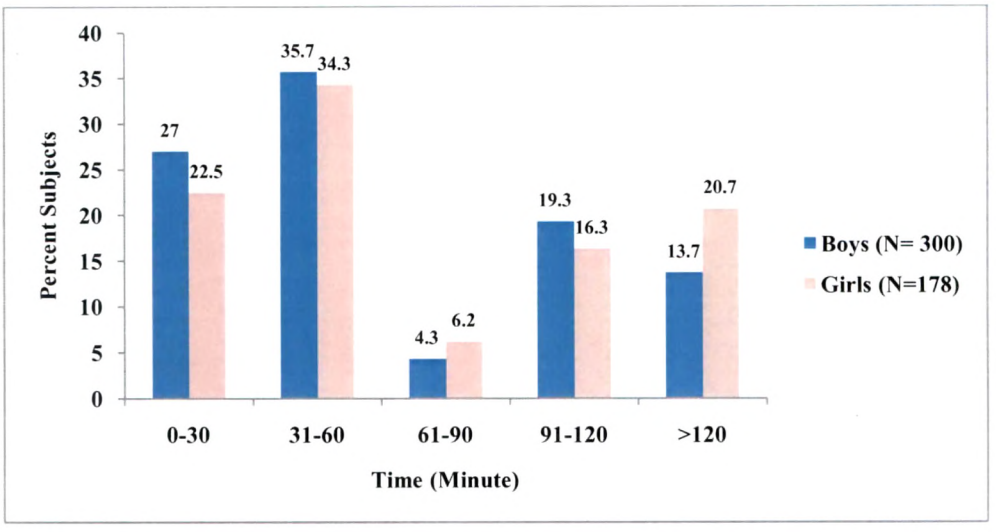


Figure 4.1.54: Reported Leisure Time - Sexwise (N=478)

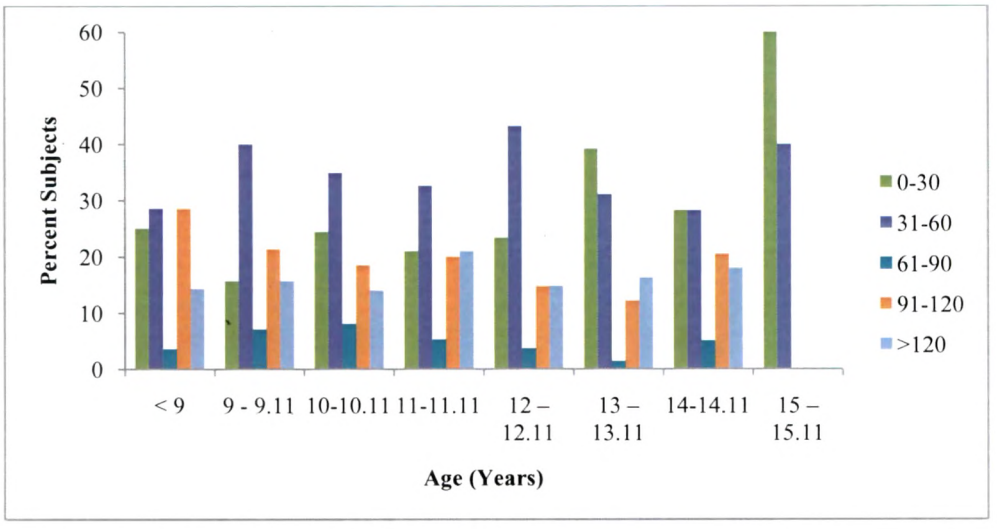


Figure 4.1.55: Reported Studytime of the Study Subjects – Sexwise (N=478)

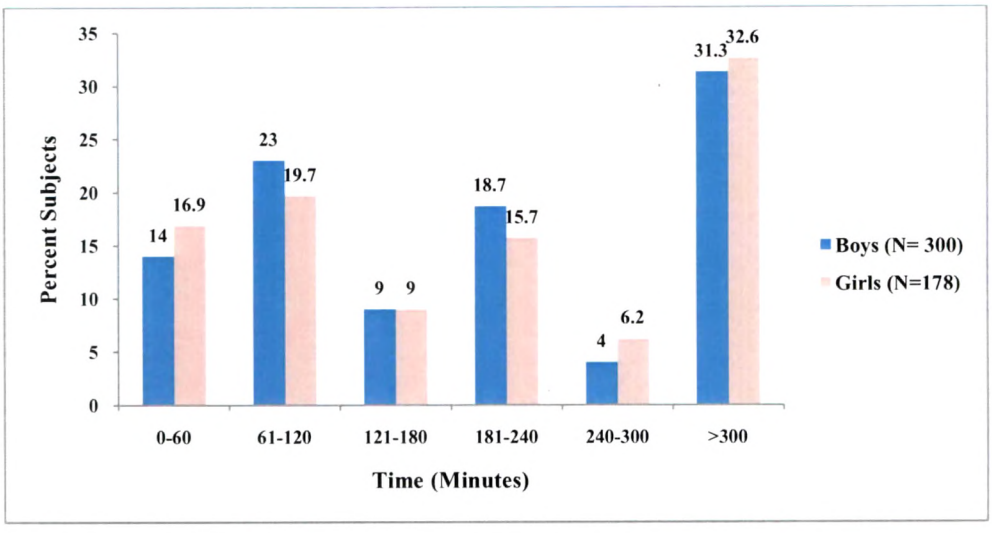


Figure 4.1.56: Reported Studytime of the Study Subjects – Sexwise (N=478)

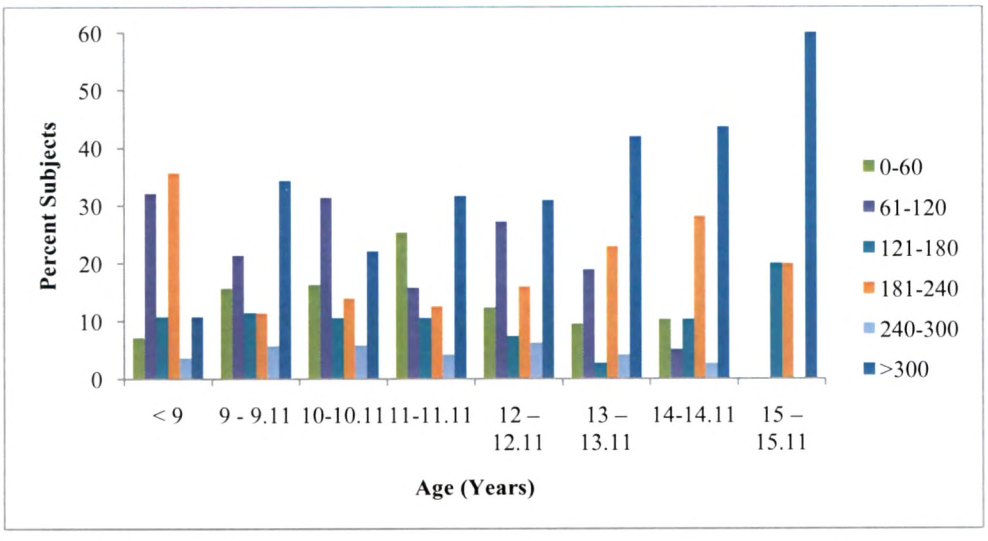


Table 4.1.31: Mean Cognitive Test Scores Sex wise (N=478)

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)

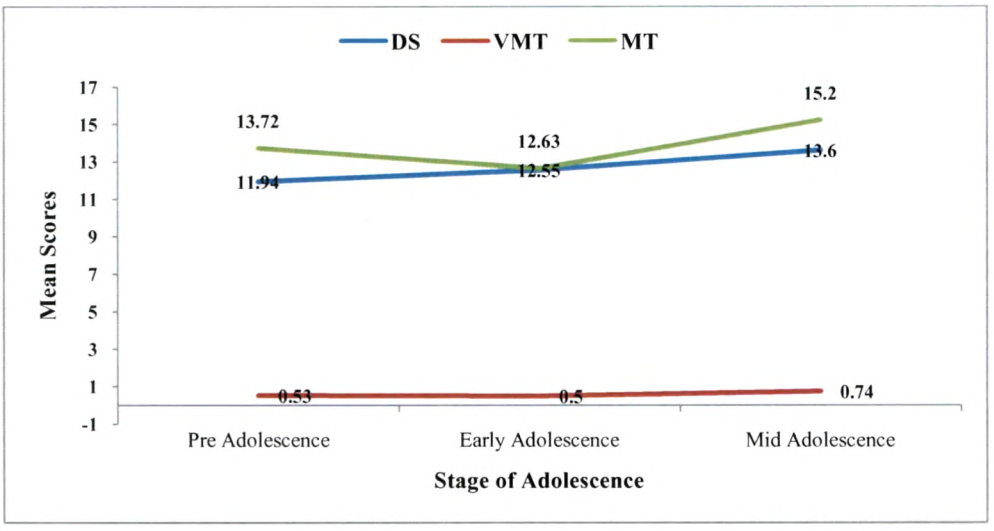


Table 4.1.33: Mean Cognitive Scores of the Subjects According to their Nutritional Status and Anemia

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)

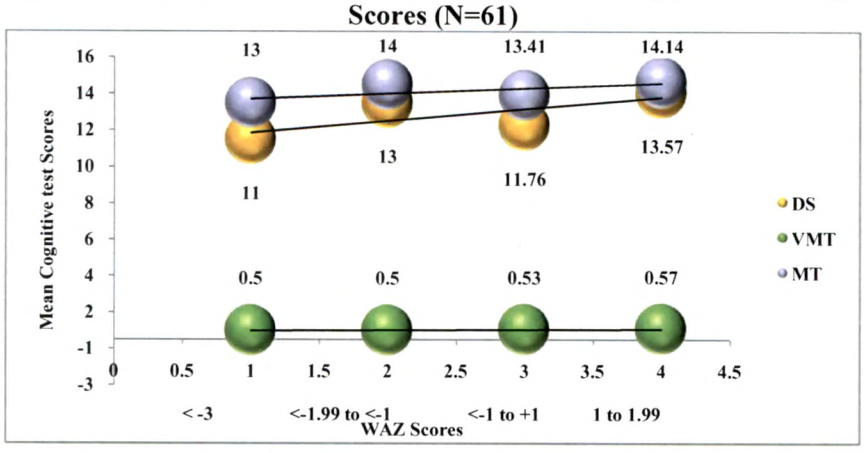


Figure 4.1.59: Mean cognitive Test Scores of the Anemic Subjects According to HAZ Scores (N=61)

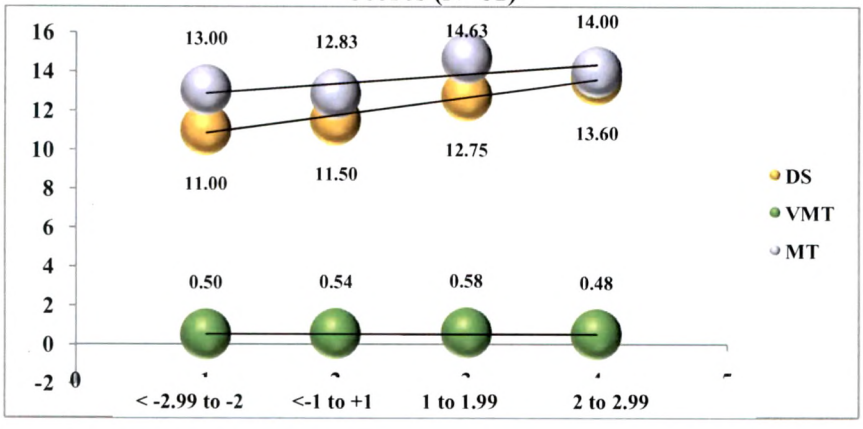
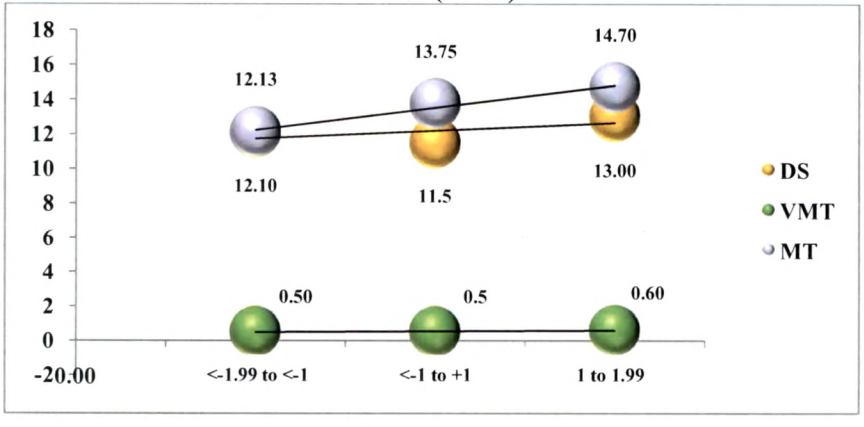


Figure 4.1.60: Mean cognitive Test Scores of the Anemic Subjects According to BAZ Scores (N=61)



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.

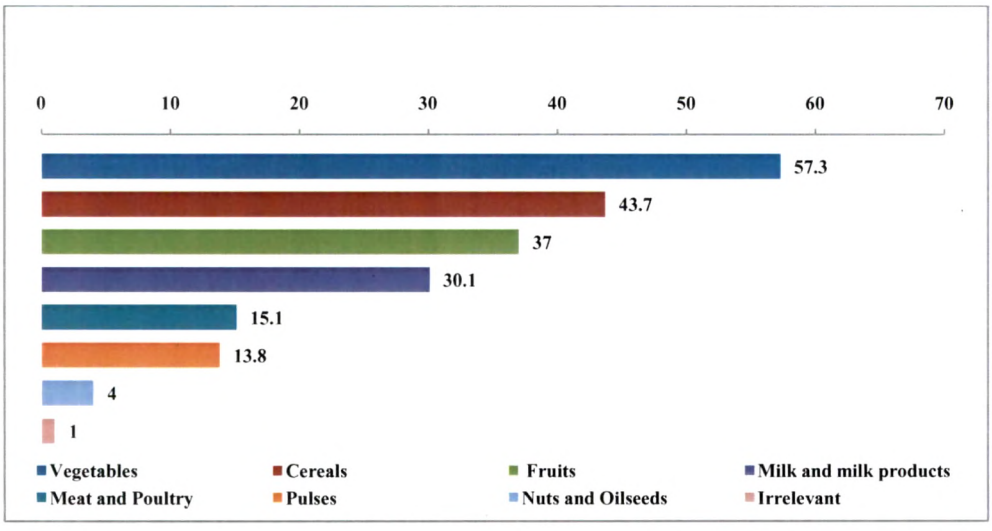
Table 4.1.34 : Knowledge and Attitude regarding Healthy Eating, Meals and Meal Pattern (N=478)

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)

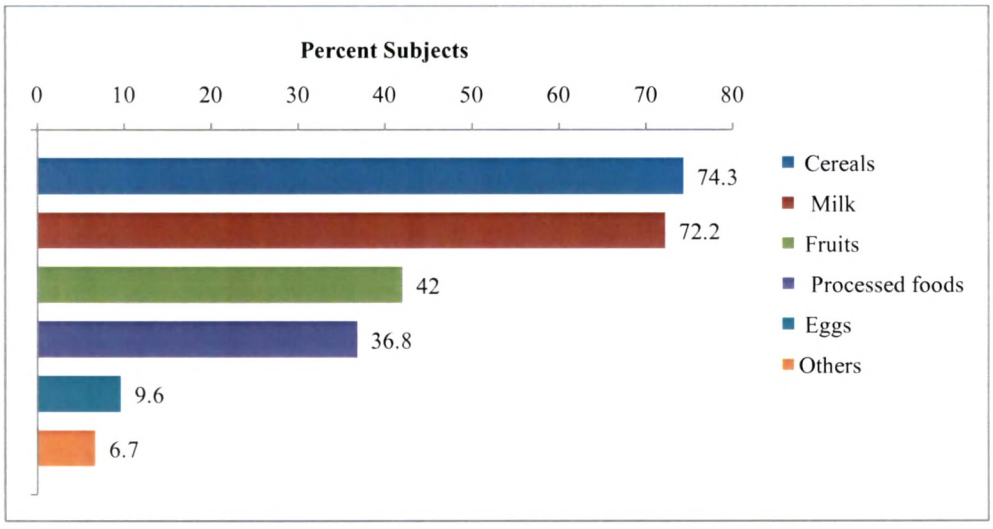


Figure 4.1.63: Commonly Consumed Food Items as Evening Snacks (N=478)

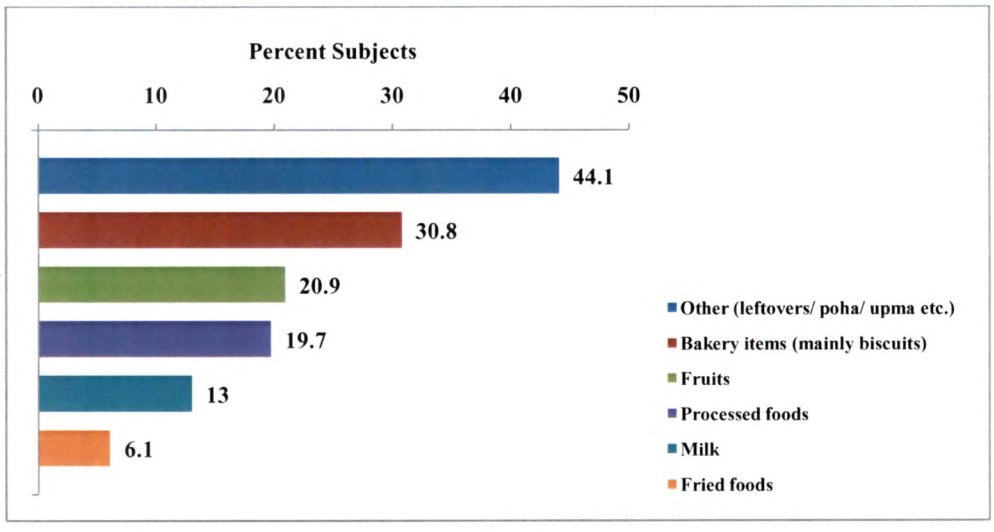


Table 4.1.35: Practices followed regarding Healthy Eating, Meals and Meal Pattern (N=478)

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 ≤ 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

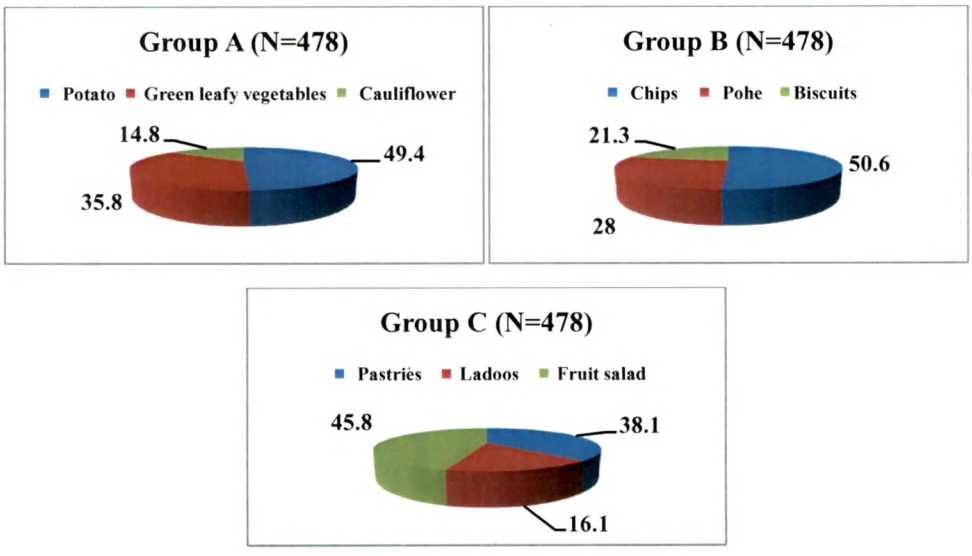


Figure 4.1.65: Reported Water Intake (Glasses/ Day) of the Subjects for the Past 24 Hours (N=478)

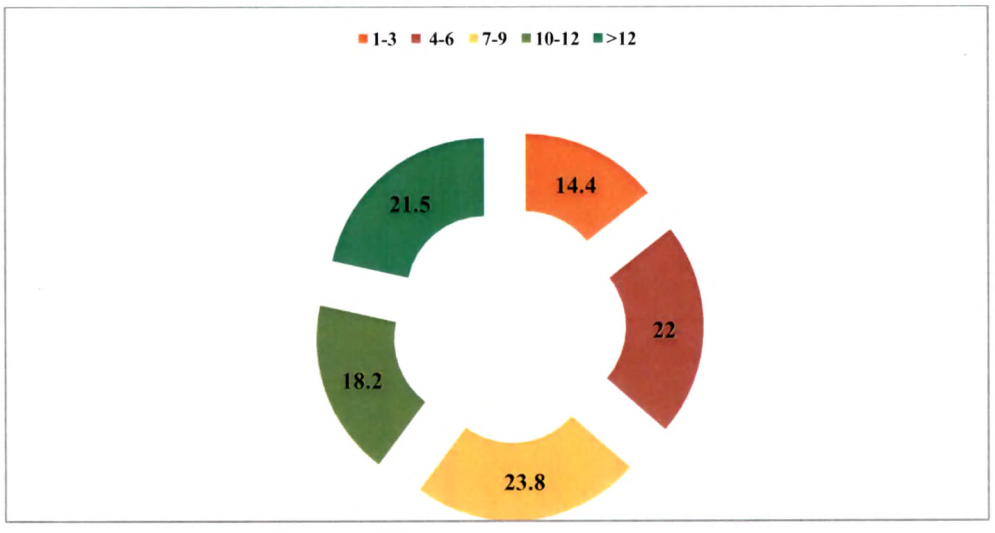


Table 4.1.37: Practices regarding Fruit Consumption, Healthy Food Choices and Water Intake (N=478)

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

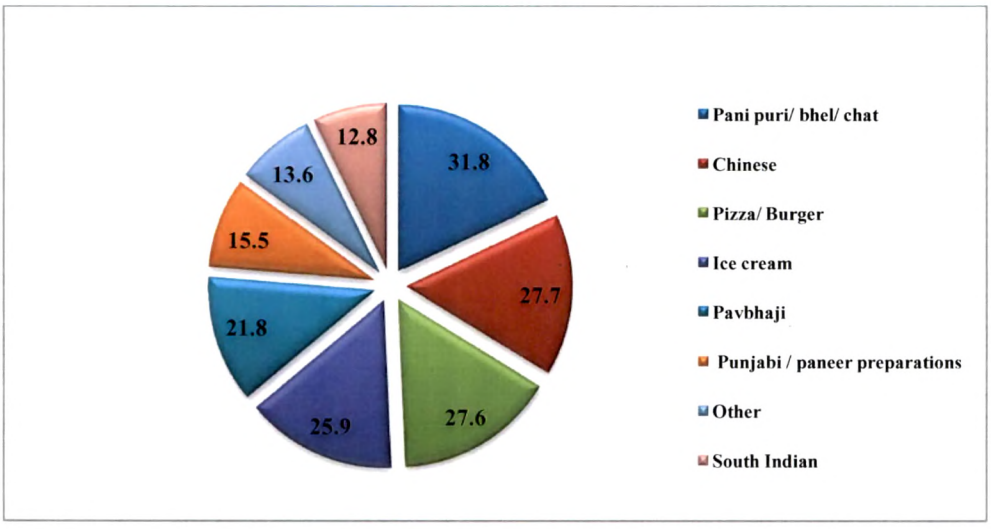
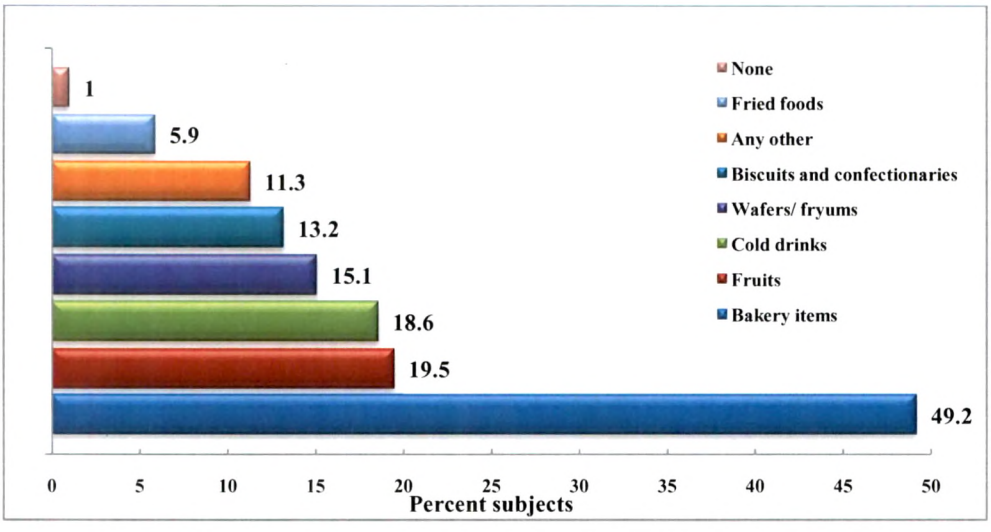


Figure 4.1.67: Foods Purchased from Street Vendor / Shops Apart from Pocket Money (N=478)



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

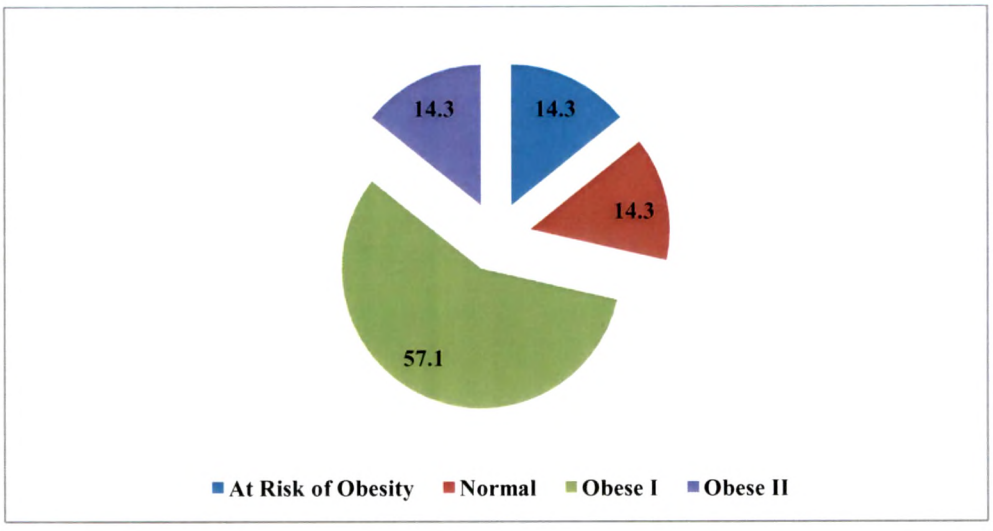
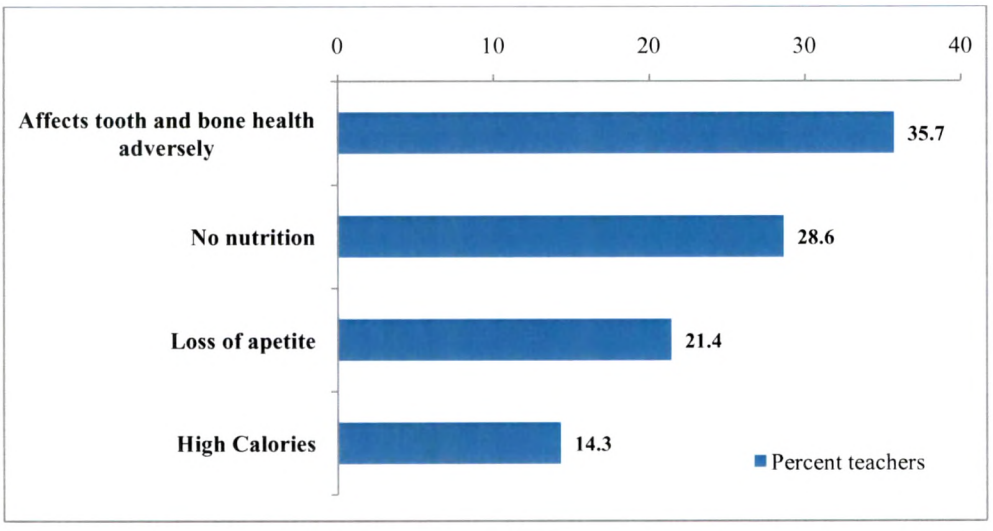


Figure 4.1.69: Response (%) of the Teachers Regarding the Harmful effects of Soft Drinks



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)

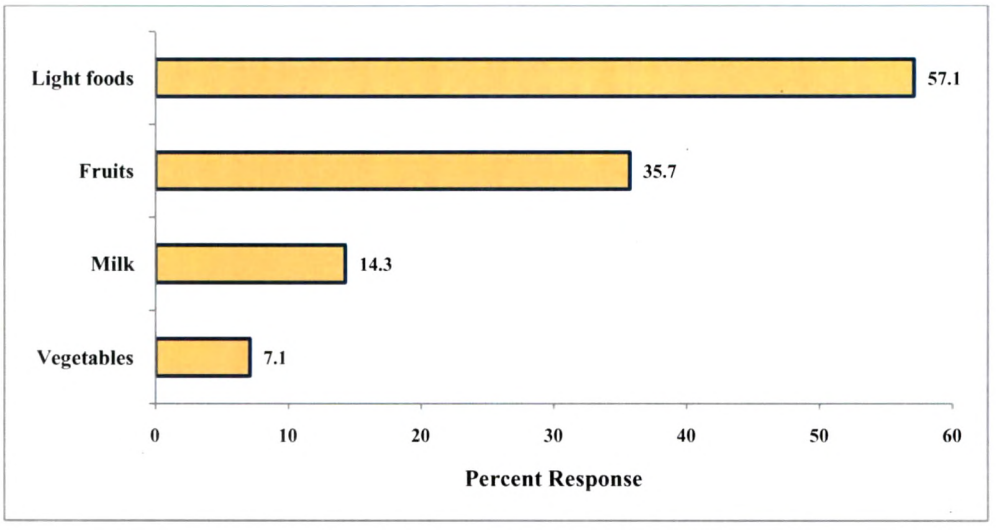
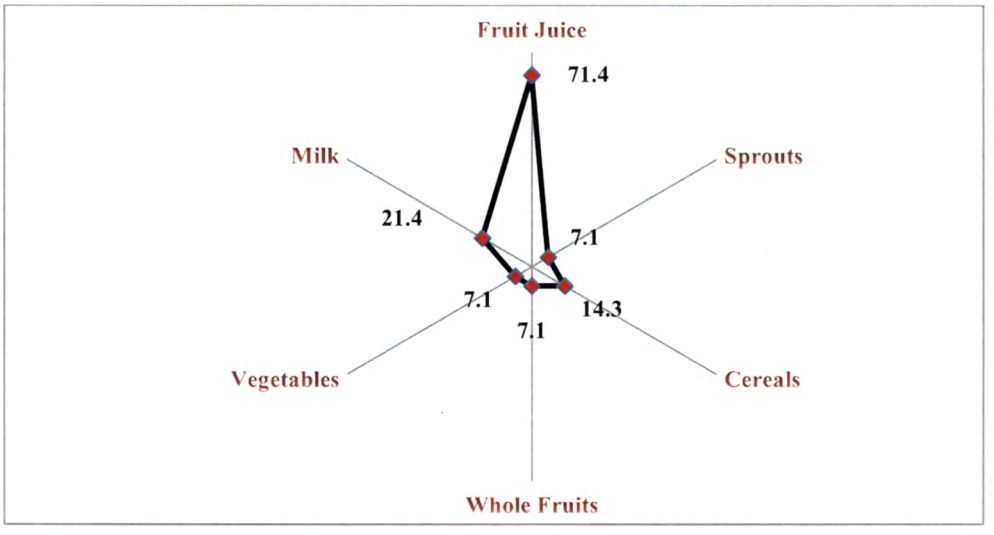


Figure 4.1.71: Response (%) Regarding Foods to be Served when the Child is Back from Play



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

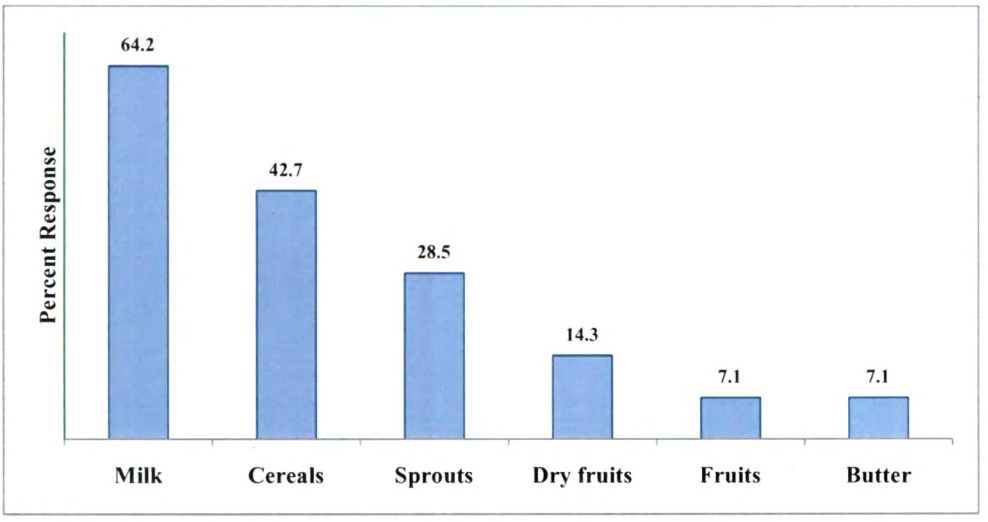
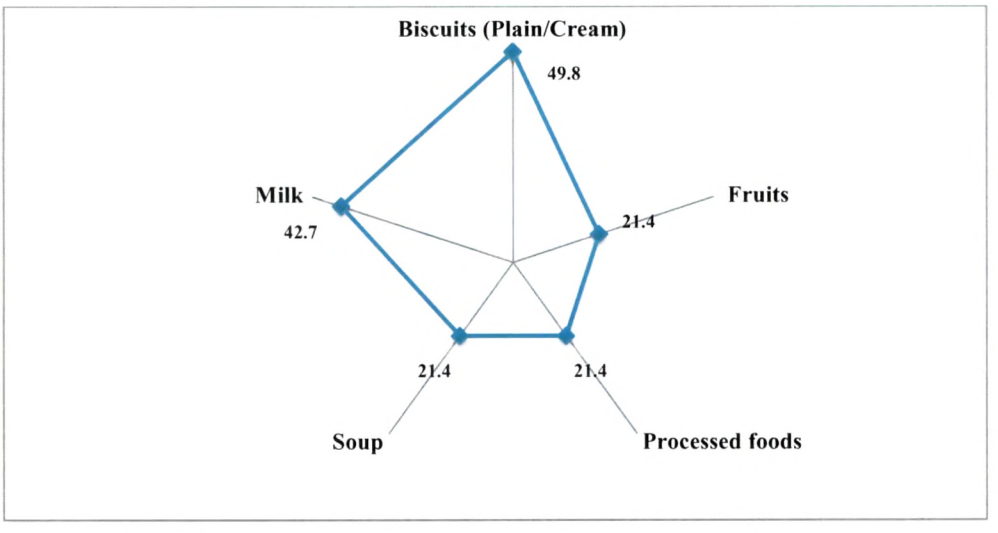


Figure 4.1.73: Response (%) Regarding Foods to be Served as Evening Snacks



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 ± 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)

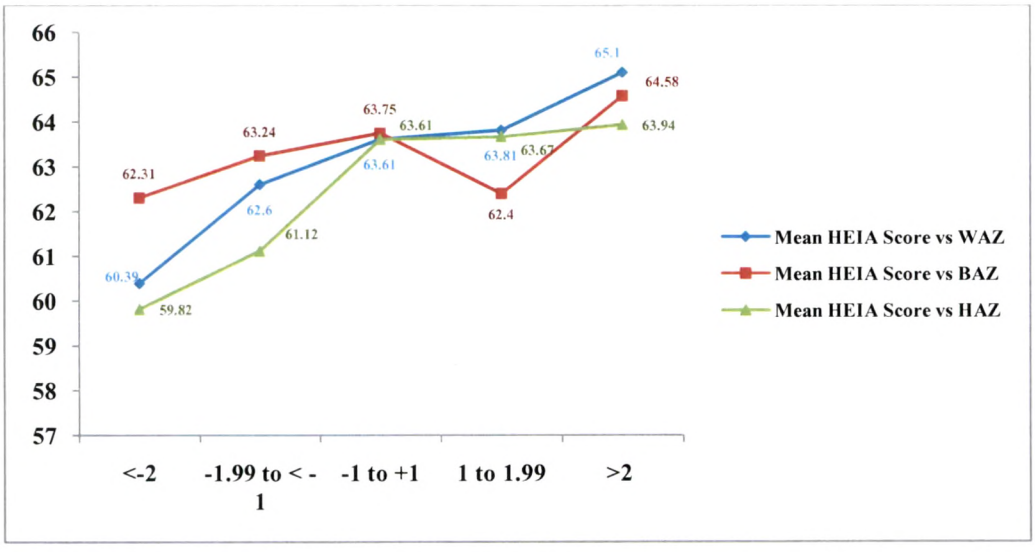
Table 4.2.5: Mean HEIA score according to the nutritional status

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

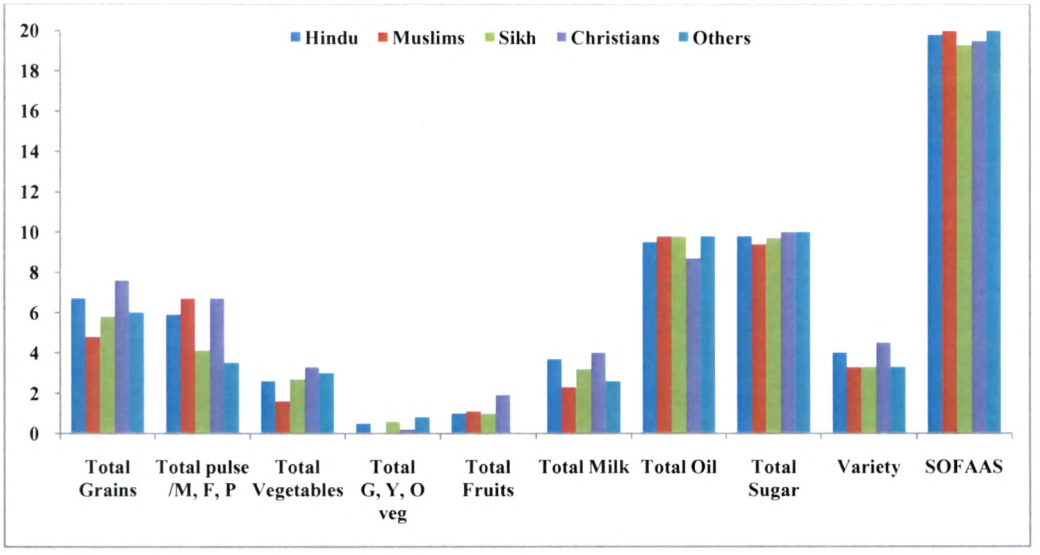
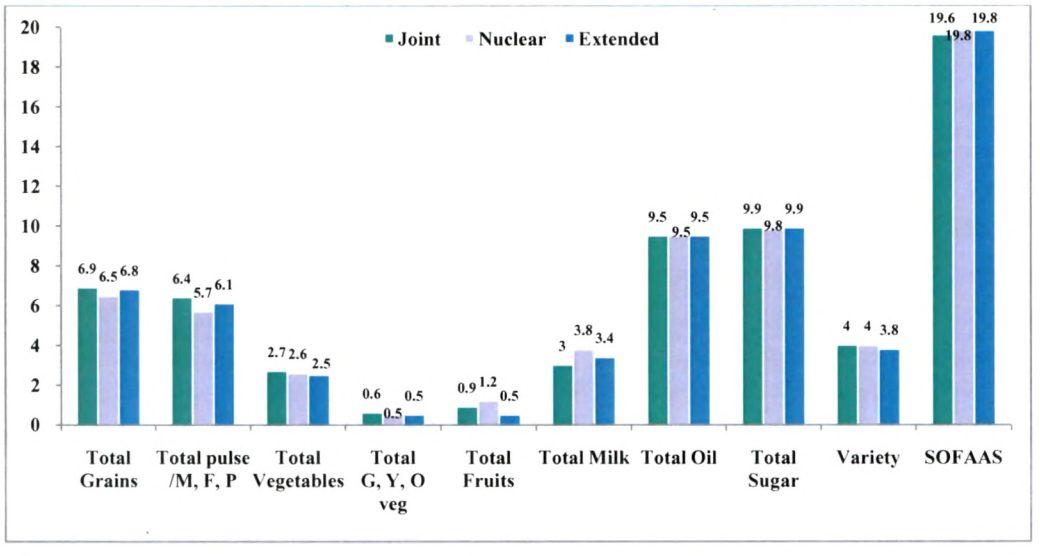


Figure 4.2.3:Mean HEIA Component Scores according to the Type of Family



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

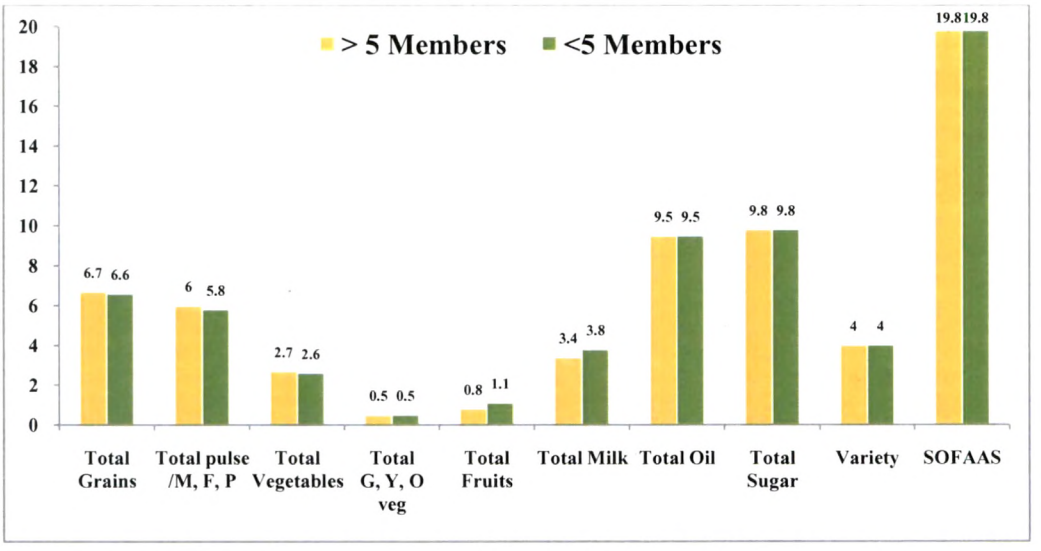


Figure 4.2.5: Relationship between Mean HEIA Component Scores and Per Capita Income

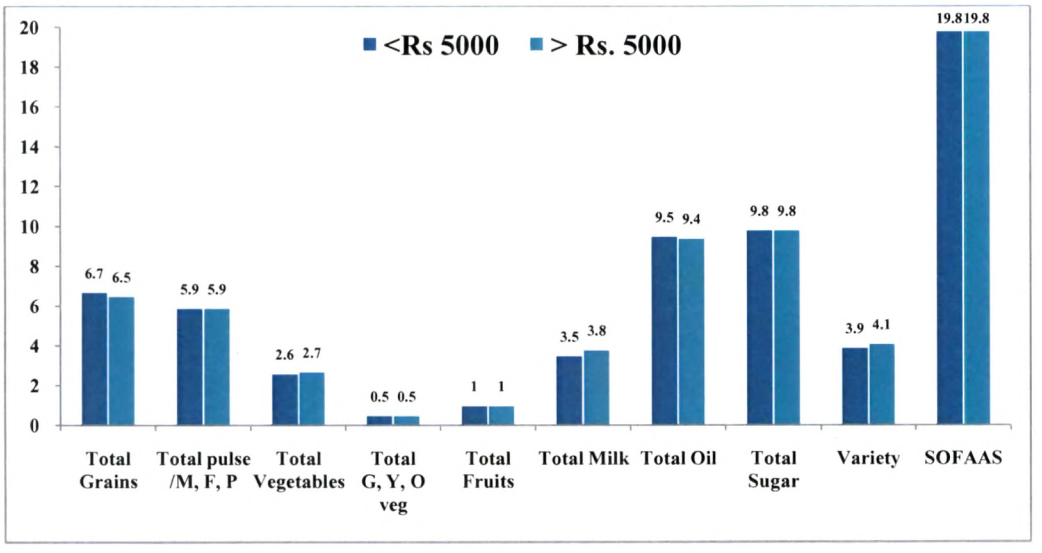


Figure 4.2.6: Relationship between Mean HEIA Component Score and Father's Education

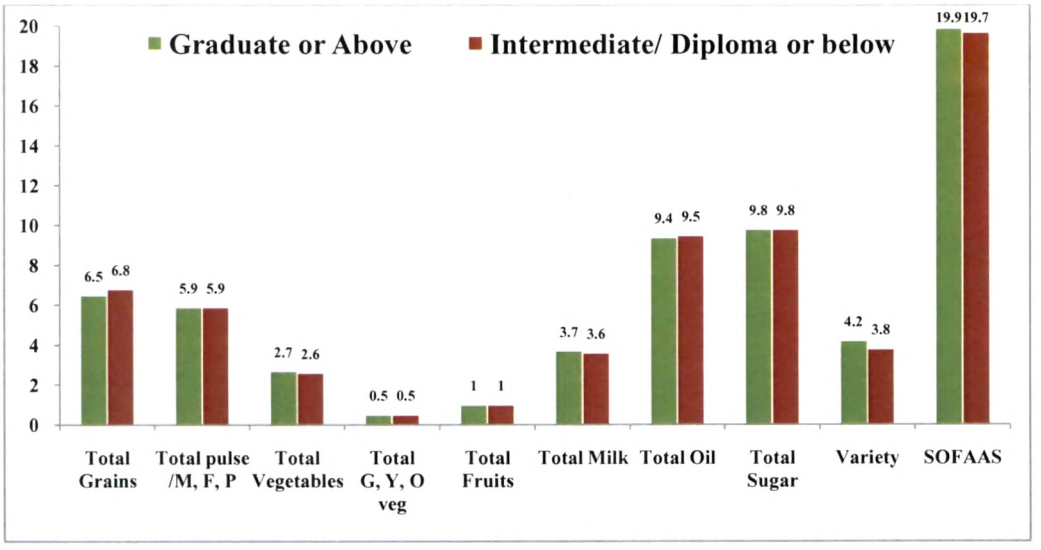


Figure 4.2.7:Relationship between Mean HEIA Component Scores and Mother's Education

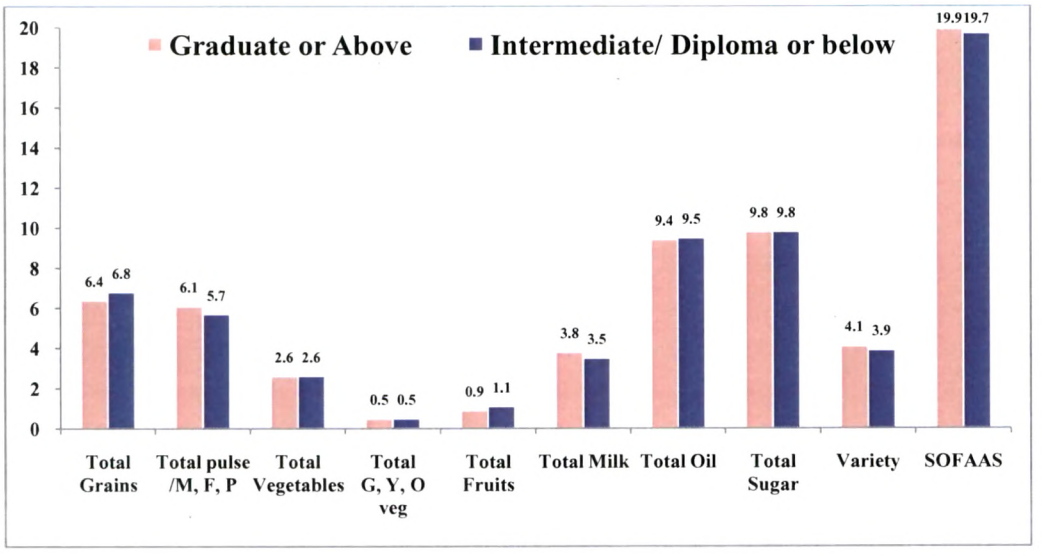


Figure 4.2.8: Relationship between Mean HEIA Component Scores and Mother's Occupation

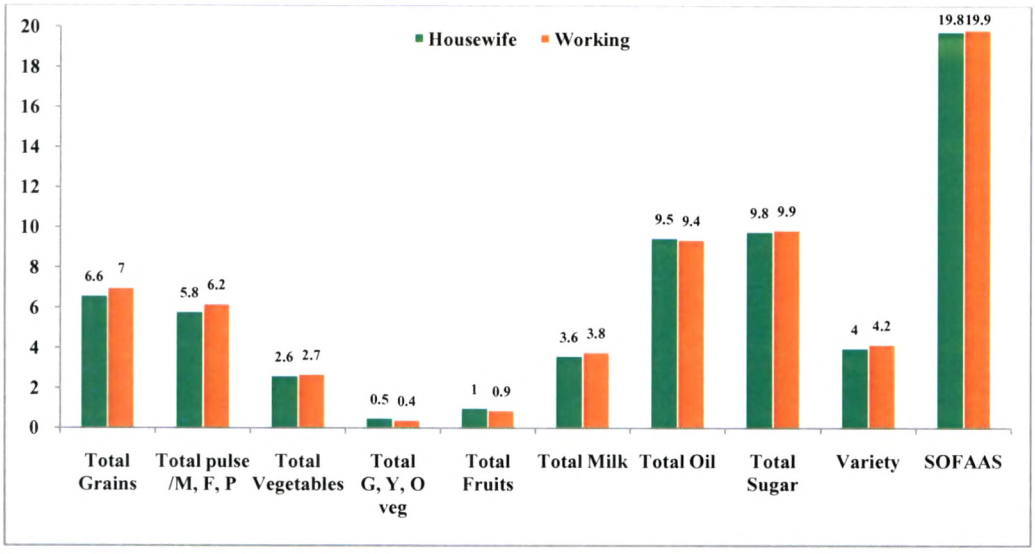
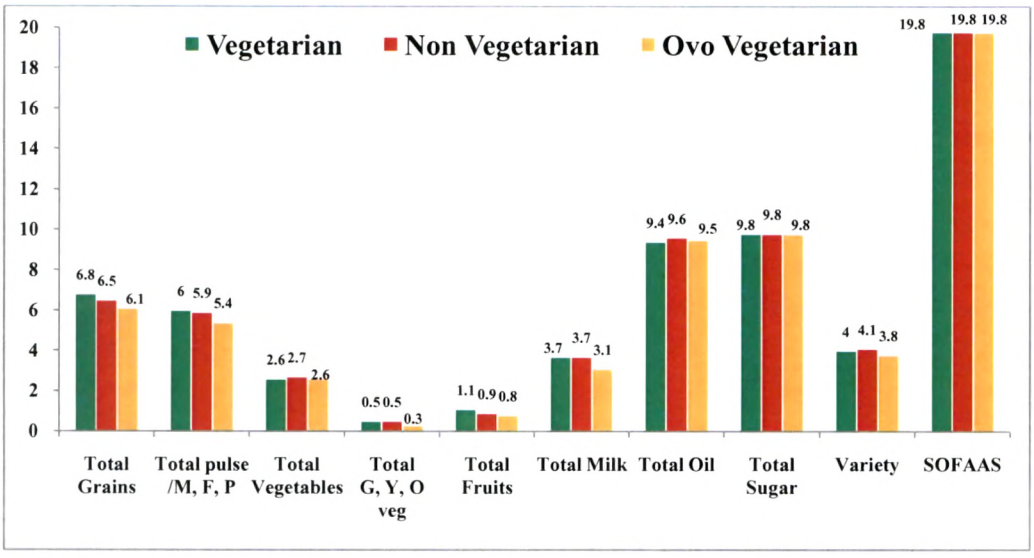


Figure 4.2.9: Relationship between Mean HEIA Component Scores and Dietary Habits



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.

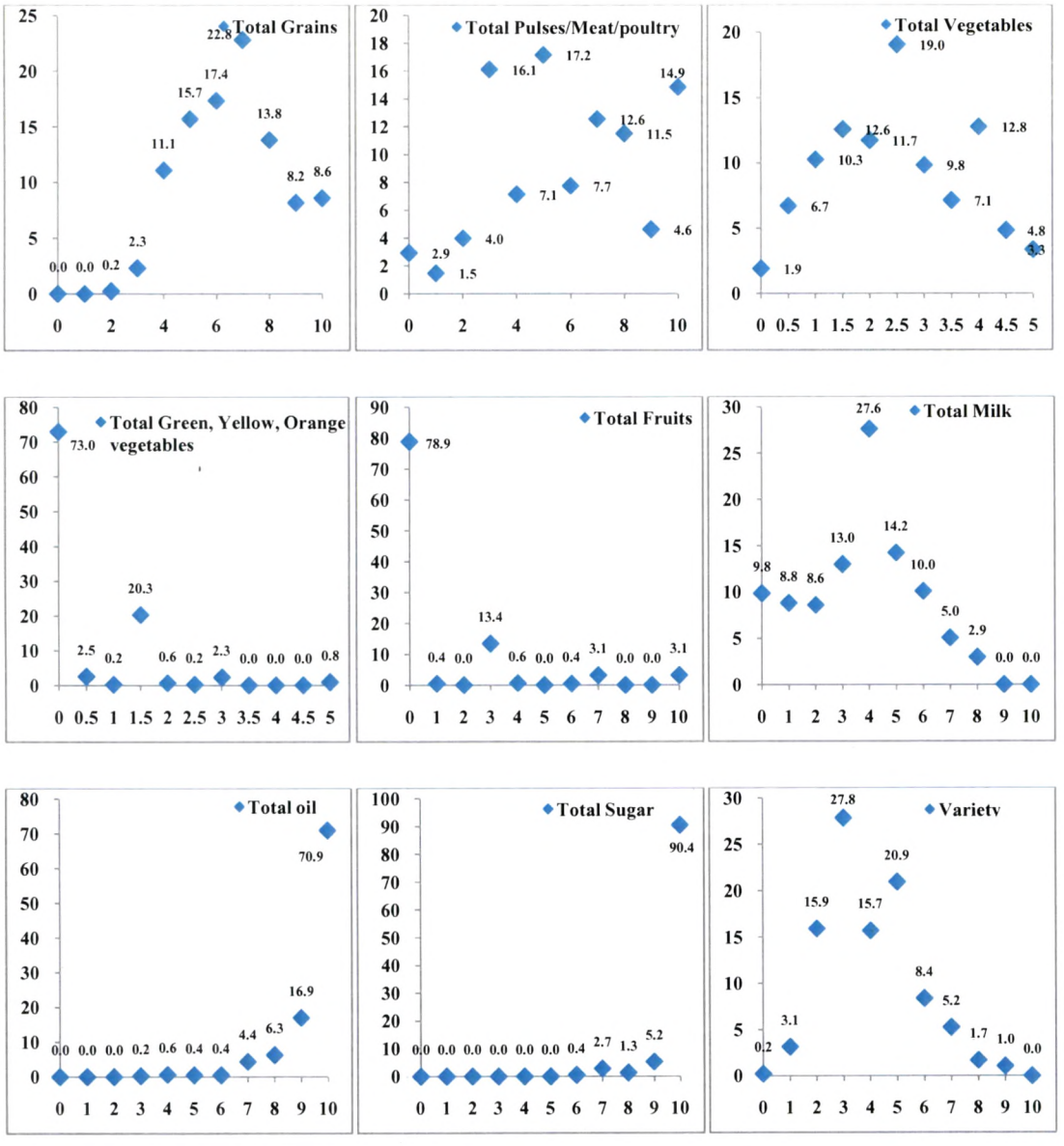


Figure 4.2.10: Scatter plot showing HEIA scores for Individual Components

X-Axis: HEIA Scores

Y Axis: Percent Subjects

Table 4.2.9: Individual component scores v/s RDA

Food Group	Boys			Girls		
	Mean Scores	Total Amount	RDA %	Mean Scores	Total Amount	RDA %
Total Grains	6.42±1.88	201.42±40.32	73.6	6.97± 1.67	189.96±43.48	76.2
Total pulse	5.82±2.72	38.98±19.65	56.1	6.01±2.68	37.98±17.73	61.4
Meat , Fish & Poultry		4.41±15.0	3.3		2.85±10.43	1.9
Total Vegetables	2.7±1.22	185.79±82.31	58.8	2.49±1.26	170.16±100.37	55
Total Fruits	1.08±2.31	15.67±35.57	14.2	0.9±2.23	15.79±51.23	13
Total Milk	3.73±1.91	194.08±95.67	38.7	3.49±2.24	181.98±113.21	34.7
Total Oil	9.44±1.02	22.89±6.34	78.9	9.55±0.80	181.98±5.56	75
Total Sugar	9.77±0.68	12.08±5.46	53.1	9.86±0.56	11.44±5.82	47.4

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)	70.19± 8.40	'F'- 1.43
Muslim (10)	71.70± 8.56	
Sikh (16)	67.69±7.95	
Christian (10)	72.8± 5.03	
Type of Family		
Joint (63)	68.94± 7.96	'F'- 1.76
Nuclear(459)	70.57± 8.33	
Extended(109)	69.34± 8.58	
Family Size		
≥ 5 members(234)	69.65± 8.2	't'- 1.27
< 5 members (397)	70.52± 8.43	
Per Capita Income		
≤ Rs. 5000 (321)	71.1± 8.28	't'- 2.78
> Rs. 5000 (310)	69.26± 8.33	
Father's Education		
Graduate or above (352)	70.55± 8.67	't'- 1.19
Intermediate/ Diploma or below (279)	69.75± 7.92	
Mother's Education		
Bachelor degree or above (251)	70.83± 8.03	't'- 1.54
Intermediate/ Diploma or below (380)	69.78± 8.55	
Mother's Occupation		
Housewife (568)	70.03± 8.44	't' – 1.51.
Working (62)	71.71±7.42	
DietaryHabits		
Vegetarian (358)	70.08±8.07	'F' – 0.24
Non-Vegetarian (196)	70.18±8.88	
Ovo-Vegetarian (77)	70.81±8.29	

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).

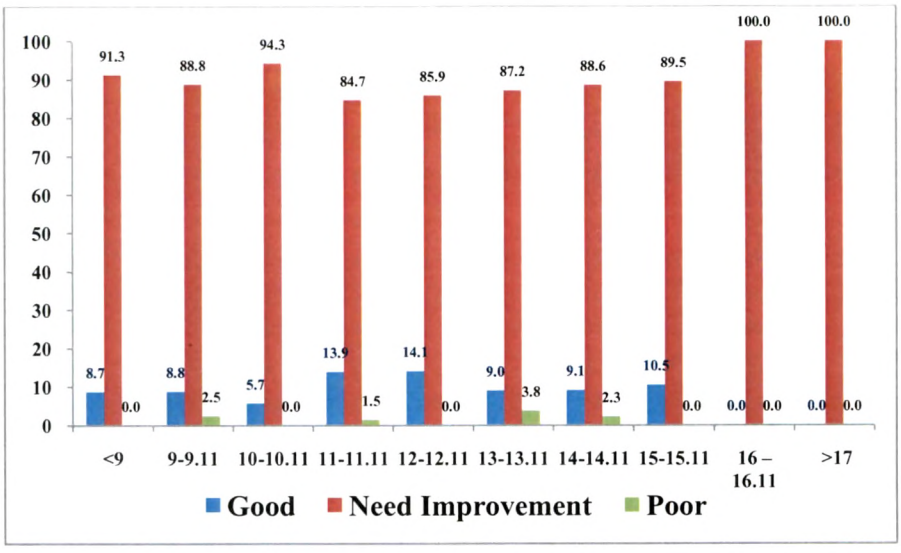
Table 4.2.13: Quality of diet and physical activity practices of the study subjects

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

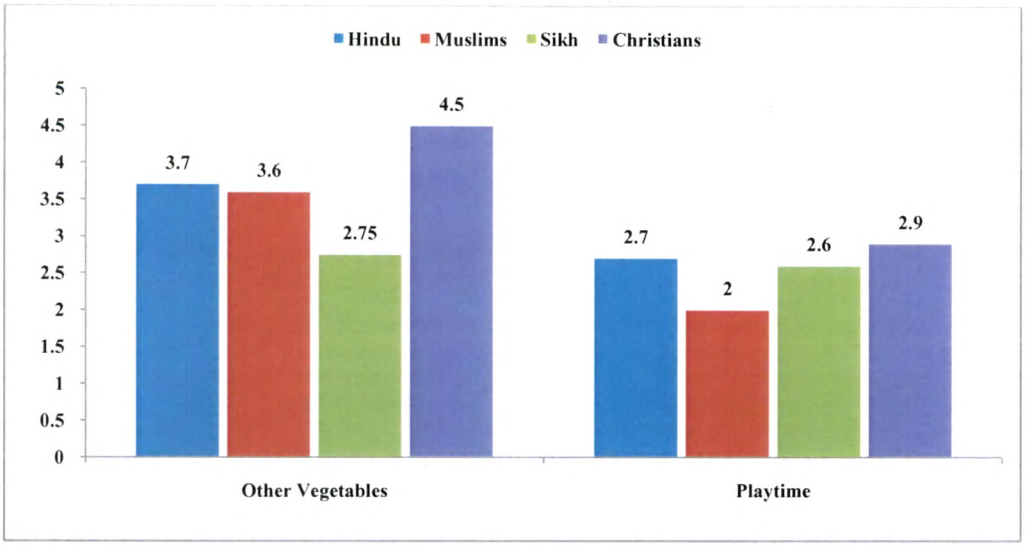


Figure 4.2.13: Mean FBACA Component Scores and Type of Family

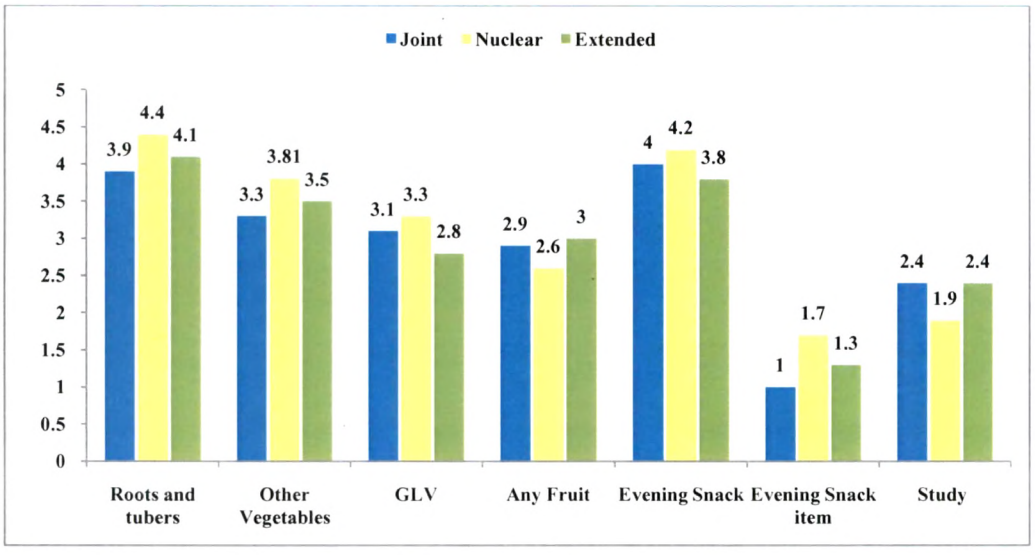


Figure 4.2.14: Mean FBACA Components Scores and Family Size

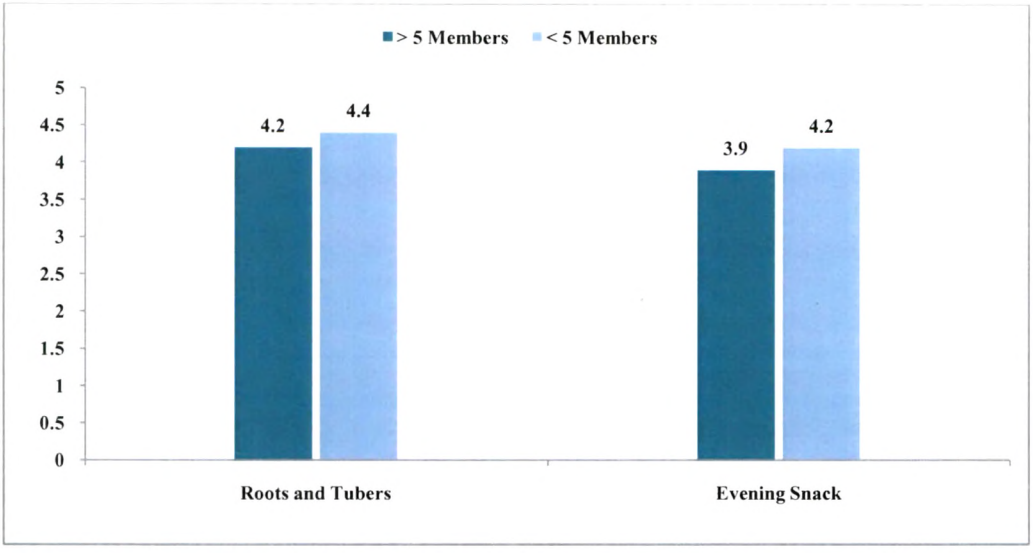


Figure 4.2.15: Relationship between Mean FBACA component Scores and Per Capita Income

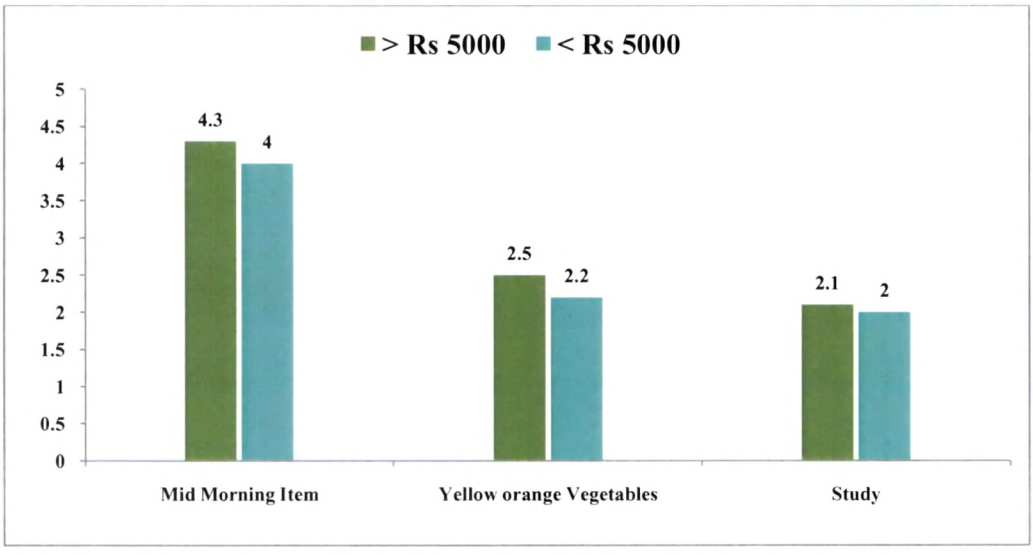


Figure 4.2.16 Mean FBACA Component Scores and Father's Education

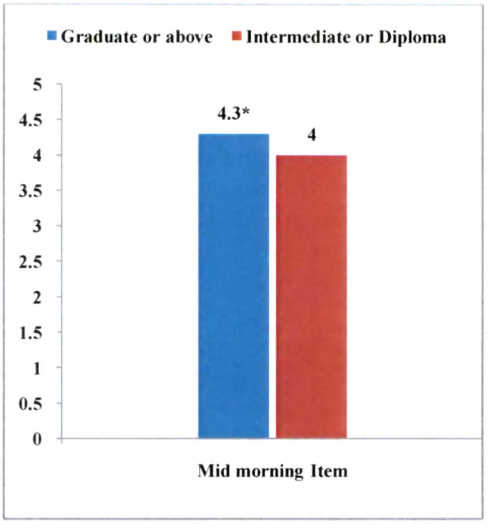
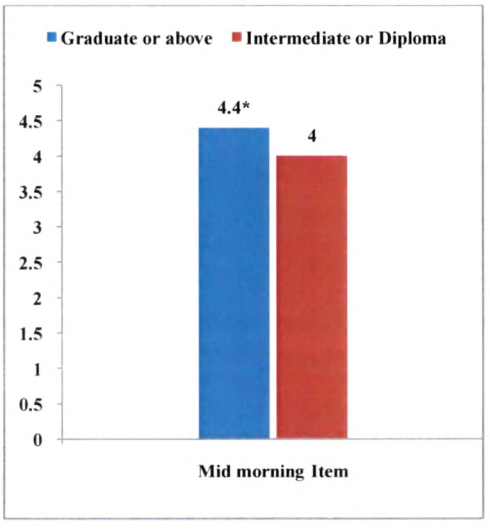


Figure 4.2.17 Mean FBACA Component Scores and Mother's Education



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

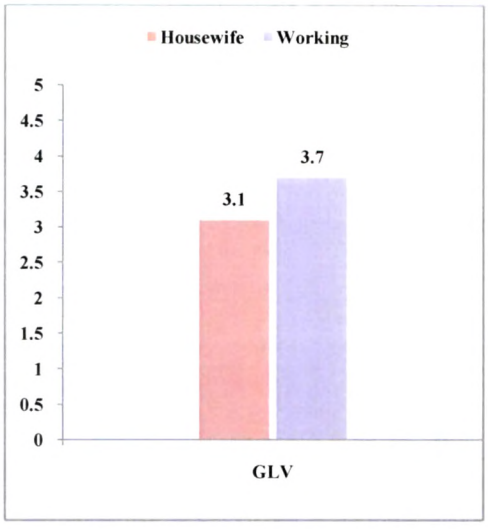


Figure 4.2.19 Mean FBACA Component Scores and Dietary Habits

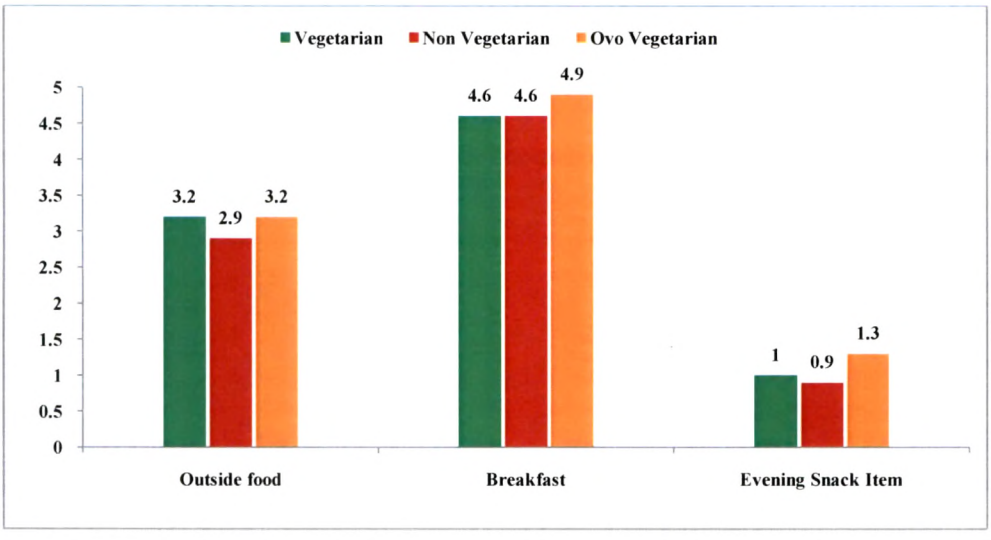
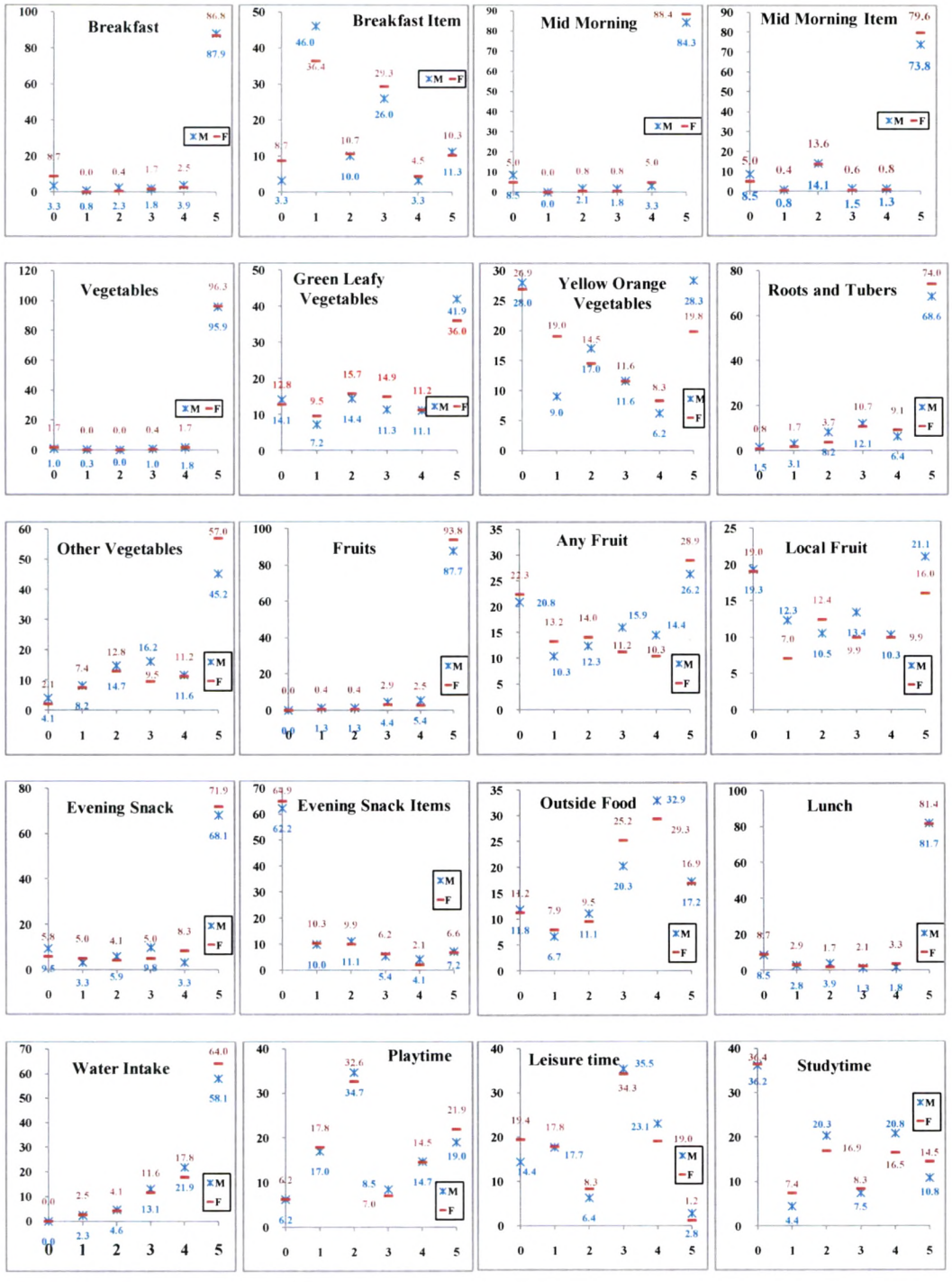
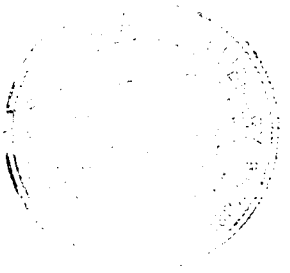


Figure 4.2.20 Scatter plot showing FBACA scores for Individual Components

X-Axis: FBACA Scores Y Axis: Percent Subjects





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 grains, total pulse, total oil and total sugar scores were a little lower. However all the diets were ranked of a good quality.

Differences in 3-day HEIA scores between undernourished (WAZ<-2SD) and well nourished (WAZ>-2SD) subjects are shown in Table 4.2.18. Three of the ten components were significantly higher for the well nourished subjects. Mean total HEIA score for undernourished subjects (60.39) was significantly lower ($p<0.005$) than the score for the well nourished subjects (63.5). Although there were certain exceptions like total pulses, total oil and SOFAAS score which were higher for the undernourished subjects.

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 4.2.16HEIA / 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

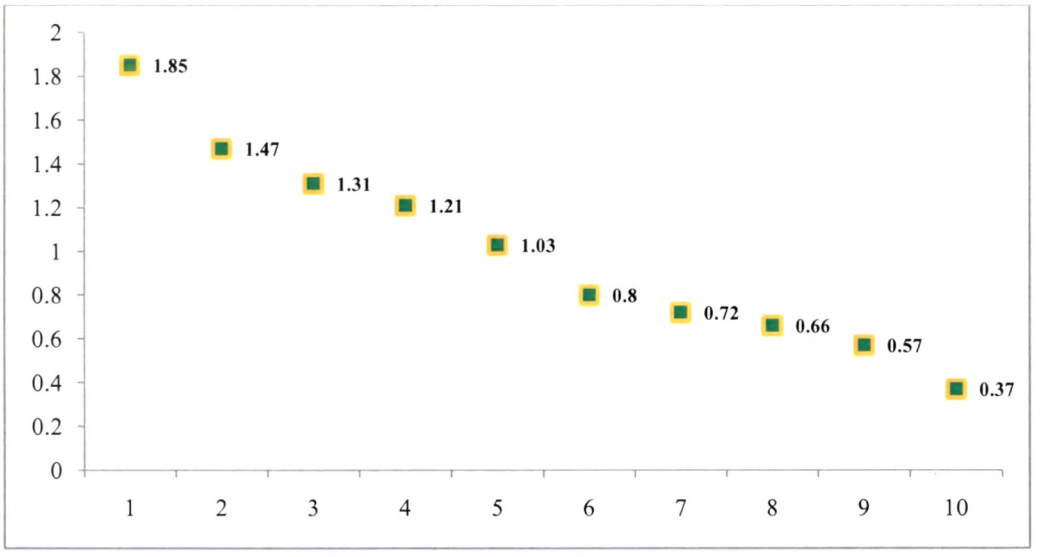
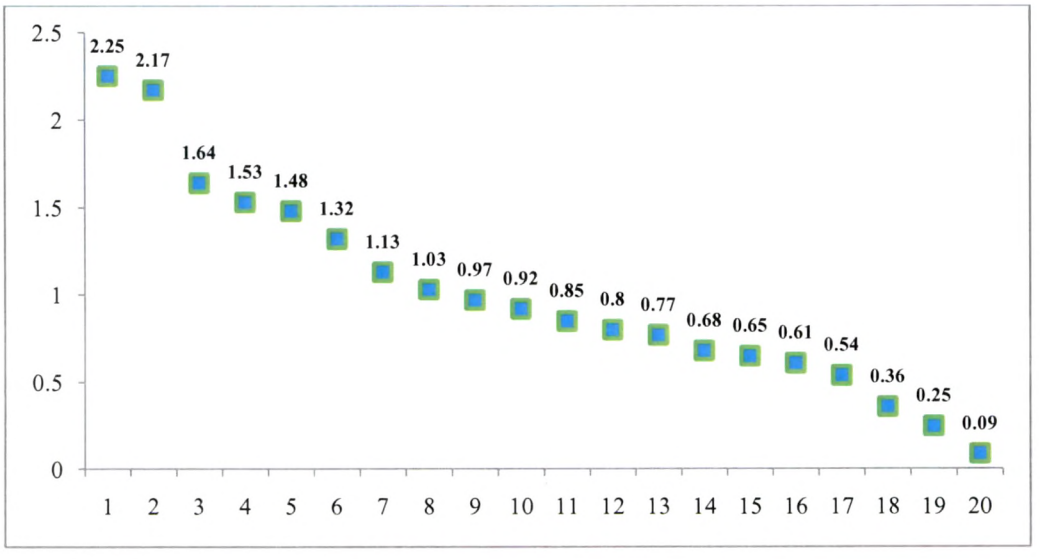


Figure 4.2.22: Scree plot – Principal Component Analysis of FBACA



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± 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.

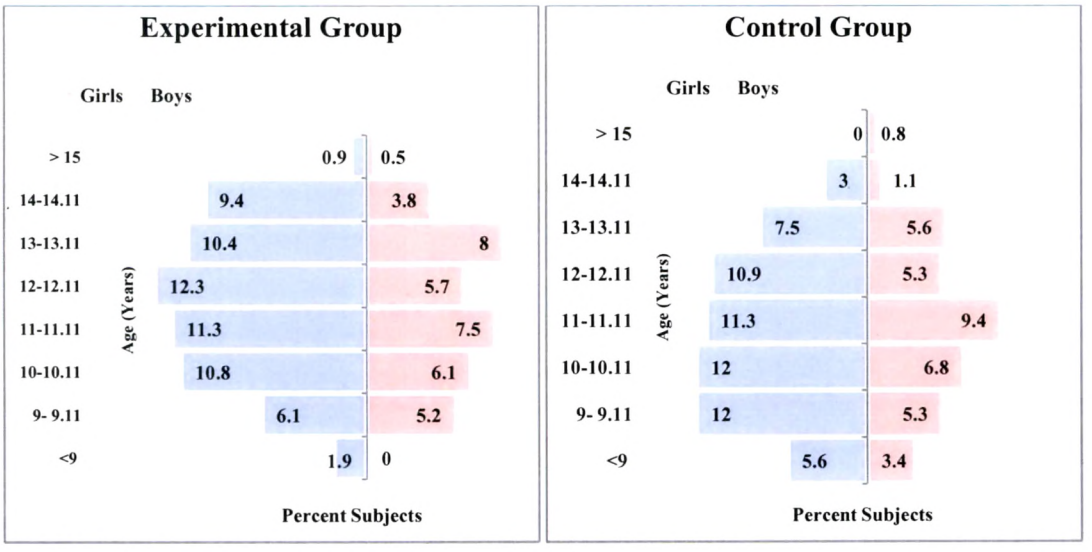
Formative Research for the development of CHALK Program

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.

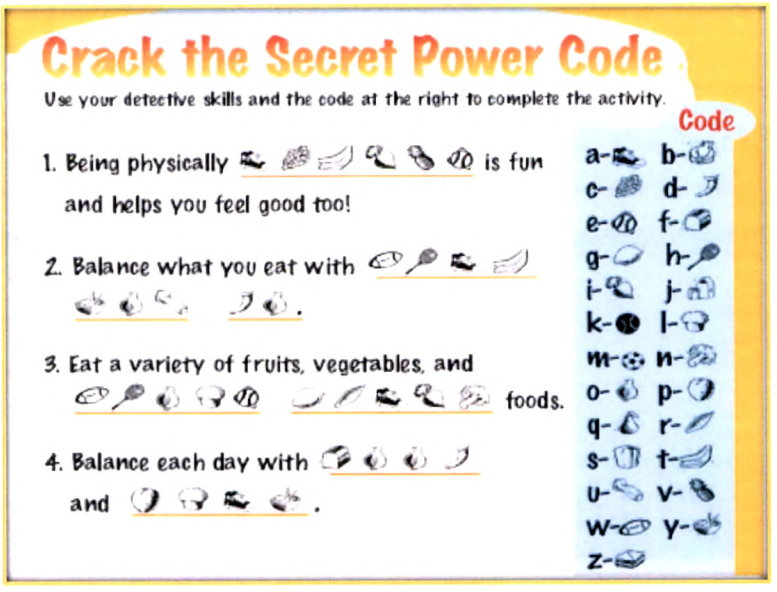
The detailed description of each session is shown below:

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

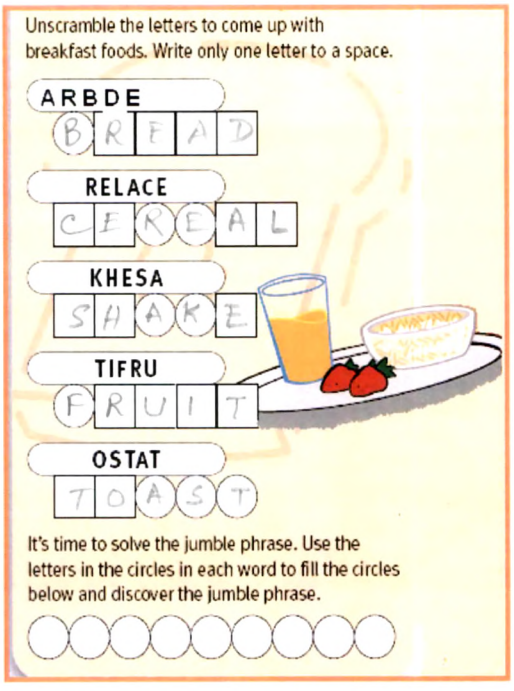
- Functions of food were explained to the subjects along with the examples of various foods
    - ✓ To provide energy to the body for sustenance, work & other activities.
    - ✓ To provide foods for building, maintenance & repair of body.
    - ✓ To protect us from various diseases.

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

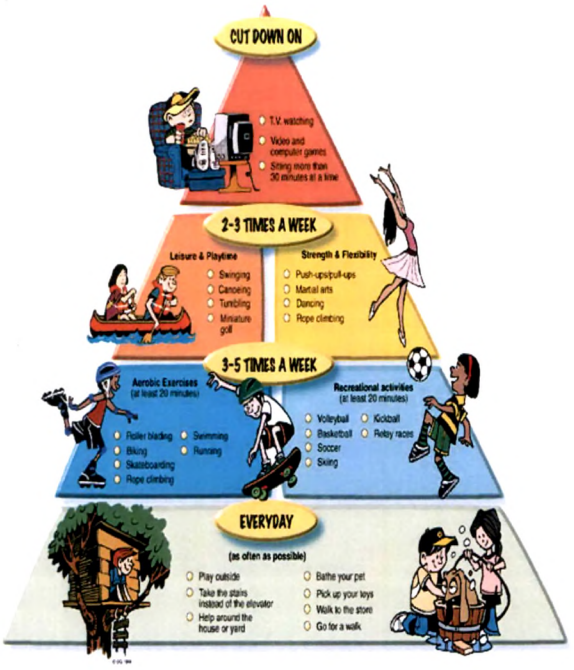
- Healthy recipes and their advantages were discussed in the class.
- Comic on why a healthy change is good was shown to children.

- 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 (≥ 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^ (≤ 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±1 00.2	205.5 ±93.6	178.58± 82.24	177.8± 83.2	0.76	6.90***	2.7	3.26***
Fruits	19.28±3 9.9	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±2 80.2	1474.7±3 06.8	0.21	7.7***	1.7	2.06*
Protein (g)	43.06±1 1.1	45.06±10. 5	43.3±11. 2	43.9 ±12.9	0.19	7.5***	3.4***	1.0
Fat (g)	47.68±1 6.9	48.58±16. 1	46.8±14. 5	46.6 ±14.7	0.62	3.8***	1.9	1.33
Calcium(mg)	391.3±1 26.2	403.14±12 2.3	382.2±11 8.3	384.39±1 21.1	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.

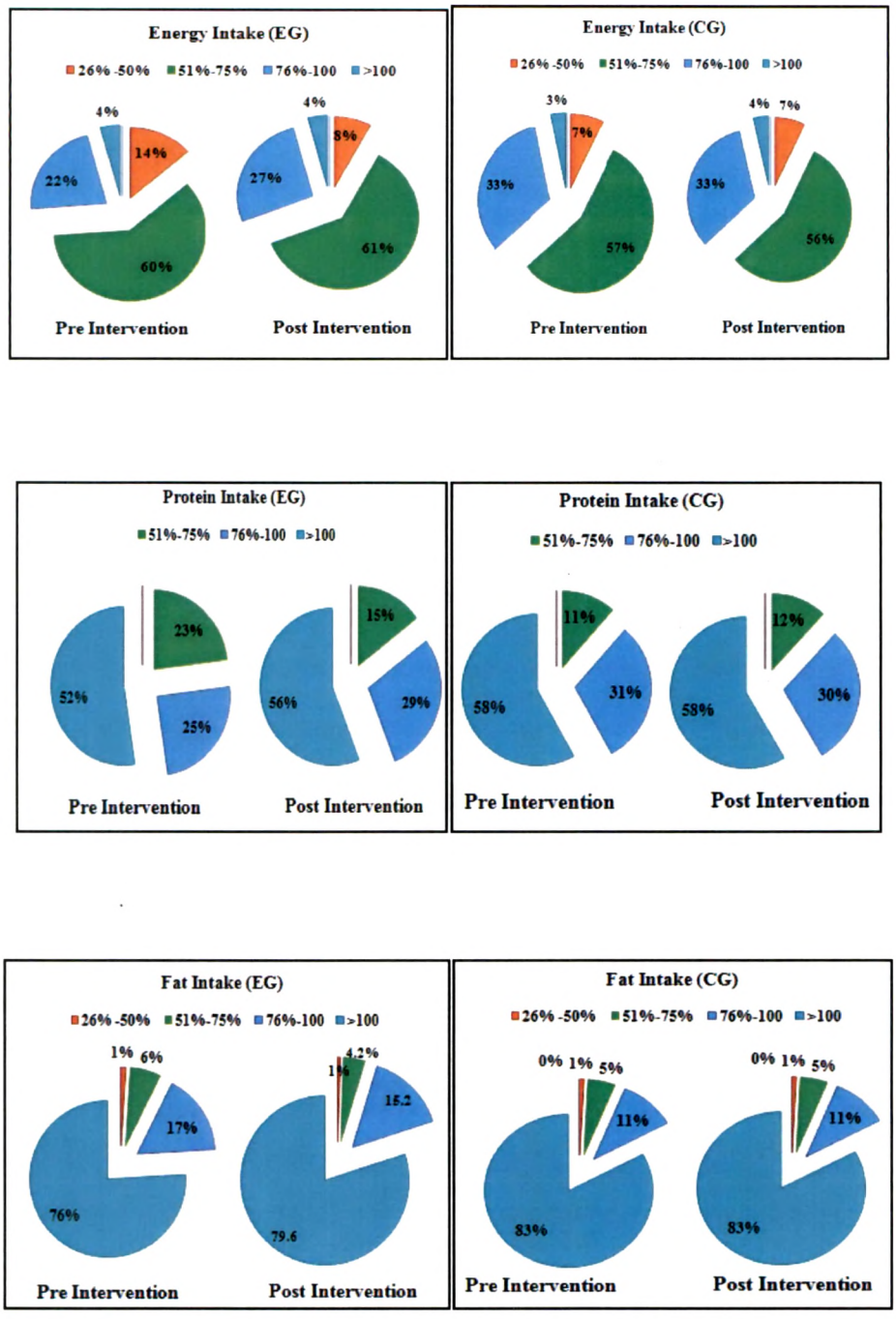


Figure 4.4.1: Mean Energy, Protein and Fat Intakes at Various Levels of RDA: Impact of the CHALK Programme (Percent Subjects)

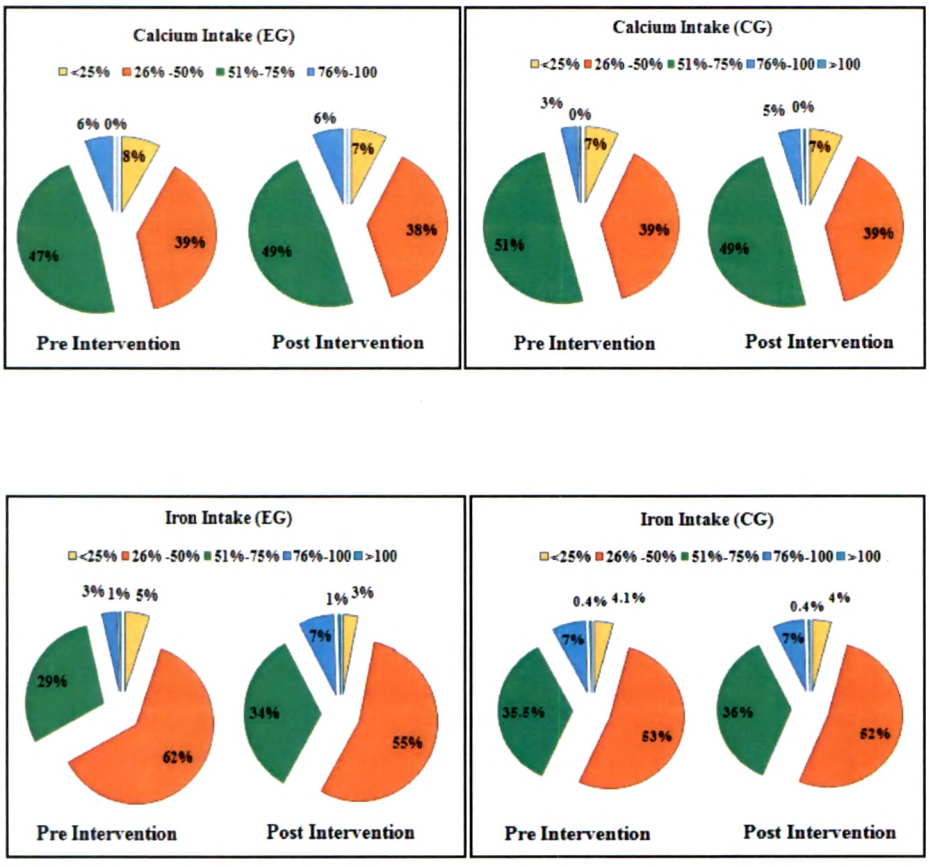


Figure 4.4.2: Mean Calcium and Iron Intakes at Various Levels of RDA: Impact of the CHALK Programme (Percent Subjects)

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.