PHASE I(A): SELECTION OF THE SCHOOL AND SITUATIONAL ANALYSIS OF ENROLLED STUDENTS

The present study was conducted for duration of two years (March 2010 – April 2012). Based on the results obtained in the Phase 1a - situational analysis and Phase 1b - evaluation of school as per the CDC guidelines, a Behaviour Change Communication (BCC) model was designed using multiple components and the last phase aimed to develop an "Active Sports Club" in a school setting as part of the BCC model.

METHODS AND MATERIALS

The methods and material for phase 1a are presented under following sub-sections:

- Rationale
- Objectives
- Study design
- Study area
- School selection
- Subject selection
- Situational analysis
- Anthropometric measurements
- Data management
- Data analysis
- Experimental design

RATIONALE

Vadodara, a cultural heritage of Gujarat is undergoing rapid socio-economic transition. Growing luxury and changing physical environment have adversely affected the dietary and physical activity pattern of the young population.

Rising prevalence of Dual Burden of Malnutrition (DBM), especially among school going children has been reported by various international (Doak et al., 2005), national (Subramanian et al., 2007) and regional (Iyer and Gandhi, 2004; Kanani and Saxena, 2008) investigators. Importantly DBM is preventable if identified and addressed at a budding stage and schools as an institute provides best opportunity for the same (Shah et al., 2010; Kanani and Jain, 2010). This phase was thus conducted with following specific objective:

OBJECTIVES

1. To conduct situational analysis of the school children and elicit data on:
    a. Background information
    b. Parental history of NCD
    c. Dietary behaviour pattern using Food Frequency Questionnaire (FFQ)
    d. Physical activity pattern using Physical Activity Pattern Score (PAPS)
2. To obtain anthropometric measurements of all students of the 10 selected schools.

STUDY DESIGN

Cross-sectional study design

STUDY AREA

Urban area of Vadodara district, located towards western Gujarat of India.

SCHOOL SELECTION

Web-based secondary data was used to get the list of all public and private schools (n=121) of urban Vadodara. Majority of the Higher Middle and Higher Income families enroll their children in English medium schools. Considering the study objective, children from affluent background had to studied for which only English medium schools were shortlisted (n=99).

Based on the inclusion criteria (mentioned below), 26 schools were shortlisted. The investigator conducted personal meetings with the school authorities in order to discuss the study protocol. Based on the consent, the investigator purposively enrolled 10 schools for study duration of 2 years. The study commenced after submitting the protocol and a time line to the administrative head followed by seeking a written permission (Annexure 1) from all the selected schools.

Inclusion criteria:

1. English medium schools
2. Schools should cater to students of middle and higher income families
3. Schools should have coeducation structure

SUBJECT SELECTION

All students from 4^{th} – 9^{th} were purposively selected from the 10 schools enrolled under MARG study, based on the inclusion criteria. Considering the variation of the population in each school, the total number of students in 4^{th} – 9^{th} standard in these schools was 6472. The study initiated only after getting an informed consent (Annexure 2) from both students and their parents. The absentee's record was maintained separately, though there were no dropouts.

Situational analysis

Information regarding the student's background, parental history of NCD, dietary behaivour, PAP and nutritional status was collected (Image 3.1 to 3.6). Details on each parameter and its methodological details are given below. The tools and techniques have been summarized in table 3.5.

a. BACKGROUND INFORMATION: Basic information on age, gender and type of school was elicited using a pre-tested and structured questionnaire (Annexure 3).

Modus Operandi: A timetable was formulated for all the classes of students enrolled in the study. Thorough coordination was maintained by the investigator to avoid an overlap of timings in the schedules of all the selected schools. According to the timetable, the schools allotted specific timings such as General Activity periods, Assisted Activity periods or Extra Learning periods as per their schedules during the school hours. This predetermined schedule was strictly adhered during data collection by the researcher for each school in order to avoid cancellation of the activity.

Procedure: Students were called class wise in their allocated time in the common room or assembly area of the school. They were oriented and provided with the pre-tested, structured questionnaire. The students filled up these questionnaires on their own in presence of the investigator so that any doubts or queries can be tackled immediately. All the questionnaires were checked for completeness, accuracy and authenticity of the information.

b. PARENTAL HISTORY OF NCD*:* Parental history of degenerative diseases is a non-modifiable risk factor (Bhuiyan et al., 2013) among the young children. Early lifestyle interventions can help to prevent or delay the onset NCD's among children.

Procedure: After distributing the questionnaire, children were explained about each enlisted disease along with their signs and symptoms. Following the same procedure as mentioned above, parental history of obesity, hypertension, diabetes, cardiovascular diseases and stroke was elicited using a pre-tested, structured questionnaire (Annexure 3). History of enlisted degenerative diseases was gathered separately for father, mother and both the parents, using specific codes.

c. DIETARY BEHAVIOUR: As reported by (Datar and Nicosia, 2009; Iyer and Gandhi, 2004), school children have an inclination towards high calorie, processed food attributed to its heavy marketing, tingling taste sensations and accessibility within and around school premises. Dietary habits established at young age, persist in adulthood and are an important contributing factor of degenerative diseases.

Principle: Based on the review (Popkin, 2001; Wardle et al., 2001), a "Dietary Risk Score Card" was developed and pre-tested. Foods were divided in healthy and unhealthy categories (Table 3.1). Within unhealthy, there were five components (mentioned below) and specific foods were enlisted under each component. Frequency of consumption of each enlisted foods was recorded.

Based on the "Healthy Eating Index: 1999 – 2000" developed by USDA (2013); each of the frequency was coded. The minimum and maximum score for each component was "0" and "10" respectively. Scores given to each frequency is given below (Table 3.2).

Procedure: The "Dietary Risk Score Card" was assessed as a part of situational analysis (Annexure 3). After distributing the questionnaire; the method of answering the "Dietary Risk Score Card" was explained to the students. Scores for all enlisted food were summed up and an average score for each component was derived for further assessment.

To assess the dietary behavior, habit of eating out of homes was included as an important parameter. Further different foods were enlisted to compute their frequency of consumption. Six food based components were made; of which former five components included unhealthy food and the sixth component included healthy and protective food group. Component 1 included food items which were prepared with a combination of refined wheat flour and deep frying. Foods made out of refined wheat flour alone and those involving just deep frying were categorized under component 2 and 3 respectively. Foods containing high sugar content and aerated drinks were grouped as component 4 and 5 respectively. The sixth component enlisted fruits and vegetables.

d. PHYSICAL ACTIVITY PATTERN (PAP): Increasing academic pressure, mechanized lifestyle and screen time entertainment have become an integral part of current lifestyle. The overall physical activity levels among children have reduced, thus sedentary lifestyle has increased the risk of developing non-communicable diseases among young children (Iyer et al., 2011)

Principle: With reference to Kowalski et al., 2004, a Physical Activity Pattern Score (PAPS) was developed under which healthy and unhealthy activity pattern was categorized. Under both the categories, three components were listed.

The maximum score for each component was "10" An average value was calculated in both healthy and unhealthy categories by summing up the

scores gained by the components. The intensity of physical activity was calculated as per the CDC's guidelines, 1993 (Table 3.3 and 3.4).

Procedure: The "Physical Activity Pattern Score (PAPS)" was assessed as a part of situational analysis (Annexure 3). After distributing the questionnaire (same procedure), students were given instructions to answer the PAPS correctly. Efforts were made to ensure that the answers are not influenced by their classmates.

Table 3.1: Foods categorized in different components

Component No.	Food category
1	Foods Based on Refined Wheat Floor and Fried Food
2	Foods Based on Refined Wheat Floor
3	Fried Foods
4	Foods with High Sugar
5	Aerated Drinks

Table 3.2: The score table used to rank the dietary components

Sr. No.	Frequency	Score
1.	Daily	10
2.	2 – 6 Times a week	8
3.	Once a week	6
4.	Once in 15 days	4
5.	Occasionally	2
6.	Never	0

Table 3.3: Categorization of physical activity

Component No.	Food category
1	Type of Physical Activity
2	Time spent in Physical Activity
3	Intensity of Physical Activity (Given below)
4	Type of Sedentary Activity
5	Time spent in Sedentary Activity
6	Choice of activity

Table 3.4 Classification of activities based on the intensity as given by CDC

Moderate Intensity Activity (3.5 - 7 Kcal/min)		**Vigorous Intensity Activity (> 7 Kcal/min)**	
Yoga	Brisk walking	Aerobic walking	Karate/Judo
Gymnastics	Badminton	Aerobic dancing	Basketball
Volleyball	Swimming	Jogging	Football
Cricket	Folk dance	Running	Skipping

Table 3.5: Tools used for situational analysis of selected parameters

Parameters assessed under situational analysis	**Tool used**	**Reference**
Background information Parental history of NCD	Self administered, Pre-tested structured questionnaire	CCT New Delhi, 2010 (Annexure 3)
Dietary behavior	Dietary Risk Score Card	USDA (www.cnpp.usda.gov)
Physical activity pattern (PAP)	Physical Activity Pattern Score (PAPS)	Kowalski et al., 2004 Centre for Disease Control (CDC)

ANTHROPOMETRIC MEASUREMENTS

For collecting anthropometric measurements, the study was cleared by the medical ethics committee of the Department of Foods and Nutrition, The M S University of Baroda no. FCSc./FND/ME/49.

a. HEIGHT: Height was measured using a portable, non-flexible fiber glass tape.

Procedure: A plain and clear wall perpendicular to an even horizontal floor was selected. Measurements up to 170 cm were marked on this wall. Students were asked to remove their footwear and stand in the required position for taking the measurements. For recording the measurement, the fiber glass tape was held straight before eye level with sufficient pressure to press hair. Measurement nearest to 0.1 cm was recorded.

Defined body position: The students were asked not to bend their knees and stand with arms at sides, shoulders relaxed, feet flat on the floor, mid-auxiliary line parallel to wall and Frankfort plane parallel to feet.

b. WEIGHT: Weight was measured using a well calibrated bathroom scale, placed on a horizontal flat surface.

Procedure: The balance was standardized on 10 students before taking the measurement and readings were taken in triplicates to an accuracy of 0.1 kg. Each time before the measurement, the balance was set at zero. Students were asked to remove shoes, socks, and other heavy outer clothing (if any) and step on the center of the platform; with weight placed equally on both the sides.

Defined body position: Students were asked to stand straight, without movement, with hands on side, head straight and eyesight in front.

c. WAIST CIRCUMFERENCE AND HIP CIRCUMFERENCE: Waist circumference have proved to be sensitively associated with BMI and can effectively associate with the risk of cardiovascular morbidities (Misra et al., 2006). Both waist and hip circumference were measured using a non stretchable tape.

Procedure: Waist circumference was measured mid ways between the lower rib margin and iliac crest; by making a mark on the skin after palpating it. The tape was passed horizontally at the mark on the skin without twisting it and measurement nearest to 0.1 cm was recorded.

Procedure: Hip circumference was measured by passing the tape horizontally around the most protruding part of the hip. Measurement nearest to 0.1cm was recorded (Table 3.6).

Defined body position: Students were asked to stand evenly on both the feet about 25-30 cm apart and breath normally and gently to avoid muscle contraction.

d. BODY MASS INDEX FOR AGE (BAZ): It is a screening tool and allows for early detection of malnutrition among school going children (Ramchandran, 2011). BAZ is age and gender specific anthropometric index of weight and height used for school going children. It is defined as weight in kilograms divided by height in meters square. The BAZ were calculated using WHO's Anthroplus software (Table 3.7).

e. WAIST: HIP RATIO (WHR): It is a strong indicator of overweight and obesity and has shown association with cardio vascular health risks (Mushtaq et al., 2011). WHR was calculated using waist and hip circumference applying the formula waist circumference (cms)/hip circumference (cms).

f. WAIST: HEIGHT RATIO (WHTR): It measures the body fat distribution and is correlated with abdominal obesity (Lee et al., 2008). WHtR was calculated was waist circumference (cms) / height (cms). Image 3.7 to 3.11 is few examples of anthropometric data collection in various schools (Table 3.8).

Table 3.6: Tools and techniques used to measure WC and HC

Nutritional Status Assessment	Tool used	Cut - off	Reference
Waist and hip circumference (cm)	Non stretchable measuring tape	***Boys:***	Kurian et al., 2011
		59.4 – 68.2 - Normal	
		≤ 59.3 – Under weight	
		≥ 68.3 – Over weight	
		Girls	
		60.2 – 69.1 – Normal	
		≤ 60.1 – Under weight	
		≥ 69.2 – Over weight	

Table 3.7: Tools and techniques used to measure BAZ

Nutritional Status Assessment	Tool used	Cut - off	Reference
BMI for Age (BAZ)	Calculated using WHO's Anthroplus Software	< -3 –Severely under wt.	WHO, 2010
		≥ -3 to < -2 – Mod un wt.	
		≥ -2 to ≤ 2 – Normal	
		≥ 2 to ≤ 3 – Mod ov wt.	
		≥ 3 – Severely ov wt.	

Table 3.8: Tools and techniques used to measure WHR and WHtR

Nutritional Status Assessment	Tool used	Cut - off	Reference
Waist Hip Ratio (WHR)	Calculating in Microsoft excel based on the standard formula	***Boys:*** 0.85 - <0.95 – Normal	WHO, 2009
		≥ 0.95 – At risk	
		Girls 0.80 - <1.18 Normal	
		≥ 1.81 – At risk	
Waist Height Ratio (WHtR)		***Boys:*** 0.41 – 0.44 – Normal	Kurian et al., 2011
		≤ 0.40 – Under weight	
		≥ 0.45 – Over weight	
		Girls 0.42 – 0.45 – Normal	
		≤ 0.41 – Under weight	
		≥ 0.46 – Over weight	

DATA MANAGEMENT

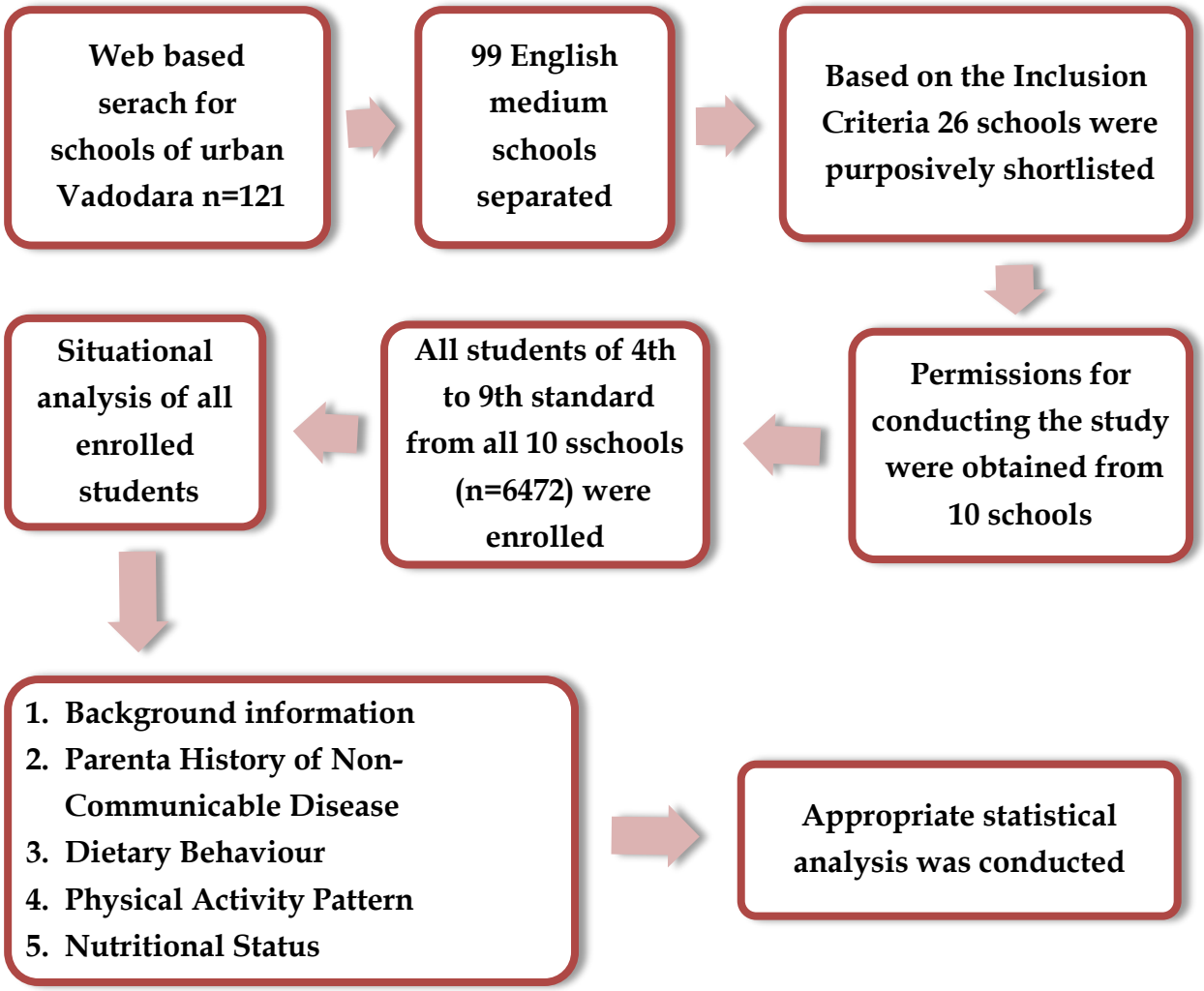
The questionnaires were checked and the responses were coded. The data was entered in Microsoft excel sheet after cross checking.

DATA ANALYSIS

BAZ was computed using WHO Anthroplus software, version 1.0.3, WHR and WHtR was calculated using Microsoft Excel, 2007 and IBM SPSS Statistics 20. Ink. Appropriate statistical tests such as frequency calculation, chi-square, ANOVA, and Independent T-test were applied for data analysis.

EXPERIMENTAL DESIGN

Figure 3.1: Experimental design for Phase 1a



RESULTS AND DISCUSSIONS

Various national studies are discussing on the upcoming trend of twin malnutrition in India and its mega cities (Doak et al., 2005). Early identification of the modifiable factors helps in designing preventable strategies from a public health perspective.

Vadodara, a small city in one of the most developed state of India, Gujarat has persistently visualized social, cultural and lifestyle changes along with increasing purchasing power of its people Kanani and Saxena, (2008). It could be thus perceived that Vadodara would soon face epidemic of new generation "The Dual Burden of Malnutrition" Iyer and Gandhi (2004).

The results of phase 1a, discuss the situational analysis of school children and are presented under following sections:

- Background information of the selected schools and enrolled subjects
- Situational analysis of the enrolled subjects
- Anthropometric measurements
- Nutritional status and affecting factors

BACKGROUND INFORMATION OF THE SELECTED SCHOOLS AND ENROLLED SUBJECTS

a. SCHOOL PROFILE: Of the ten schools selected, five of them were public schools (The Mother's School, Delhi Public School, Shree Shreyas Vidyalay, Bhartiya Vidya Bhavans and Kendriya Vidyalay) while the remaining five (two branches of Bright Day School, Mira School, Navrachna School and Navrachna Vidyani Vidyalay) were run by the private trust of Vadodara city.

Five schools (Bright Day School, Navrachna School, Delhi Public School, Bhartiya Vidya Bhavans and Kendriya Vidyalay) followed the Central Board of Secondary Education (CBSE) while the remaining five (The Mother's School, Shree Shreyas Vidyalay, Bright Day School, Mira School and Navrachna Vidyani Vidyalay) followed the syllabus of Gujarat Secondary Education Board (GSEB).

All schools had preprimary to higher secondary section with co-educational structure. Based on the fee structure, it was interpreted that the schools catered to middle, higher middle and higher socio-economic families.

The average strength of students in each class was 40 (Table 3.9). Based on the student's strength, classes were divided into divisions or sections. Delhi Public School with a total strength of 3240 had five sections. Mira School and The Mother's School had minimum strength of 1009 and 1200 respectively; therefore the classes were not divided into any sections.

b. STUDENT PROFILE: The total strength of selected schools was 16,495. For the present study, 39% of the total strength (n=6472) was enrolled. This included all students of 4^{th} to 9^{th} standard from the 10 schools. Of these 58% were boys and 42% were girls. Of the total number 49% were from public schools and 51% students belonged to the private schools (Table 3.10). The distribution of selected students as per the age and class is shown in Figure 3.2.

Table 3.9: Details of the selected schools and the number of children enrolled

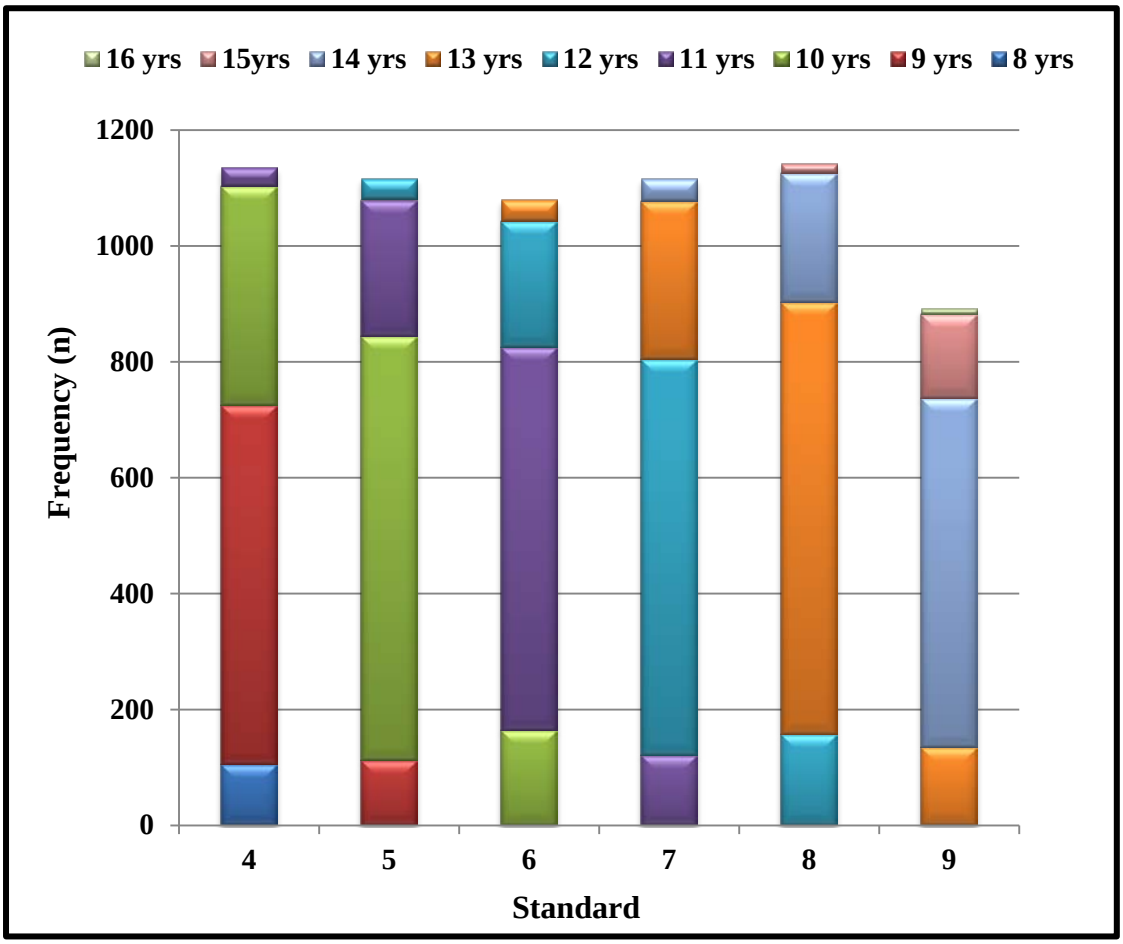
Code	Name	Type	Education Board	SES of Students	Total Strength	Students enrolled	Boys	Girls
I	The Mother's School	Public	GSEB	MIG	1200	240	135	105
II	Bright Day School	Private	GSEB	MIG + MHIG	1540	560	306	254
III	Bright Day School	Private	CBSE	MHIG + HIG	1736	679	412	267
IV	MIRA School	Private	GSEB	MIG + MHIG	1009	294	177	117
V	Delhi Public School	Public	CBSE	MHIG + HIG	3240	1210	681	529
VI	Shree Shreyas Vidyalay	Public	GSEB	MIG	1342	455	297	158
VII	Bhartiya Vidya Bhavans	Public	CBSE	MHIG + HIG	1658	643	421	222
VIII	Navrachna School	Private	CBSE	HIG	1360	714	408	306
IX	Navrachna Vidyani Vidyalay	Private	GSEB	MIG + MHIG	1674	781	428	353
X	Kendriya Vidyalay	Public	CBSE	MIG	1736	896	493	403
Total Strength					**16,495**	**6472 (39)**	**3758 (58)**	**2714 (42)**

**Values in parenthesis are the percentages*

Table 3.10: Distribution of students based on gender, age and type of school (n=6472)

Distribution of variables		Frequency (n)	Percent (%)
Gender	Boys	3758	58
	Girls	2714	42
Age (years)	8 – 11 years	3183	49
	12 – 16 years	3289	51
School type	Public	3203	49
	Private	3269	51

Figure 3.2: Age-wise distribution of students in 4th to 9th standard



SITUATIONAL ANALYSIS OF THE ENROLLED SUBJECTS

Parental history, dietary habits and physical activity pattern are major lifestyle parameters affecting a child's habits, health and nutritional status. These modifiable and non-modifiable parameters were analyzed individually to understand the current trend and compare their significant difference in selected groups.

a. PARENTAL HISTORY OF NCD: Parental history of morbidities such as obesity, diabetes, hypertension, heart disease and stroke was assessed among the parents of selected students. History of obesity (25.4%) was maximum followed by diabetes (11.3%), heart disease (9%) and hypertension (10%) (Figure 3.3); while history of stroke (1.5%) was minimum among the parents. Nearly 57.5% prevalence of parental history of morbidities was observed; of which highest was among mothers (30%), followed by fathers (19.5%) and about 8% prevalence was found among both the parents. Among all the NCD's prevalent in mother's. 11% was obesity, 8% was diabetes and 5% was heart disease or hypertension.

As shown in table 3.11, parental history of obesity showed highest significant difference between age groups $X^2 = 74$, $p<0.001$ followed by school types $X^2 = 7.7$, $p<0.01$ and least among the gender $X^2 = 6.6$, $p<0.05$. Similar trend was observed for parental history of heart disease and hypertension.

Maternal obesity (12%), diabetes (8.1%) and heart disease (5%) were more among girls while paternal history of morbidities was similar among boys and girls (Figure 3.4). Age based comparison showed 14% and 11% parental history of obesity among 8-11 year children and rest morbidities were higher among 12-16 year children (Figure 3.5). Parental history of obesity (10-12%) and hypertension (4-6%) was more in public school;

while diabetes (2.3-7.4%) and heart disease (2-3%) was found in private schools.

Non-communicable morbidities among mothers have shown greater sensitivity when compared across gender and age group. Mothers of 8-11 year old female children had highest prevalence of obesity (11.4%) followed by diabetes (7.8%), hypertension and heart disease (5%). Unlike the previous belief, NCD's showed nearly equal distribution among the different socio-economic groups.

Figure 3.3: Prevalence of different non-communicable diseases among parents of selected children

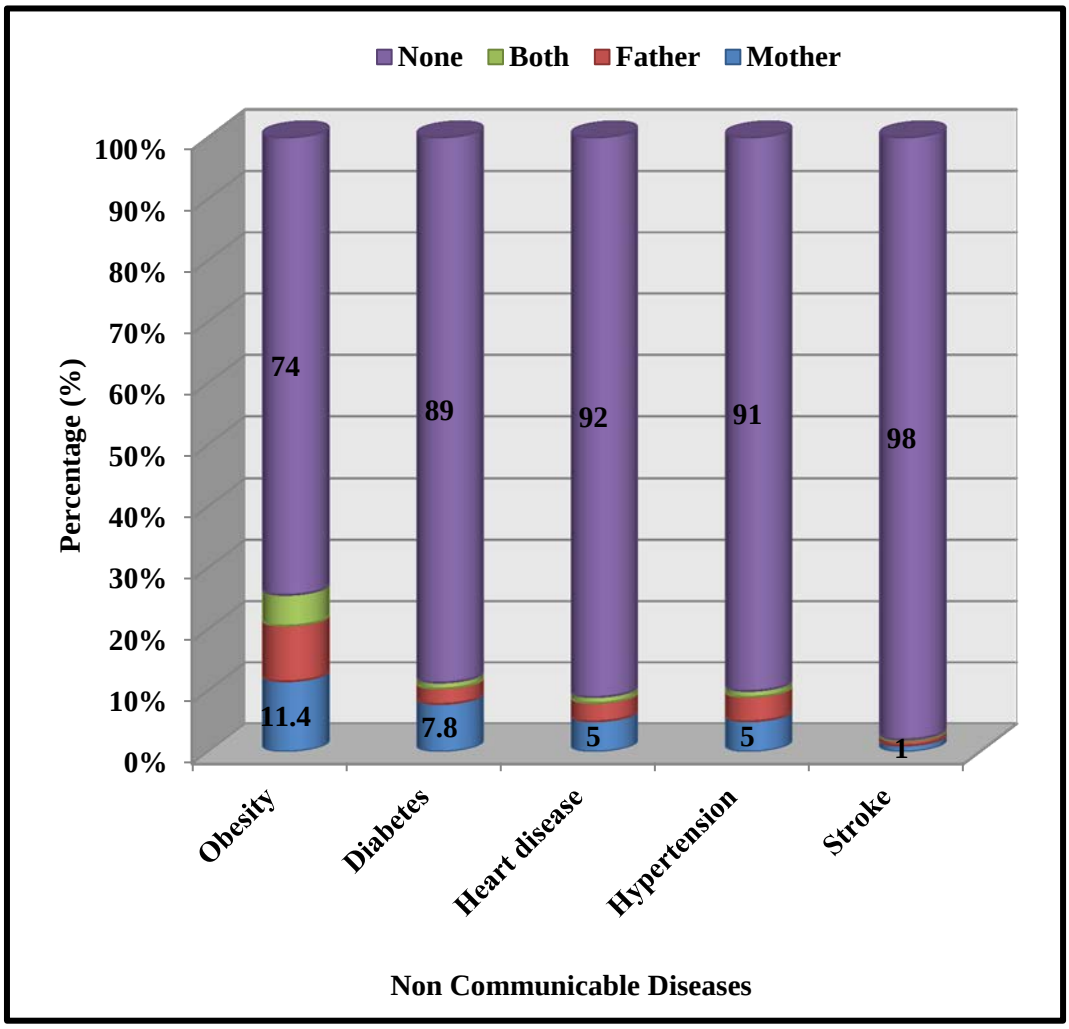


Table 3.11: Baseline information on parental history of NCD's among the enrolled students (n=6472)

Variables		Parental History of NCDs				
		Obesity	Diabetes	Heart disease	Hypertension	Stroke
Gender	Boys (n=3758)	937 (25)	412 (11)	367 (10)	310 (8)	74 (2)
	Girls (n=2714)	743 (27)	312 (11)	245 (9)	240 (8)	46 (1)
X^2-Value		6.6*	0.9 NS	3.9 NS	0.7 NS	6 NS
Age group (years)	8 – 11 (n=3183)	972 (31)	328 (10)	266 (8)	198 (6)	57 (2)
	12 – 16 (n=3289)	708 (21)	396 (12)	346 (11)	352 (11)	63 (2)
X^2-Value		74***	6.1 NS	10**	42***	0.4 NS
Type of school	Public school (n=3208)	876 (27)	335 (10)	355 (11)	191 (6)	50 (2)
	Private school (n=3261)	804 (25)	389 (12)	257 (8)	359 (11)	70 (2)
X^2-Value		7.7**	3.6 NS	20***	53***	6.1 NS
Total		1680 (26)	724 (11)	612 (9)	550 (8)	120 (2)

The total value in all three variables is the same; therefore it is represented just once. Values in parenthesis are the percentages. The significance is established at 95% CI, p < 0.05*, 0.01** and 0.001*

Figure 3.4: Percent prevalence of specific morbidities among individual parents compared between boys and girls

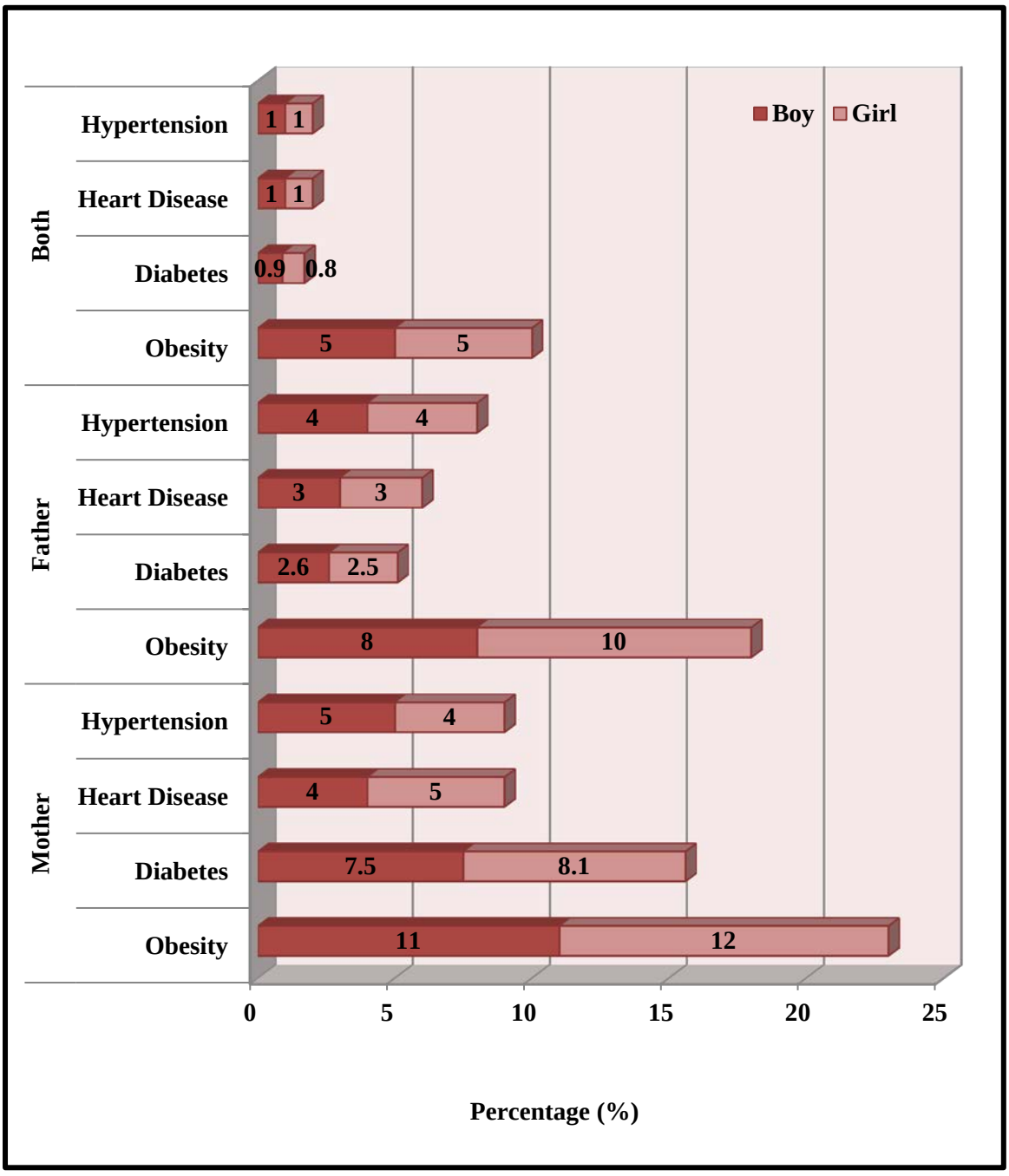


Figure 3.5: Percent prevalence of specific morbidities among individual parents compared between the two age groups

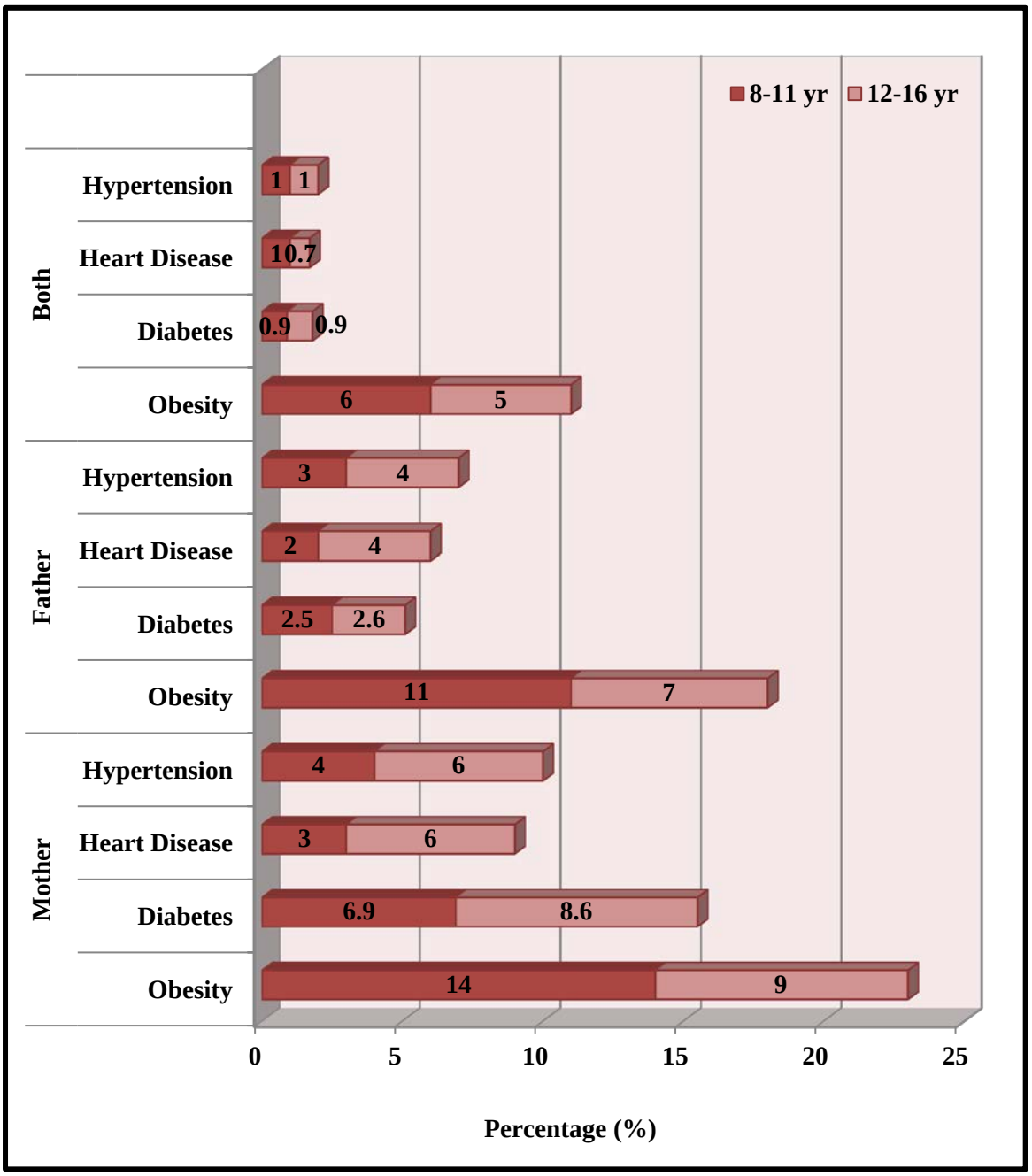
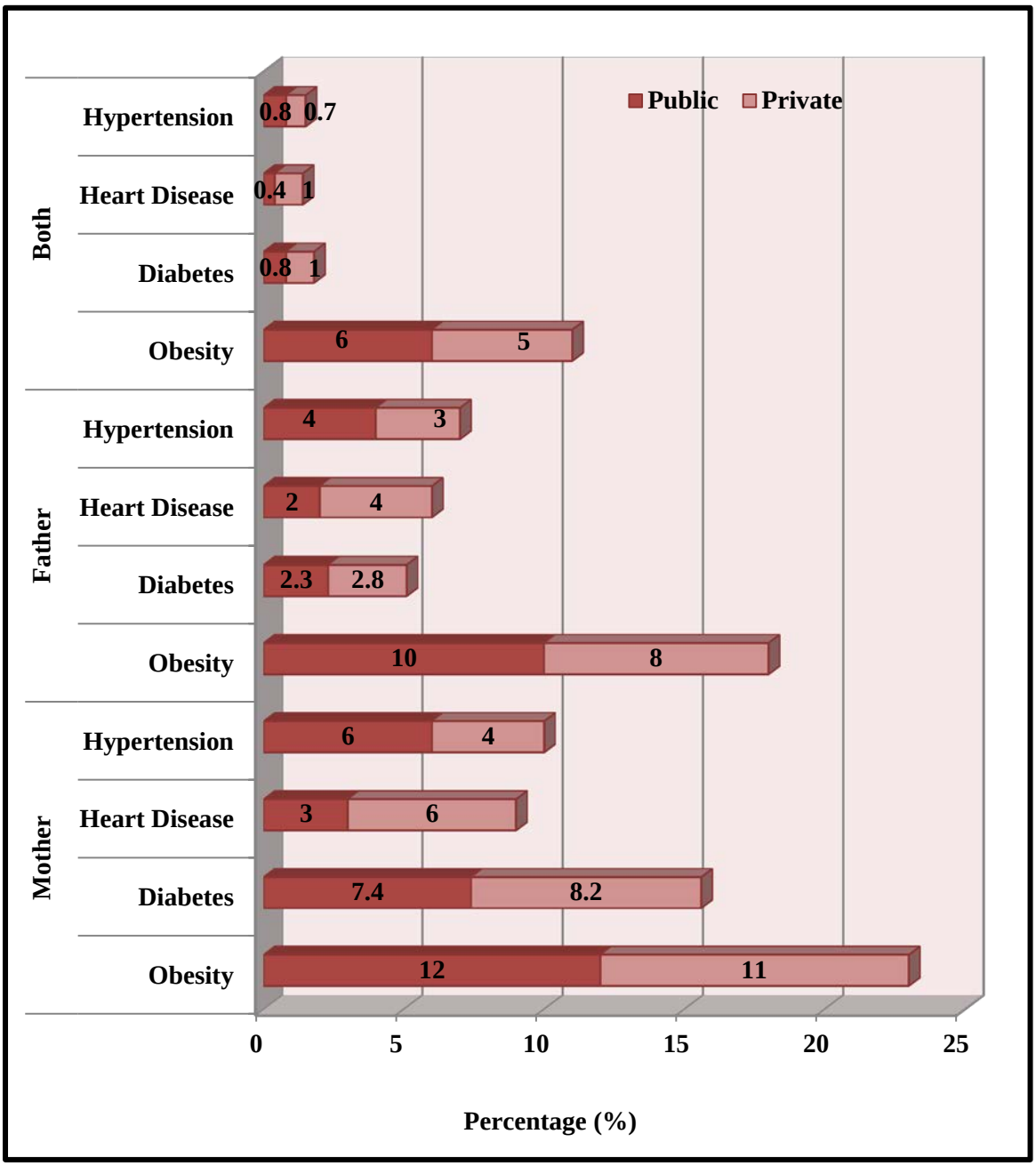


Figure 3.6: Percent prevalence of specific morbidities among individual parents compared between the two types of schools



b. DIETARY BEHAVIOR: Of all the students interviewed, 7% reported to eat out daily and 36% ate out of home at least once in 15 days. Frequency of foods enlisted in all unhealthy components revealed that 26% - 35% students ate either of the unhealthy combinations at least once in 15 days. Nearly 10% - 17% consumed unhealthy food on a weekly basis and 2% - 9% students daily consumed some or the other unhealthy recipe. Whole fruits and juices under the healthy component were consumed daily by 24% students, weekly by 41% students and occasionally by 33% students (Table 3.12 to 3.18). Thus the ratio of unhealthy and healthy food choice is extremely poor with higher inclination towards unhealthy dietary habits.

As shown in figure 3.7, 10% - 22% students ate unhealthy food 2-6 times a week; 12% to 16% students consumed it once a week; while 21% - 35% students ate unhealthy food once in 15 days. On a whole, 22% - 38% students were in habits of consuming unhealthy food on a weekly basis. Foods rich in sugar were preferred the most (38%); followed by fried foods (32%), aerated drinks and a combination of refined wheat flour and fried food. To sum up, the ratio of healthy and unhealthy food was 13:14% weekly and 21:29% once in 15 days.

Thus there is only 1% difference between weekly intake of healthy : unhealthy food and large difference of 8% within a fortnight. If the current trend of dietary habits among school going children continues there is a possibility of increased frequency of consuming the unhealthy food by school children in near future.

Table 3.12: Frequency of eating out and the assigned score (n=6472)

Parameter	Frequency	Percentage	Score
Daily	428	7	10
2 – 6 days per week	619	10	8
Once a week	1037	16	6
Once in 15 days	2354	36	4
Occasionally	177	27	2
Never	263	4	0

Table 3.13: Consumption frequency of foods made of refined wheat flour and deep fried (component 1) (n=6472)

Food	Frequency					
	Daily	2 – 6 days /week	1 / week	1 / 15 days	Occasionally	Never
Samosa	152 (2)	776 (12)	915 (14)	2293 (35)	1638 (25)	698 (11)
Bhatura	121 (1)	639 (10)	652 (10)	1829 (28)	1881 (29)	1350 (21)
Kachori	134 (2)	547 (8)	716 (11)	2607 (40)	1763 (27)	705 (11)
Average	***136 (2)***	***654 (10)***	***761 (12)***	***2243 (35)***	***1761 (27)***	***918 (14)***

**Values in parenthesis are the percentages*

Table 3.14: Consumption frequency of foods made of refined wheat flour (component 2) (n=6472)

Food	Frequency					
	Daily	2 – 6 days /week	1 / week	1 / 15 days	Occasionally	Never
Burger	40 (1)	373 (6)	915 (14)	2097 (32)	1970 (30)	1369 (22)
Pizza	47 (1)	401 (6)	652 (10)	2423 (37)	2100 (32)	960 (15)
Noodles	251 (4)	1373 (21)	716 (11)	2251 (35)	689 (11)	322 (5)
Average	***113 (2)***	***716 (11)***	***761 (12)***	***2257 (35)***	***1586 (24)***	***884 (14)***

**Values in parenthesis are the percentages*

Table 3.15: Consumption frequency of deep fried food (component 3) (n=6472)

Food	Frequency					
	Daily	2 – 6 days /week	1 / week	1 / 15 days	Occasionally	Never
French fries	115 (2)	570 (9)	685 (11)	1880 (29)	1732 (27)	1490 (23)
Chips	285 (4)	1167 (18)	1286 (20)	1991 (31)	1300 (20)	443 (7)
Puri	1047 (16)	1512 (23)	1041 (16)	1581 (24)	823 (13)	468 (7)
Average	***482 (7)***	***1083 (17)***	***1004 (15)***	***1817 (28)***	***1285 (20)***	***800 (12)***

**Values in parenthesis are the percentages*

Table 3.16: Consumption frequency of food high in sugars (component 4) (n=6472)

Food	Frequency					
	Daily	2 – 6 days /week	1 / week	1 / 15 days	Occasionally	Never
Ice-cream	322 (5)	1315 (20)	1195 (18)	2151 (33)	1153 (18)	336 (5)
Sweets and chocolates	857 (13)	1863 (29)	1074 (17)	1415 (22)	863 (13)	401 (6)
Sweets during or after meal	513 (8)	1071 (16)	900 (14)	1514 (23)	1410 (22)	1064 (16)
Average	***564 (9)***	***1416 (22)***	***1047 (16)***	***1693 (26)***	***1142 (18)***	***600 (9)***

**Values in parenthesis are the percentages*

Table 3.17: Consumption frequency of aerated drinks (component 5) (n=6472)

Food	Frequency					
	Daily	2 – 6 days /week	1 / week	1 / 15 days	Occasionally	Never
Cola	176 (3)	727 (11)	700 (11)	1596 (25)	1757 (27)	1516 (23)
Soda	212 (3)	874 (13)	944 (14)	1413 (22)	1680 (26)	1349 (21)
Average	***194 (3)***	***800 (12)***	***822 (13)***	***1504 (23)***	***1715 (26)***	***1432 (22)***

**Values in parenthesis are the percentages*

Table 3.18: Consumption frequency of healthy food (component 6) (n=6472)

Food	Frequency					
	Daily	2 – 6 days /week	1 / week	1 / 15 days	Occasionally	Never
Fruit juice	648 (10)	1155 (18)	924 (14)	1583 (25)	1181 (18)	981 (15)
Whole fruits	2446 (38)	1470 (23)	724 (11)	1076 (17)	431 (7)	324 (5)
Average	***1547 (24)***	***1312 (28)***	***824 (13)***	***1329 (21)***	***806 (12)***	***652 (10)***

**Values in parenthesis are the percentages*

Figure 3.7: Average percent consumption of foods enlisted in each component

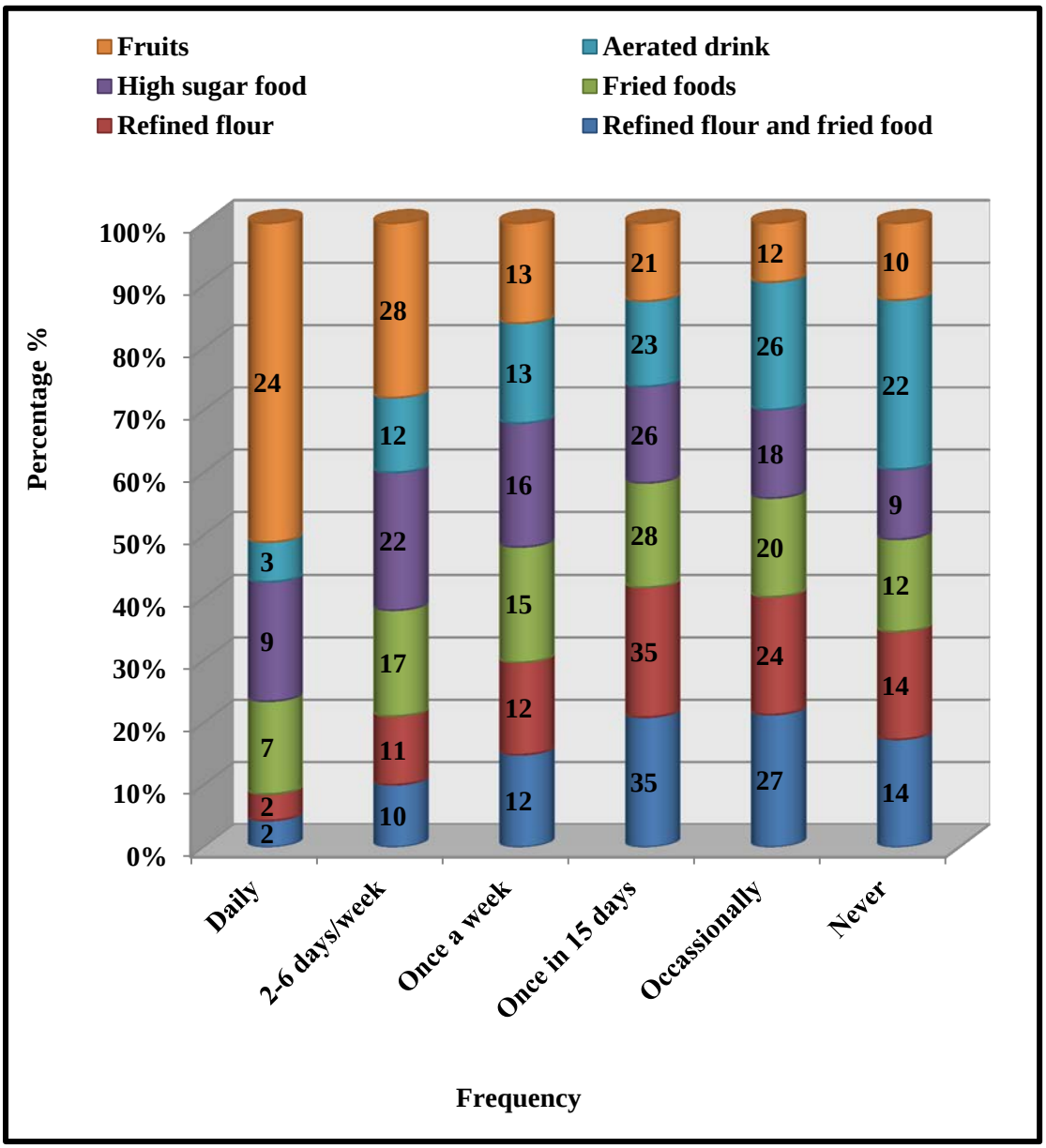


Figure 3.8: Consolidated frequency of consuming foods enlisted in each component

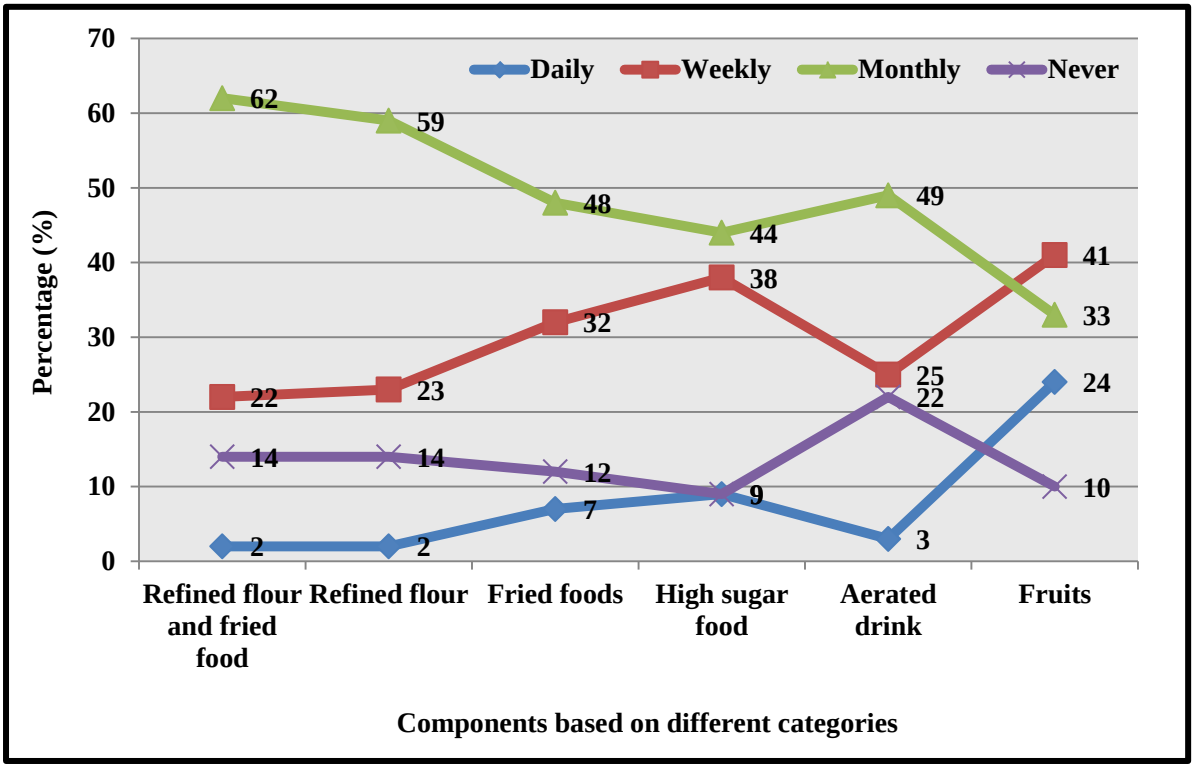
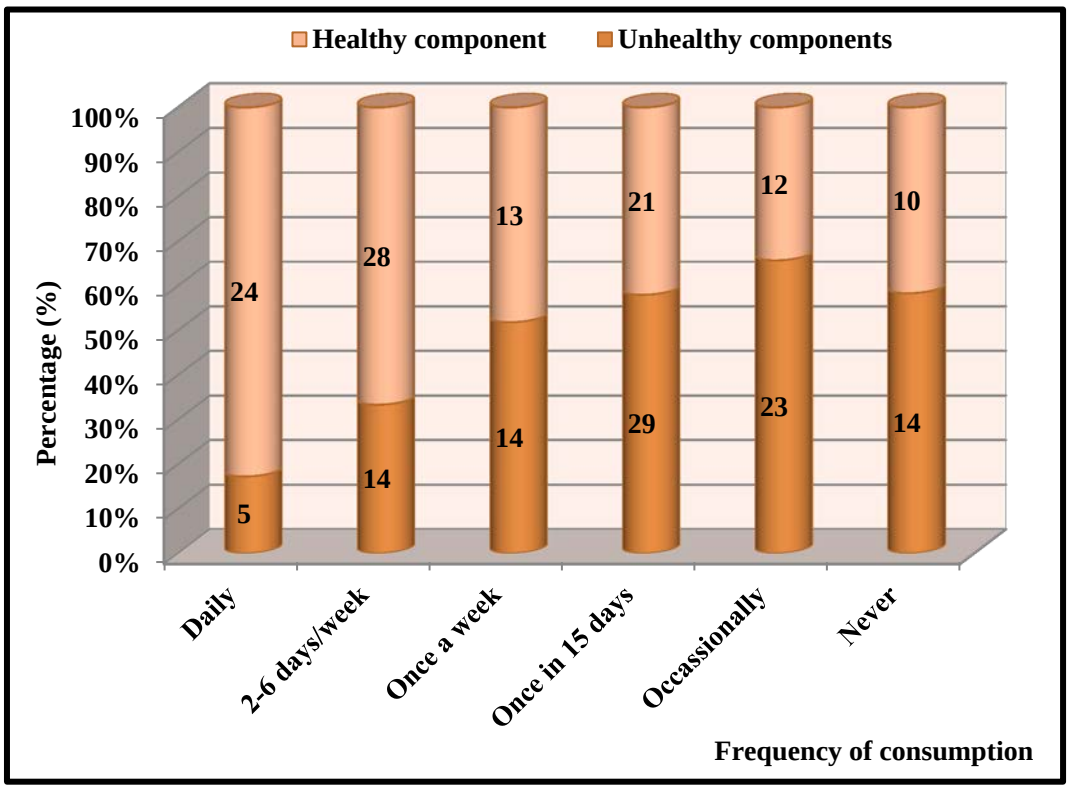


Figure 3.9: Comparing the frequency of consuming healthy and unhealthy food



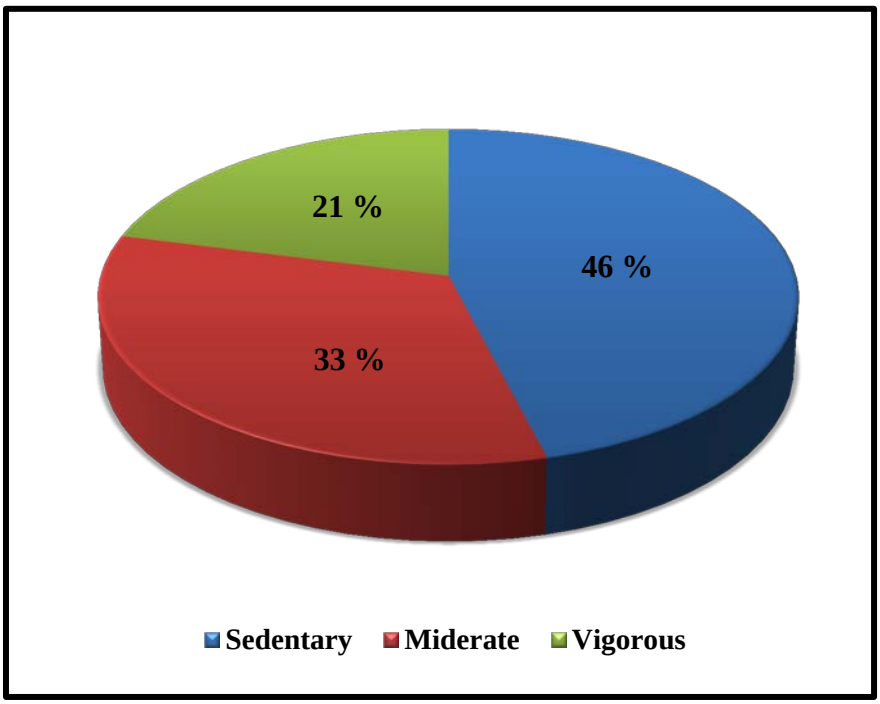
c. PHYSICAL ACTIVITY PATTERN: Information gathered on activity pattern was categorized as outdoor and indoor and further segregated as per the intensity. All enrolled students performed some outdoor activity (Figure 3.10) of varying intensity such as sedentary (46%), moderate (46%) and vigorous (21%). Among the indoor activities, 69% were sedentary and 30% students spent their time in front of the screen (Figure 3.11).

Time spent on physical activity was categorized as adequate (≥ 30 minutes/day) and inadequate (≤ 30 minutes/day) based on CDC' guidelines. More than 80% of boys belonging to the younger age group studying in public schools reported to spent adequate time on different types of physical activity. On the other hand, 21% of girls in the age range of 12 – 16 years studying in private schools spent inadequate time on physical activity (Table 3.19). High level of significant difference was observed in the pattern of physical activity and the time spent, across the three groups.

As shown in figure 3.12 55% boys, 51% children of 8-11 years and 52% students studying in public schools reported moderate intensity of activity performed daily. Intensity of activity ($X^2 = 108$) and screen time ($X^2 = 42$), both were significantly different among boys and girls at $p<0.001$. Though the younger children performed more activity of moderate intensity, yet the difference was not significant, however the screen time was significantly higher (44.7%) among the younger age group at $X^2 = 13.8$, $p<0.001$. Children studying in public schools were more (52%) involved in moderate intensity physical activity as compared to their counterparts from private school at $X^2 = 18.8$, $p<0.001$.

Increasing academic pressure, inadequate facilities, lack of family support, safety issues, non-motivating school environment and physical changes in body due to puberty (especially among girls) were some of the major reasons for reduced participation in physical activity among the students.

Figure 3.10: Intensity of outdoor physical activities categorized based on CDC's guidelines



**Physical activity of moderate intensity burns 3.5 – 7 Kcal/min, while that of vigorous intensity burns > 7 Kcal/min. As stated in the CDC's guideline.*

Figure 3.11: Choice of indoor activity

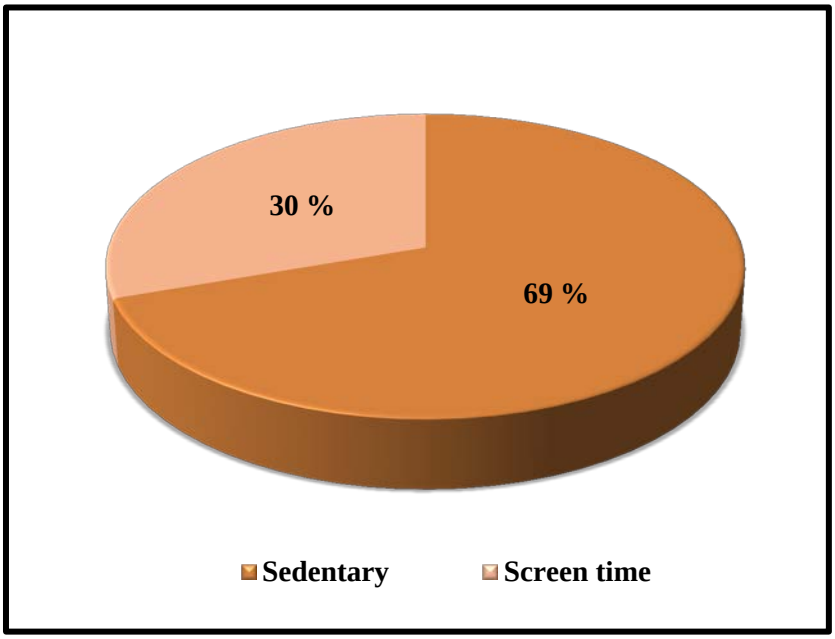
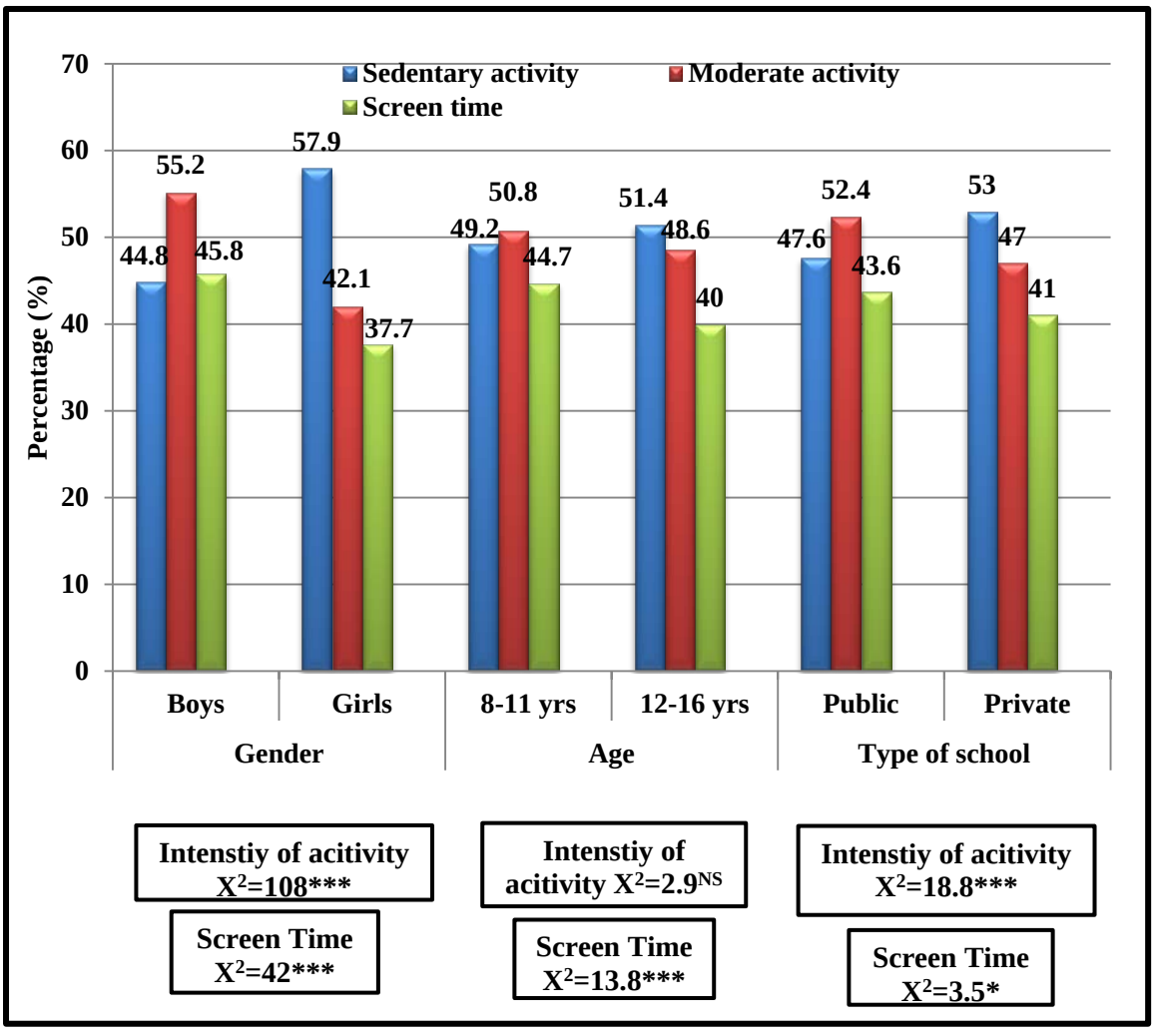


Table 3.19: Comparing the time spent on physical activity between selected variables (n=6472)

Variables	Sub-groups	Adequate time	Inadequate time	Chi-Square (X^2-Value)
Gender	Boys (3758)	641	3117	17***
	Girls (2714)	573	2141	
Age group (yreas)	8 – 11 years (3183)	538	676	14.1***
	12 – 16 years (3289)	2645	2613	
Type of school	Public (3203)	410	2793	147***
	Private (3269)	804	2465	

Values in parenthesis are the percentages. The significance is established at 95% CI, p < 0.05* and 0.001**

Figure 3.12: Comparing the intensity of activities and screen time between selected variables



The significance is established at 95% CI, p < 0.05* and 0.001*, NS=Not Significant*

ANTHROPOMETRIC MEASUREMENTS

All students from the 10 schools were evaluated for their height, weight, waist and hip circumference. Anthropometric indicators such as BMI, BMI for age (BAZ), waist hip ratio (WHR) and waist height ratio (WHtR) were calculated to assess their nutritional status. Rising picture of DBM was seen in all the schools. Prevalence of undernutrition ranged from 0.3% to 1.2%; while prevalence of overnutrition ranged from 0.2% to 2.1% with no specific trend seen as per the type of school (Table 3.20).

As shown in table 3.21, there was a significant difference ($p < 0.001$) in height, waist and hip circumference between boys and girls; whereas all the parameters varied significantly among the two age groups which ascertain the effect of gender difference and growing age respectively on the physical growth and development among children.

The nutritional status was assessed by computing BAZ (BMI for age) and BMI for all the selected children. As per BAZ (WHO, 2010), 81% children had normal nutritional status; while 10% children were undernourished and 9% children were overnourished (Figure 3.13). BMI values were compared against four different standards viz. Khadilkar et al., (2011) WHO, IOTF and NHANES (Figure 3.14).

As per the IOTF standards, 59% prevalence of undernutrition was computed; 30% students had normal nutritional status, 6% were overweight and 5% were obese (4% - grade 1 and 1% - grade 2 obesity). However Khadilkar et al. (2011) showed 13% prevalence of overnutrition. Though BAZ clearly reflects dual burden of malnutrition, yet BMI tends to over predict undernutrition. Moreover cut off ranges given by Khadilkar et al. (2011) seem to be closer and comparable for Indian data and were comparable with WHO and IOTF.

WC, WHR and WHtR were computed to categorize the students "at risk" of developing NCD's. As shown in figure 3.15 WC was compared with Khadilkar et al. (2011) (based on Indian data) and NHANES (based on USA data). There was a significant difference in the prevalence of students at risk as per Khadilkar et al., 2011 (33%) and NHANES (9%). Thus there is a need of national reference standards.

Moreover such a high prevalence of students "at risk" stress the need to initiate and universalize preventive interventions at an early age. Moreover, nutritional status assed using WHR and WHtR also revealed high prevalence of students at risk, 78% and 42% respectively; of which WHR could be computed as more sensitive indicator

Nutritional status was compared between gender, age group and type of school. Significant difference at $p<0.01$ was observed in the nutritional status of boys and girls across the two age groups. Prevalence of overnutrition was more among boys as compared to girls, while children of 8 – 11 years of age had higher prevalence of overnutrition (Table 3.21).

Table 3.20: School wise nutritional status of children as measured by BAZ based on WHO cutoffs (n=6472)

School Code	Nutritional Status (BAZ)		
	Undernourished	Normal	Overnourished
I	39 (0.5)	191 (3)	10 (0.2)
II	69 (1)	557 (9)	53 (0.8)
III	57 (1)	452 (7)	51 (0.8)
IV	18 (0.3)	240 (4)	36 (0.5)
V	98 (1.4)	989 (15)	123 (2.1)
VI	120 (2)	311 (5)	24 (0.3)
VII	30 (0.4)	516 (8)	97 (1.2)
VIII	55 (1)	599 (9)	60 (1.1)
IX	82 (1.2)	634 (10)	65 (0.9)
X	190 (1.2)	757 (12)	49 (0.7)

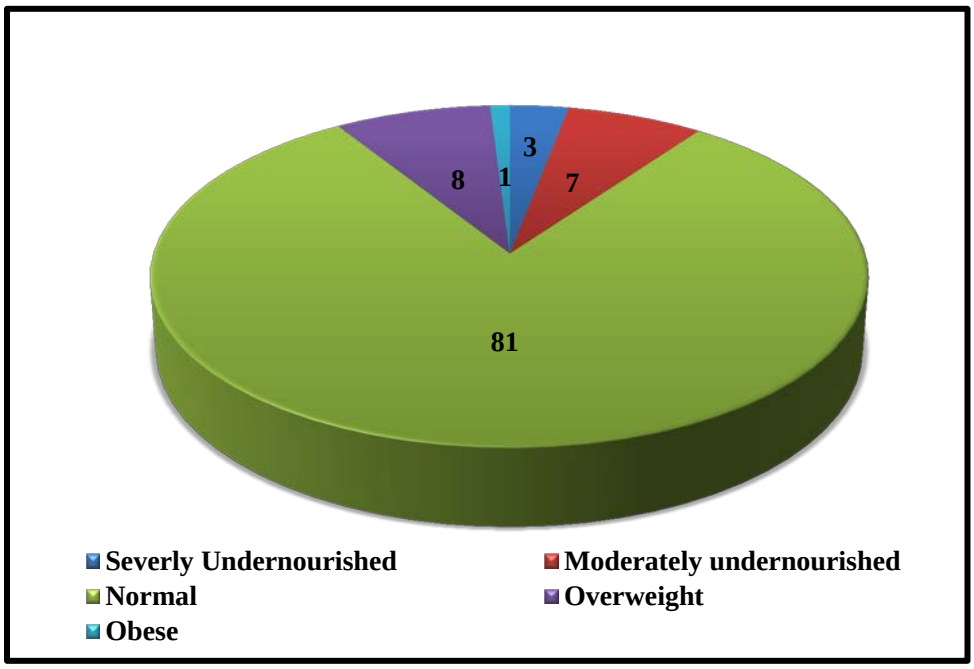
**Values in parenthesis are the percentages*

Table 3.21: Anthropometric measurements compared across gender, age and type of school (n=6472)

Parameters	Sub-groups	Measurements			
		Height (cm)	Weight (kg)	WC (cm)	HC (cm)
Gender	Boys	147.0 ± 13	40.0 ± 12	66 ± 10	78 ± 10
	Girls	146.6 ± 11	39.8 ± 11	65 ± 9	80 ± 10
T-test		2.7***	1.7^{NS}	5***	-7.5***
Age	8-11 yrs	138.9 ± 9	33.6 ± 9	62.7 ± 9	74 ± 8
	12-16 yrs	154.8 ± 10	45.9 ± 11	68.7 ± 10	83.9 ± 9
T-test		-65.7***	-46***	-24.4***	-42.5***
School type	Public	147.5 ± 12	40.0 ± 11	65.7 ± 10	78.8 ± 10
	Private	146.7 ± 12	39.9 ± 11	65.8 ± 10	79.5 ± 10
T-test		2.6**	1.49^{NS}	-0.4^{NS}	-2.6**

** The significance is established at 95% CI, p < 0.05*, 0.01** and 0.001***, NS=Not Significant*

Figure 3.13: Nutritional status of children using BAZ cut off defined by WHO (n=6472)



**As per WHO, 2010 cutoffs*

Figure 3.14: Comparing the nutritional status of calculated using BMI with different standards (n=6472)

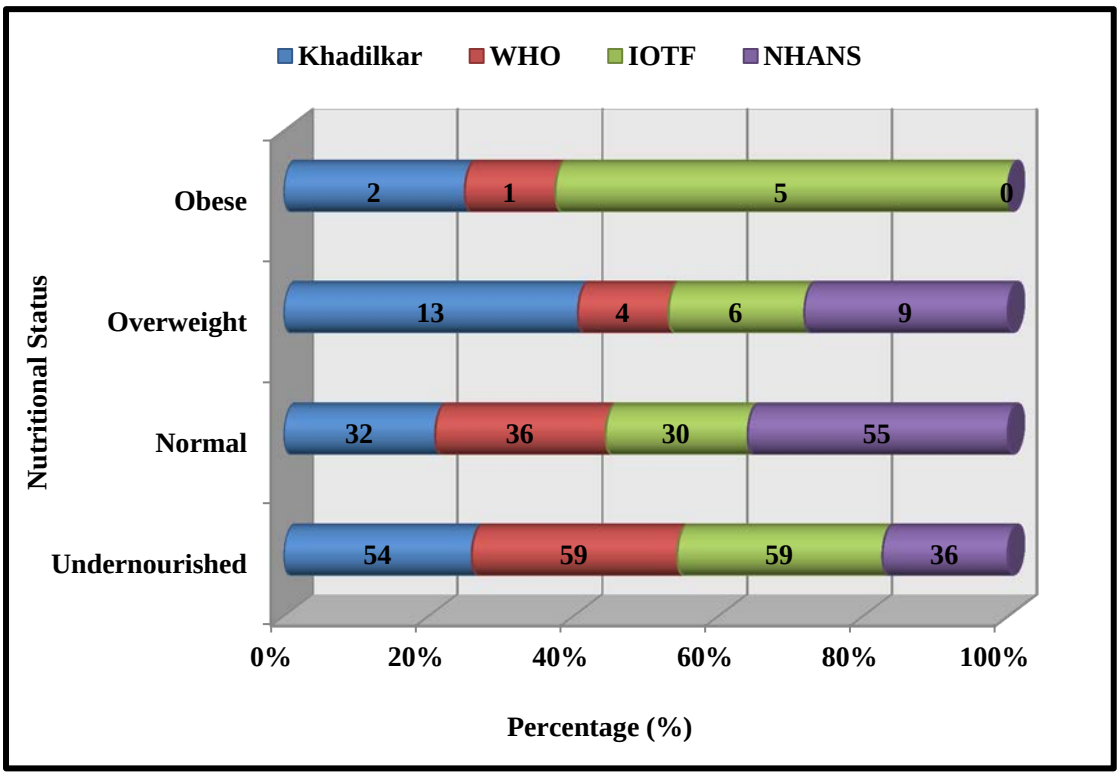


Figure 3.15: Nutritional status defined on basis of WC compared between two standards (n=6472)

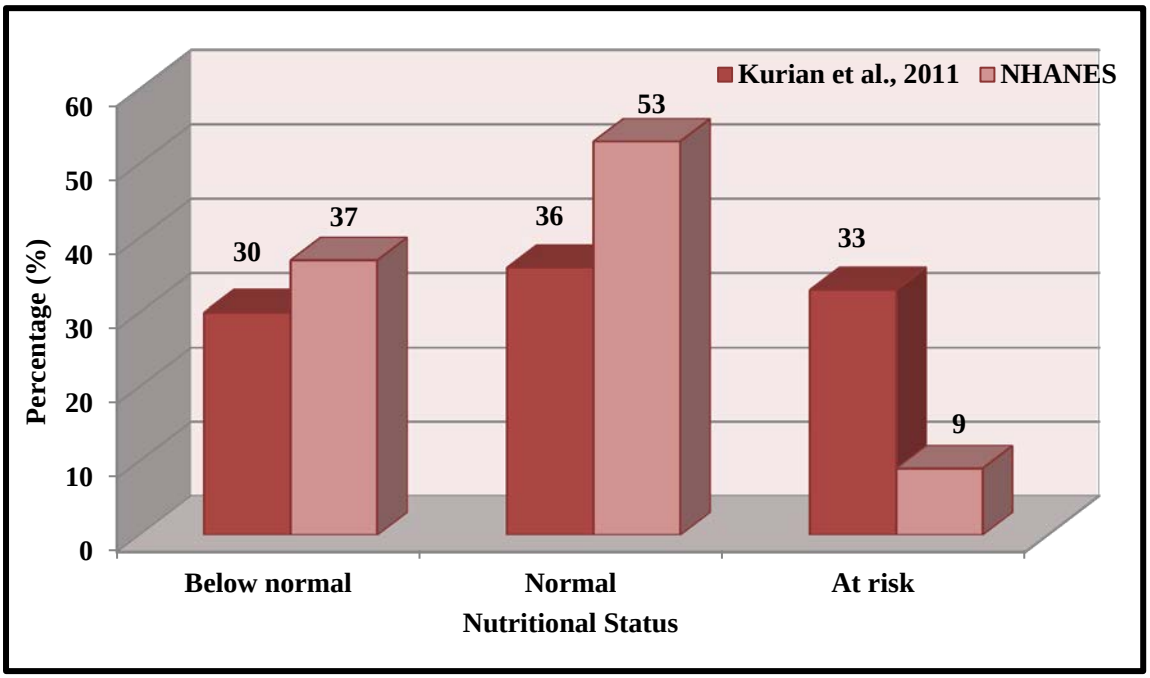
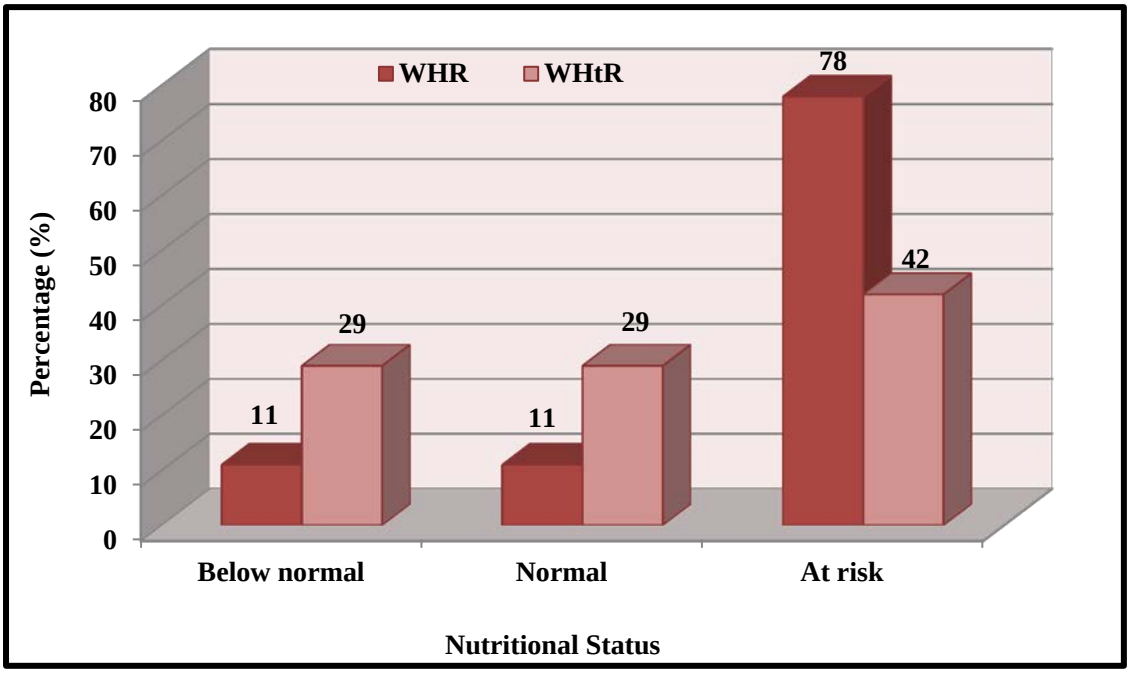


Figure 3.16: Comparison of nutritional status on basis of WHR and WHtR (n=6472)



**WHR: As per WHO, 2009 cutoffs and WHtR: As per Kurian et al., 2011 cutoffs*

Table 3.22: Nutritional status of children compared as per gender, age group and type of school (n=6472)

Parameters		Nutritional status (BAZ)					Chi-Square Value
		Severely UN	Moderately UN	Normal	Overweight	Obese	
Gender	Boys	137 (2)	268 (4)	2970 (46)	334 (5)	49 (1)	33.9**
	Girls	65 (1)	188 (3)	2276 (35)	167 (3)	18 (0.2)	
Age (yr)	8 – 11	92 (1)	213 (3)	2535 (39)	295 (5)	48 (1)	36**
	12 – 16	110 (2)	243 (4)	2711 (42)	206 (3)	19 (0.2)	
Type of school	Public	106 (2)	232 (4)	2572 (40)	251 (4)	42 (1)	6.26^{NS}
	Private	96 (1)	224 (4)	2674 (41)	250 (4)	25 (0.3)	

**** The significance is established at 95% CI, p < 0.05*, 0.01** and 0.001***, NS=Not Significant. Values in parenthesis are the percentages. As per WHO, 2010 cutoffs***

NUTRITIONAL STATUS AND AFFECTING FACTORS

Students belonging to the moderately undernourished category, normal nutritional status and overweight category showed closest association with parental history of obesity ($X^2 = 72$, $p<0.001$ at 95% CI) and diabetes ($X^2 = 21$, $p<0.05$ at 95% CI); as shown in table 3.23.

Waist circumference was also used to categorize the children as "below normal", "normal" and "at risk". Nearly equal proportions of children were distributed in the three categories of nutritional status (Table 3.24). Children categorized as "normal" and "at risk" showed close association with parental history of morbidities. 9% normal and 10% at risk children were associated with parental history of obesity. Similarly a difference range between 0.3% - 1.1% in the nutritional status was recorded which exhibited close association with parental history of diabetes, heart disease and hypertension.

Prevalence of "at risk" children were more when categorized based on the WHR. The prevalence was highest against history of obesity (21%) followed by diabetes (10%), heart disease (8%) and least against hypertension (7.5%), with a higher proportion of maternal history of morbidities. WHR showed strong significance with parental history of obesity and heart disease at $p<0.001$, while diabetes and hypertension co-related at $p<0.01$. Thus WHR could be considered as the most sensitive anthropometric indicator for early detection of risk factors.

Thus irrespective of the current nutritional status of the children, parental history of NCD's continues to be a potent non-modifiable risk factor.

Table 3.23: Association between parental history of morbidities and nutritional status o children based on BAZ

Parental History		Nutritional Status as per BMI for age					Chi-Square Value
		Severely UN	Moderately UN	Normal	Overweight	Obese	
Obesity	Mother	16 (0.2)	49 (1)	588 (9)	75 (1)	11 (0.1)	72***
	Father	20 (0.3)	36 (1)	462 (7)	65 (1)	8 (0.1)	
	Both	3 (0.04)	16 (0.2)	271 (4)	52 (1)	8 (0.1)	
Diabetes	Mother	9 (0.1)	21 (0.3)	412 (6)	55 (1)	6 (0.1)	21*
	Father	2 (0.01)	11 (0.1)	137 (2)	12 (0.1)	2 (0.01)	
	Both	1 (0.01)	5 (0.1)	45 (1)	6 (0.1)	0 (-)	
Heart Disease	Mother	3 (0.01)	17 (0.2)	249 (4)	26 (0.4)	4 (0.1)	18^{NS}
	Father	2 (0.01)	8 (0.1)	167 (3)	22 (0.3)	2 (0.01)	
	Both	0 (-)	2 (0.01)	44 (1)	4 (0.1)	0 (-)	
HBP	Mother	4 (0.1)	26 (0.4)	256 (4)	36 (1)	4 (0.1)	13^{NS}
	Father	8 (0.1)	20 (0.3)	188 (3)	17 (0.2)	1 (0.01)	
	Both	1 (0.01)	2 (0.01)	43 (1)	5 (0.1)	1 (0.01)	

Frequency of parental history of morbidity for father, mother and both only have been computed, "none" has not been included. Therefore the total percent would not come up to 100. Values in parenthesis are the percentages. The significance is established at 95% CI, p < 0.05*, 0.01** and 0.001, NS=Not Significant. As per WHO, 2010 cutoffs***

Table 3.24: Association between parental history of morbidities and nutritional status o children based on WC

Parental History		Nutritional Status as per WC			Chi-Square Value
		Below Normal	Normal	At Risk	
Obesity	Mother	218 (3)	259 (4)	262 (4)	53***
	Father	203 (3)	194 (3)	194 (3)	
	Both	73 (1)	103 (2)	174 (3)	
Diabetes	Mother	118 (2)	180 (3)	205 (3)	28.6***
	Father	40 (1)	54 (1)	70 (1)	
	Both	18 (0.2)	14 (0.1)	25 (0.4)	
Heart Disease	Mother	65 (1)	100 (2)	134 (2)	46.3***
	Father	43 (1)	77 (1)	81 (1)	
	Both	8 (0.1)	12 (0.1)	30 (0.4)	
HBP	Mother	84 (1)	106 (2)	136 (2)	11.9*
	Father	65 (1)	90 (1)	79 (1)	
	Both	15 (0.2)	17 (0.2)	20 (0.3)	

Frequency of parental history of morbidity for father, mother and both only have been computed, "none" has not been included. Therefore the total percent would not come up to 100. The significance is established at 95% CI, p < 0.05*, 0.01** and 0.001, NS=Not Significant. Values in parenthesis are the percentages. As per Kurian et al., 2011***

Table 3.25: Association between parental history of morbidities and nutritional status o children based on WHR

Parental History		Nutritional Status as per WHR			Chi-Square Value
		Below Normal	Normal	At Risk	
Obesity	Mother	66 (1)	102 (2)	571 (9)	31***
	Father	88 (1)	80 (1)	423 (7)	
	Both	29 (0.4)	29 (0.4)	292 (5)	
Diabetes	Mother	51 (1)	29 (0.4)	423 (7)	20.8**
	Father	13 (0.2)	21 (0.3)	130 (2)	
	Both	2 (0.03)	7 (0.1)	48 (1)	
Heart Disease	Mother	12 (0.2)	12 (0.2)	275 (4)	63***
	Father	9 (0.1)	8 (0.1)	184 (3)	
	Both	3 (0.04)	2 (0.03)	45 (1)	
HBP	Mother	49 (1)	41 (0.6)	236 (4)	18.3**
	Father	23 (0.3)	34 (0.5)	177 (3)	
	Both	7 (0.1)	11 (0.2)	34 (0.5)	

Frequency of parental history of morbidity for father, mother and both only have been computed, none has not been included. Therefore the total percent would not come up to 100. Values in parenthesis are the percentages. The significance is established at 95% CI, p < 0.05*, 0.01** and 0.001, NS=Not Significant. As per Kurian et al., 2011.***

Nutritional status based on BAZ have shown close significance with fried foods such as chips and puri; high sugar foods such as chocolates and ice-creams at p<0.01 (Table 3.26 to 3.28). WC is strongly associated with consumption of RWF (p<0.01 95% CI), fried foods and foods with high sugar content at (p<0.001, 95% CI). WHR has shown strongest correlation with both health and unhealthy foods at p<0.001, 95% CI.

Table 3.26: Dietary pattern and nutritional status of children based on BAZ

Nutritional status		RWF and Fried	RWF	Fried Food	High Sugar
Severely UN	202 (3)	Samosa 1.7*	Burger 1.6*	Chips 2.6*	Ice-cream 2**
Moderately UN	456 (7)		Pizza 1.6*	Puri 3.1**	Chocolates 2**
Normal	5246 (81)				
Overweight	501 (8)				
Obese	67 (1)		Noodles 1.5*		

RWF=Refined Wheat Flour. Values in parenthesis are the percentages. The significance is established at 95% CI, p < 0.05*, 0.01 and 0.001***, NS=Not Significant*

Table 3.27: Dietary pattern and nutritional status of children based on WC

Nutritional status		RWF and Fried	RWF	Fried Food	High Sugar	Aerated Drinks
Below normal	1954 (30)	Samosa 4.3**	Noodles 2.4*	Chips 2.5*	Ice-cream 4**	Colas 3.3*
Normal	2347 (36)			Puri 6.3***	Chocolates 4.7***	
At risk	2171 (36)					

RWF=Refined Wheat Flour. Values in parenthesis are the percentages. The significance is established at 95% CI, p < 0.05*, 0.01 and 0.001***, NS=Not Significant*

Table 3.28: Dietary pattern and nutritional status of children based on WHR

Nutritional status		RWF and Fried	RWF	Fried Food	High Sugar	Aerated Drinks	Fruits and Veg
Below normal	695 (11)	Samosa 67.3***	Burger 8.1***	Chips 22***	Ice-cream 53.7***	Colas 14.8***	16***
Normal	710 (11)		Pizza 19***	Puri 39***	Chocolates 38.5***		
At risk	5067 (78)		Noodles 29***	French fries 5.3**	Sweets after/during meal 2.5*		

RWF=Refined Wheat Flour. Values in parenthesis are the percentages. The significance is established at 95% CI, p < 0.05*, 0.01** and 0.001, NS=Not Significant***

PAP of the children was co-related against their nutritional status based on BAZ, WC and WHR. The PAP was condensed to amount of time spent, intensity of outdoor activity and type of indoor activity. "Time spent" and the "intensity of activity" did not show any significant relation with the nutritional status of the children (Table 3.29); while indoor sedentary activity and screen time, did affect the nutritional status as calculated by BAZ at $p<0.05$.

Waist circumference of the children did co-relate significantly with time spent on physical activity and the choice of indoor activity at $p<0.05$ and $p<0.01$ respectively. Intensity of activity did not show any significant relation with WC as a parameter. However, WHR revealed strong co-relation with the time spent on PA, intensity of outdoor activities, hours spent in front of screen and indulging in other household sedentary activities at $p<0.001$.

Table 3.29: Physical activity pattern of the children and nutritional status as per BAZ

Nutritional status	Time spent		Intensity of outdoor activity		Nature of indoor activity	
	Adequate	Inadequate	Moderate	Sedentary	Screen time	Sedentary
Severely UN	171 (3)	31 (0.4)	97 (1)	105 (2)	84 (1)	118 (2)
Moderately UN	381 (6)	75 (1)	226 (3)	230 (4)	210 (3)	246 (4)
Normal	4235 (65)	1011 (16)	2589 (40)	2657 (41)	2189 (34)	3057 (47)
Overweight	413 (6)	88 (1)	271 (4)	230 (4)	229 (3)	272 (4)
Obese	58 (1)	9 (0.1)	33 (1)	34 (1)	3 (1)	36 (1)
F-Value	5.7^{NS}		4.3^{NS}		6.1*	

Values in parenthesis are the percentages. The significance is established at 95% CI, p < 0.05*, 0.01** and 0.001, NS=Not Significant***

Table 3.30: Physical activity pattern of the children and nutritional status as per WC

Nutritional status	Time spent		Intensity of outdoor activity		Nature of indoor activity	
	Adequate	Inadequate	Moderate	Sedentary	Screen time	Sedentary
Below normal	1611 (25)	343 (5)	972 (15)	982 (15)	864 (13)	1090 (17)
Normal	1884 (29)	463 (7)	1155 (18)	1192 (18)	1008 (16)	1339 (21)
At risk	1763 (27)	408 (6)	1089 (17)	1082 (17)	871 (13)	1300 (20)
F-Value	3.3*		0.4^{NS}		7.5**	

Values in parenthesis are the percentages. The significance is established at 95% CI, p < 0.05*, 0.01** and 0.001, NS=Not Significant***

Table 3.31: Physical activity pattern of the children and nutritional status as per WHR

Nutritional status	Time spent		Intensity of outdoor activity		Nature of indoor activity	
	Adequate	Inadequate	Moderate	Sedentary	Screen time	Sedentary
Below normal	615 (10)	80 (1)	423 (7)	272 (4)	360 (6)	335 (5)
Normal	615 (10)	95 (1)	394 (6)	316 (5)	345 (5)	365 (6)
At risk	4028 (62)	1039 (16)	2399 (37)	2668 (41)	2038 (31)	3029 (47)
F-Value	47.5***		55.4***		46***	

Values in parenthesis are the percentages. The significance is established at 95% CI, p < 0.05*, 0.01** and 0.001, NS=Not Significant***

TO SUM UP

1. The selected schools were a proportionate mix of public and private management as well as state and central board. The school's strength ranged from minimum 1009 to maximum 3240 of the enrolled subjects (n=6472); of which 58% were boys and 42% were girls.
2. Maternal history of obesity (23%), diabetes (15.6%), heart disease (9%) and hypertension (9%) was nearly two fold higher than paternal history. Parental history of obesity, specifically maternal obesity showed close association with girls of 8-11 years studying in public school.
3. Dietary habits revealed that 22% - 38% students were in habits of consuming unhealthy food. Foods rich in sugar were preferred the most (38%); followed by fried foods (32%), aerated drinks and a combination of refined wheat flour and fried food. Only 1% difference was observed between weekly intake of healthy : unhealthy food and large difference of 8% within a fortnight.
4. However the students also reported healthy eating practices such as 24% students consumed fruits and vegetables daily, 13% consumed it weekly and 21% students consumed fruits and vegetables "once in 15 days".
5. The physical activity pattern revealed that 46% were performing only sedentary activities and 21% students were involved in activities of vigorous intensity. Boys of young age group (55%) performed physical activity of moderate intensity as compared to the girls. Moreover children studying in public schools showed higher level of physical activity.
6. As per BAZ (WHO, 2010), 81% children had normal nutritional status; while 10% children were undernourished and 9% children were overnourished; revealing a clear trend of DBM without significant difference across the type of school.

7. BMI values compared between national and international data also revealed DBM, but it tends to over predict undernutrition. Moreover prevalence showed Khadilkar et al., 2011 (54% undernutrition and 15% overnutrition) was comparable with WHO and IOTF standards (59% undernutrition and 5 – 11% overnutrition).
8. As per WC 33% children were categorized at risk, 78% were in the risk category as per WHR and 42% children were overnourished as per WHtR.
9. Prevalence of overnutrition was more among boys as compared to girls, while children of 8 – 11 years of age had higher prevalence of overnutrition.
10. Among the 3 anthropometric indicators (BAZ, WC and WHR), WHR showed strongest association with parental history of morbidities. As a matter of concern, however children across the nutritional status categorized by any indicator showed significant relation with parental history of NCD's.
11. Similarly WHR also exhibited close relation at $p<0.001$, 95% CI with RWF, fried food and sugar dense food along with fruits.
12. Time spent on PA, intensity of PA and screen time affected WHR the most than BAZ and WC.

The trends of parental history of morbidities, dietary habits, PAP and nutritional status, among school going children in Vadodara are under rapid transition. Early identification and prevention is therefore necessary to halt or delay the onset of lifestyle disorders as a "public health concern". The findings reveal that WHR followed by WC stands out to be sensitive marker that can be used for screening school children. Moreover the results also justify an urgent need to initiate "healthy school programme" as an effective and sustainable approach for preventing detrimental lifestyle alterations.

LIMITATIONS

1. Out of the 121 public private schools of Vadodara, only 10 school data could be generated
2. The study could not cover children from lower and lower middle income group families.
3. DBM is a potential risk for developing NCD at early stage of life, for which assessment of body composition along with anthropometric parameters would have added deeper understanding. However this could not be covered in the study.

FUTURE SCOPE OF WORK

1. Similar studies across India for all economic classes of populations could help in developing national standards for BAZ, BMI, WC and WHR for Indian children and adolescents.
2. Physical activity and dietary habits are potential but modifiable risk factors for development of NCD's, therefore its correlations can be studied in depth.
3. School based promotion of physical activity needs to be strengthened.
4. Body composition and DBM should be studied in details.

DISCUSSION

The present section of the study assessed the situational analysis of students of 4th to 9th standard from ten schools (n=6472) of Vadodara city which catered to affluent sections. Genetic influence of obesity and co-morbidities were identified as a potential risk factor for both boys and girls between the age group of 8 to 16 years belonging to middle as well as high-income families.

In the present study, 57.5% of students had parental history of morbidities; of which maximum (30%) prevalence was among mothers followed by 19.5% among fathers. Among all the morbidities, prevalence of obesity was highest (25.4%) affecting 11% mothers. Bhuiyan et al. (2013) mentions that having at least one overweight parent (OR = 2.8, p = 0.001) is an independent risk factor for childhood overweight and/or obesity (Delisle and Strychar, 2006; Speiser et a., 2005). The trend of maternal morbidity observed in the study showed close association with girls of younger age group studying in public schools, which were either undernourished or normally nourished. Overweight mothers and underweight children in the same household is a uprising paradox (Doak et al. 2005) in developing countries and a matter of concern.

Though 24% students consumed fruits and vegetables daily in the present study, yet 36% of them had a habit of eating out of home. 22% - 38% students consumed unhealthy food such as those rich in sugar (38%); fried foods (32%), aerated drinks (25%) and a combination of refined wheat flour and fried food (22%) on a weekly basis. Frequently eating out of home exposes the children to energy dense foods and erratic snacking habits (Amin et al., 2008; Kumar et al., 2007; Grier et al., 2007).

Junk food were reported to be the favourite dishes among 22% adolescents (Laxmiah et al., 2007); bakery snacks and sweets were consumed daily by 42% and 58% students respectively because they were available within school premises (Hasanbegovic et al., 2010). Such a trend increased the risk of

overweight and obesity among children at OR=2.54; 95% CI=1.82-3.53, p<0.0001 (Thakre et al., 2011). Arya et al., 2006 have reported that more than 10% energy consumption from saturated fat increases serum CRP levels among Asian Indian adolescents.

As reported by Laxmaiah et al. (2008), approximately 45% of adolescents did not participate in any outdoor activities, which is similar to the findings of the present study where 46% performed some sort of sedentary activities. Anrig (2003), reports that physical activities such as jumping rope, riding bikes, and skating have been replaced with television, video games and computer games (Branca et al., 2007) in nearly 91% school children and adolescents (Laxmaiah et al., 2008)

Results of the study documents that 21% students performed PA of vigorous intensity; boys of young age group (55%) performed PA of moderate intensity as compared to the girls. Low participation rate of adolescent girls in sports is also associated with increased obesity prevalence (Quazi et al., 2010). Children studying in public schools of Vadodara showed higher level of physical activity, attributed to the influence of parents (predominantly mothers). Moderate to vigorous PA, at least one hour a day should be the general recommendation (Griffith et al., 2007; Agarwal, 2008).

The BAZ values of the present study revealed a clear trend of Dual Burden of Malnutrition (DBM); with 10% undernourished and 9% overweight children. This data is in tandem with global, national and regional prevalence rates (Kanani and Jain, 2010). This does not rule out the 81% normal children to be safe as Indians have excess cardiovascular risk even at normal BMI and WC values (Vikram et al., 2003). Soekirman et al. (2002) and Weisell (2002) reported that children from public schools had a much greater problem of undernutrition than overnutrition as also observed in Jakarta and Bogor.

In the present study, 12.24% boys and 14.31% girls were overweight, and 5.92% boys and 6.27% girls were obese. Prevalence of overweight and obesity was 14.2% and 9.7% among older children of urban areas of Punjab (Kaur et al., 2006); which was as high as or higher than some developed countries (Amin et al., 2008; Frorentino et al., 2002). In a Greek study, the mean body weight was not different between sexes, yet there was a higher percentage of overweight and obesity among boys (Papadimitriou et al., 2006). Where in another study the overall prevalence of overweight among the adolescents was 7.2%; where more girls were overweight than boys. The prevalence among girls tended to increase from 6.2% to 10.8% at 12 years (Laxmaiah et al., 2008).

Prevalence of overweight among adolescents studying in private school (9.6%), belonging to higher SES (15%), consuming unhealthy food (12.6%) and those using automated vehicles (9.9%) has been higher; while the prevalence of overweight and obesity is lower among adolescents who participate in outdoor games (9.7%) (Laxmaiah et al., 2008). Increase in generalized and abdominal adiposity among Indian adolescents has higher value of CRP, which may contribute in early development of metabolic syndrome and atherosclerosis (Vikram et al., 2003). However such prevalence is increasingly observed in the public school adolescents of India (N-Doc, 2009) as well as several in western (Eisenmann et at., 2002).

The results also reveal that WHR has shown to be a sensitive marker for early identification of risk parameters such as dietary habits, PAP and parental history of morbidities. WHR could segregate more undernourished and normal individuals as being abdominally obese than did waist circumference (Kurpad et al., 2003). Consumption of junk food, non-vegetarian food and sedentariness showed association with WHR (Dapi et al., 2005) and it has also been established as the most reliable predictor of CVD (Kaur and Walia, 2007).

Thus the overall findings of the study merits the need for lifestyle interventions with a preventive strategy for the school going children and adolescents to reduce the future burden on health, social and economic development of India.