RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The socio-economic development in various countries of Southeast Asia is increasing at a rapid pace. This has resulted in co-existence of both the extreme types of malnutrition – undernutrition and overnutrition in all ages. With the advanced health sciences the countries have been successful in reducing nutritional deficiencies among its most vulnerable subjects. These days diet related non-communicable diseases such as diabetes, coronary heart disease and some forms of cancer are being observed more frequently among urban population. It is expected that the nutritional status of the people will change in proportion to their country's socio-economic growth. This explains the significance of continuous monitoring of nutritional development of the community groups including school children.

The rising prevalence of obesity among people at large and more specifically among children and adolescents is a matter of concern for all. There is no adequate baseline data available on the prevalence of overweight and obesity in school children in western part of India particularity in Gujarat state. The present study aimed at mapping the prevalence of overweight and obesity among school children in urban Vadodara and explore the risk factors responsible for the same.

The study population comprised of a total 4808 secondary and higher secondary school children (12-18 years) from 10 schools of urban Vadodara. Out of these 2890 were boys and 1918 were girls. The background information and anthropometric measurements were recorded for all the study children. The data for risk factor analysis was obtained on a sub sample of 214 children. The biochemical estimations were done on 197 children.

The findings of the study for prevalence of overweight and obesity and risk factors responsible for the same are presented under the following sections.

Section I
- School profile
- Background information of the children

Section II
- Anthropometric measurements of the children
- Prevalence by different BMI for age standards
- Age wise prevalence
- Class wise prevalence
- School wise prevalence
- Measurement of agreement (kappa index) between various standards
- BMI percentiles

Section III
- Influence of risk factors on prevalence
- Nutrient intake
- Energy intake and energy expenditure
- Fasting blood sugar and lipid profile

Section IV
- Trends of BMI at 6,12 and 24 months of interval

SECTION I

School Profile

For the purpose of study, 10 private, regular, co-educational and non boarding schools having upto higher secondary level were randomly selected from different zones in urban Vadodara such that they represented children from different socio-economic groups. Out of the selected 10 schools, 4 of them were English medium schools while 6 were Gujarati medium schools.

Four schools offered school bus facility for commutation for children. All the schools except one had computer as one of their subjects and imparted

computer training to children. Eight schools had playground for outdoor activities. Two schools had school meal programme, whereas 5 schools had canteen facilities for children. Eight schools had annual health check up programme for children wherein only height and weight measurement were recorded. Table 4.1 summarises the facilities available in different schools.

Background Information of the children

Sex specific socio-economic profile of the study children is given in Table 4.2. Based on student strength, almost 80% of the selected school children were from Gujarati medium schools and about 20% from English medium. Ninety two percent of the children followed Hindu religion. Seventy one percent children belonged to the nuclear family type. About 70% of the children belonged to family with per capita income ranging from Rs. 1,000 to Rs. 4,999 where as 12% belonged to family with per capita income of Rs. 5,000 and above.

About 50% of the children's fathers were graduates. Sixty percent of the children's fathers were employed in service and 31% were businessmen. Around 40% of mothers were graduates while 31% had only primary school education. About 83% of the mothers were housewives (Table 4.3).

Discussion

The nutrition transition focuses on a broad range of socio-economic and demographic shifts that bring rapid changes in diet and physical activity levels in majority countries of the world. This is apparent from the shifts in the distribution of the population, income, and occupation patterns. One consequence of the nutritional transition has been a decline in undernutrition accompanied with a most rapid increase in obesity. The causes of obesity should be considered as an environmental factor rather than personal or genetic.

Nowadays the growing epidemic of childhood obesity afflicting both developed and developing countries is of major concern on account of its consequences and enormous burden on health care system.

TABLE 4.1

SCHOOL PROFILE

Variable	N
Medium of instruction	
English	4 (40)
Gujarati	6 (60)
School bus	4 (40)
Computer facility	9 (90)
Playground	8 (80)
Canteen	5 (50)
School meal programme	2 (20)
Annual health check up (height and weight measurement)	8 (80)

Values in parenthesis indicate percentage

TABLE 4.2

SEX SPECIFIC SOCIOECONOMIC PROFILE OF THE CHILDREN

Variable	Boys	Girls	Total
Religion			
Hindu	2628 (90.9)	1791 (93.4)	4419 (91.9)
Muslim	152 (5.3)	55 (2.9)	207 (4.3)
Christian	12 (0.4)	10 (0.5)	22 (0.5)
Sikh	14 (0.5)	6 (0.3)	20 (0.4)
Sindhi	6 (0.2)	12 (0.6)	18 (0.4)
Parsi	3 (0.1)	-	3 (0.1)
Jain	75 (2.6)	44 (2.3)	119 (2.5)
Family type			
Joint	674 (23.3)	480 (25.0)	1154 (24.0)
Nuclear	2052 (71.0)	1360 (70.9)	3412 (71.0)
Extended nuclear	164 (5.7)	78 (4.1)	242 (5.0)
Family size			
< 5	1536 (53.1)	892 (46.5)	2428 (50.5)
5-8	1177 (40.7)	911 (47.5)	2088 (43.4)
> 8	177 (6.1)	115 (6.0)	292 (6.1)
Per capita income (Rs.)			
< 1000	562 (19.5)	284 (14.8)	846 (17.6)
1000-4999	2003 (69.3)	1375 (71.6)	3378 (70.3)
≥ 5000	325 (11.2)	259 (13.5)	584 (12.1)
Total	2890	1918	4808

Values in parenthesis indicate percentage

TABLE 4.3

OCCUPATIONAL AND EDUCATIONAL BACKGROUND OF THE PARENTS OF THE CHILDREN

Variable	Boys	Girls	Total
Occupation of the father			
Service	1665 (58.3)	1137 (59.7)	2802 (58.9)
Business	873 (30.6)	601 (31.6)	1474 (31.0)
Professional	49 (1.7)	36 (1.9)	85 (1.8)
Self-employed	169 (5.9)	79 (4.2)	243 (5.2)
Agriculture	56 (2.0)	39 (2.0)	95 (2.0)
Others (pensioner, labourer, housework)	42 (1.5)	11 (0.6)	53 (1.1)
Occupation of the mother			
Service	406 (14.1)	287 (15.0)	693 (14.4)
Business	16 (0.6)	15 (0.8)	31 (0.6)
Professional	9 (0.3)	10 (0.5)	19 (0.4)
Self-employed	40 (1.4)	25 (1.3)	65 (1.4)
Housewife	2389 (83.0)	1578 (82.4)	3967 (82.7)
Others (labourer or maid servant)	20 (0.7)	1 (0.1)	21 (0.4)
Education of the father			
Primary	125 (4.4)	39 (2.1)	164 (3.4)
Secondary	489 (17.1)	309 (16.2)	798 (16.8)
Higher secondary	327 (11.5)	211 (11.1)	538 (11.3)
Diploma	176 (6.2)	93 (4.9)	269 (5.7)
Graduate	1387 (48.6)	967 (50.8)	2354 (49.5)
Post graduate	312 (10.9)	264 (13.9)	576 (12.1)
Ph. D.	37 (1.3)	20 (1.1)	57 (1.2)
Education of the mother			
Illiterate	7 (0.2)	-	7 (0.1)
Primary	323 (11.2)	140 (7.3)	463 (9.6)
Secondary	918 (31.9)	575 (30.0)	1493 (31.2)
Higher secondary	333 (11.6)	241 (12.6)	574 (12.0)
Diploma	59 (2.1)	48 (2.5)	107 (2.2)
Graduate	1064 (37.0)	760 (39.7)	1824 (38.1)
Post graduate	167 (5.8)	148 (7.7)	315 (6.6)
Ph.D.	6 (0.2)	3 (0.2)	9 (0.2)

Values in parenthesis indicate percentage

With a view to investigate the influence of socio-economic status on magnitude of the prevalence of overnutrition, the information on school profile and socio-economic background of the children were looked into. The information on school profile revealed that all the schools enrolled for the study were imparting education to children belonging to middle and high income groups. The schools had various facilities like computer room, canteen and playground. About 50% schools had their own buses for commutation of their children.

The background information of the children showed that majority of the children's fathers were educated and employed. Income is an important element in the nutrition transition because it controls flow of goods and services. In other words income allows us to purchase goods or services affecting the socio-economic status and nutritional status. In the present study, information regarding children's family income revealed that 18% of the children belonged to family with per capita income of < Rs. 1,000, 70% belonged to per capita income of Rs. 1,000–Rs. 4,999 and 12% belonged to family with per capita income > Rs. 5,000 or more.

Highlights

- Ninety two percent of the children followed Hindu religion.
- Seventy one percent of the children belonged to nuclear family type.
- Eighty two percent of the children belonged to middle and high income group.
- Fifty percent of the children's fathers had minimum graduate qualifications.
- Thirty eight percent of the children's mothers had minimum graduate qualifications.

- Fifty nine percent of the children fathers were employed in private/public sectors.

- Eighty three percent of the children's mothers were housewives.

SECTION II

Anthropometric Measurements of the Children

The age and sex specific anthropometric profile of the study children is given in Table 4.4. The graphical representation of the same is shown in Figure 4.1. Out of selected 4808 children, there were 2868 boys and 1910 girls in the age range of 12-18 years and studying in 8^{th}–12^{th} class. The mean age of the boys and girls was 14.0 and 14.1 years respectively in the age group of 12-15 years (younger age group) while it was 16.5 and 16.6 years respectively in the age group of 16-18 years (older age group). The mean BMI of boys and girls was 17.50 and 18.63 respectively in younger age group and 19.41 and 19.81 in the older age group respectively. BMI was significantly higher ($p<0.001$) in girls than boys in the age range of 12-18 years. The waist and hip ratio was 0.81 and 0.75 for boys and girls respectively in younger age group and it was 0.80 and 0.73 respectively in older age groups.

The body fatness measurements-BMI ranged from 15.75 to 20.11 in the age range of 12-18 years whereas the fatness distribution measurements - WHR and WC ranged from 0.72 to 0.82 and 57.96 to 70.95 respectively in the same age range. At the age of 17.5 years the highest BMI in boys and girls was 19.67 and 20.11 respectively. The BMI increased with age in both boys and girls. The class wise BMI is shown in Figure 4.2.

TABLE 4.4

ANTHROPOMETRIC PROFILE OF THE CHILDREN

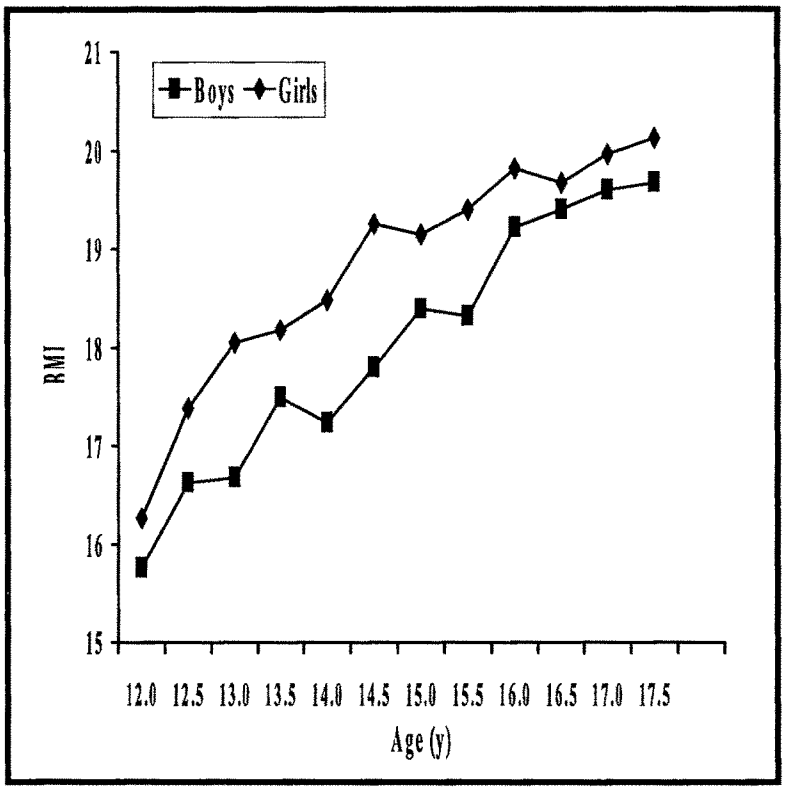
(MEAN ± SD)

Anthropometric Measurements	Boys	Girls	't' Value
12-15 years			
N	2086	1228	-
Age	14.01 ± 1.06	14.17 ± 1.05	-
Height	1.577 ± 0.10	1.535 ± 0.65	12.63**
Weight	44.06 ± 11.55	44.03 ± 9.46	-
BMI	17.50 ± 3.29	18.63 ± 3.56	9.26**
WHR	0.812 ± 0.056	0.756 ± 0.053	28.42**
16-18 years			
N	782	682	-
Age	16.52 ± 0.53	16.60 ± 0.56	-
Height	1.684 ± 0.07	1.554 ± 0.06	36.03**
Weight	55.07 ± 12.17	47.78 ± 9.71	12.54**
BMI	19.36 ± 3.80	19.76 ± 3.68	-
WHR	0.802 ± 0.057	0.737 ± 0.052	22.75**
12-18 years			
N	2868	1910	-
Age	14.69 ± 1.46	15.03 ± 1.47	-
Height	1.606 ± 0.11	1.542 ± 0.06	22.63**
Weight	47.06 ± 12.70	45.37 ± 9.71	4.64**
BMI	18.01 ± 3.53	19.03 ± 3.64	9.84**
WHR	0.809 ± 0.057	0.749 ± 0.053	37.01**

** $p < 0.001$

FIGURE 4.1

ANTHROPOMETRIC PROFILE OF THE CHILDREN



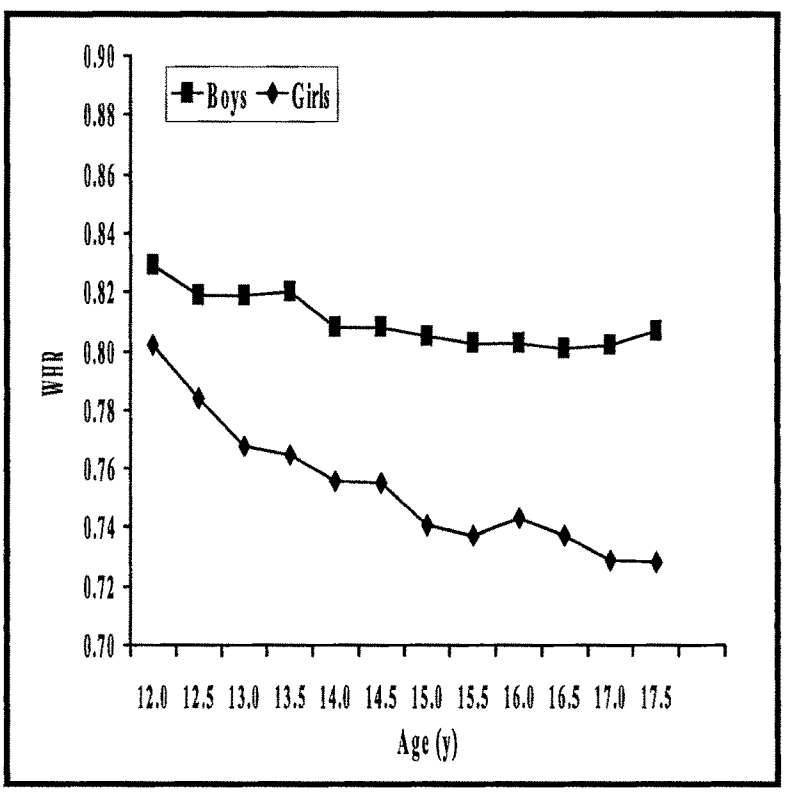


FIGURE 4.1

ANTHROPOMETRIC PROFILE OF THE CHILDREN

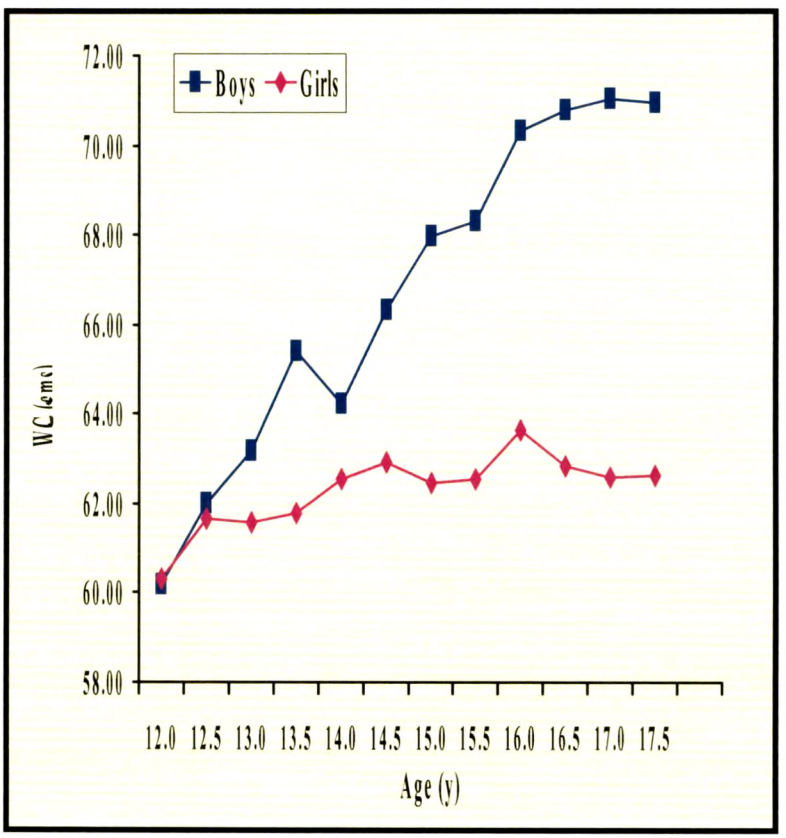
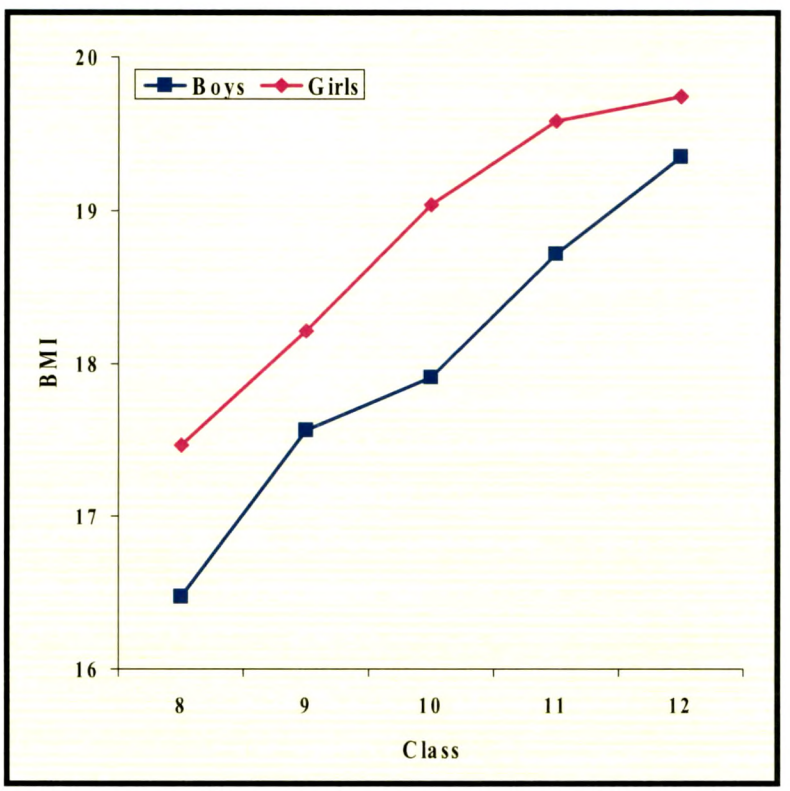


FIGURE 4.2

BMI OF THE CHILDREN IN RELATION TO CLASS



Prevalence by Different Standards

The prevalence of overweight and obesity in the children was determined using following age and sex specific cut off points based on BMI.

- Must et al standards (1991)
- Cole et al standards (2000) recommended by IOTF
- CDC standards (2000)
- Agarwal standards (2003)

The anthropometric measurements for non overweight/obese, overweight and obese children in the younger age group and older age group are given in Table 4.5. The prevalence of overweight and obesity in children by Must et al, Cole et al and CDC standards are presented in Table 4.6.

Must et al Standards

The overall prevalence of overweight was 7.3% and that of obesity was 1.9%. The prevalence of overweight was higher in girls (8.0%) than in boys (6.9%).

Cole et al Standards

The prevalence of overweight and obesity was 7.5% and 1.3% respectively in the younger age group while it was 10.5% and 2.0% respectively in the older age group. The overall prevalence was higher in older age group children as compared to the younger group. The prevalence was higher in girls than boys. The overall prevalence of overweight was 8.4% and that of obesity was 1.5%.

CDC Standards

The prevalence of overweight and obesity was found to be 6.5% and 2.1% respectively in the younger age group whereas it was 8.5% and 2.9% respectively in the older age. In the younger age group the prevalence of overweight and obese was higher in girls than boys. The overall prevalence of overweight was 7.1% and that of obesity was 2.4%.

Agarwal Standards

When the data was subjected to most recently available Agarwal standards, it was found that the overall prevalence of overweight was 10.4% and

TABLE 4.5

ANTHROPOMETRIC PROFILE OF YOUNGER AND OLDER AGE GROUP CHILDREN

(MEAN ± SD)

Anthropometric Measurement	Non Overweight/Obese		Overweight		Obese	
	Boys	Girls	Boys	Girls	Boys	Girls
12-15 years						
N	1917	1106	143	104	26	18
BMI	16.81 ± 2.29	17.81 ± 2.56	24.46 ± 1.43	25.20 ± 1.44	30.22 ± 2.91	31.04 ± 2.76
WHR	0.808 ± 0.054	0.752 ± 0.052	0.854 ± 0.055	0.787 ± 0.046	0.889 ± 0.088	0.794 ± 0.072
WC	63.78 ± 7.23	60.70 ± 6.03	81.74 ± 8.06	74.44 ± 5.13	91.65 ± 12.97	85.44 ± 7.27
16-18 years						
N	681	600	86	68	15	14
BMI	18.25 ± 2.42	18.71 ± 2.31	25.92 ± 1.47	26.47 ± 1.27	32.19 ± 2.76	32.14 ± 1.84
WHR	0.794 ± 0.052	0.732 ± 0.051	0.849 ± 0.052	0.766 ± 0.054	0.917 ± 0.052	0.779 ± 0.058
WC	67.97 ± 7.38	60.97 ± 6.49	85.72 ± 7.42	75.14 ± 6.48	101.2 ± 6.51	85.85 ± 6.21

TABLE 4.6

PREVALENCE OF OVERWEIGHT AND OBESITY BY MUST et al, COLE et al AND CDC STANDARDS

Age Group	N	Must et al Standards		Cole et al Standards		CDC Standards	
		Overweight	Obese	Overweight	Obese	Overweight	Obese
12-15 years							
Boys	2086	132 (6.3)	34 (1.6)	143 (6.9)	26 (1.2)	119 (5.7)	46 (2.2)
Girls	1228	88 (7.2)	23 (1.9)	104 (8.5)	18 (1.5)	98 (8.0)	25 (2.0)
Total	3314	220 (6.6)	57 (1.7)	247 (7.5)	44 (1.3)	217 (6.5)	71 (2.1)
16-18 years							
Boys	782	65 (8.3)	19 (2.4)	86 (11.0)	15 (1.9)	61 (7.8)	28 (3.6)
Girls	682	64 (9.4)	15 (2.2)	68 (10.0)	14 (2.1)	63 (9.2)	15 (2.2)
Total	1464	129 (8.8)	34 (2.3)	154 (10.5)	29 (2.0)	124 (8.5)	43 (2.9)

Values in parenthesis indicate percentage

that of obesity was 3.0%. The overall prevalence of obesity was higher in girls than boys (Table 4.7).

Different standards used to map the prevalence of overweight and obesity gave different values. Figure 4.3 gives an overview of such values obtained. The overall prevalence of overweight and obesity based on Must et al, Cole et al and CDC Standards were comparable. The prevalence rates were higher for Agarwal standards (cut off points based on Indian children). The overall prevalence of overweight ranged from 7.1% to 10.4% and that of obesity from 1.5% to 3.0%.

Table 4.8 gives the cut off points to classify overweight and obese children by different standards. The cut off points for overweight and obesity are lower for Agarwal standards than by Cole et al and CDC standards. In the present study Cole et al standards were used for risk factor analysis as it is recommended by IOTF for meaningful comparison between populations.

Age Wise Prevalence

Figure 4.4 shows the age wise prevalence of overweight and obesity at 6 months intervals from 12-18 years of age for boys and girls separately based on Cole et al standards. The prevalence of overweight ranged from 3.7% to 12.7% and that of obesity from 0.6% to 5.1%. The prevalence of overweight was highest at 16 years and 13 years for boys and girls respectively. The prevalence of obesity was highest at 17 years and 17.5 years for boys and girls respectively. Similar trend was observed when prevalence for both overweight and obesity was traced by CDC standards.

Class Wise Prevalence

The children enrolled in the study were from 8^{th}-12^{th} classes. Class wise prevalence of overweight and obesity based on Cole et al standards is shown in Table 4.9. The overall prevalence of overweight increased with class, ranged from 6.0% to 11.1% and was highest in 12^{th} class children. The prevalence of obesity ranged from 0.8% to 2.6% and was highest in 11^{th} class children. The prevalence of overweight and obesity was found both in boys and girls and in all classes.

TABLE 4.7

PREVALENCE OF OVERWEIGHT AND OBESITY BY AGARWAL STANDARDS

Age Group	N	Agarwal Standards	
		Overweight	Obese
12-15 years			
Boys	2086	218 (10.5)	48 (2.3)
Girls	1228	117 (9.5)	28 (2.3)
Total	3314	335 (10.1)	76 (2.3)
16-18 years			
Boys	782	96 (12.3)	31 (4.0)
Girls	655	61 (9.3)	37 (5.6)
Total	1437	157 (10.9)	68 (4.7)
12-18 years			
Boys	2868	314 (10.9)	79 (2.8)
Girls	1883	178 (9.5)	65 (3.5)
Total	4751	492 (10.4)	144 (3.0)

Values in parenthesis indicate percentage

FIGURE 4.3

PREVALENCE OF OVERWEIGHT AND OBESITY USING DIFFERENT STANDARDS

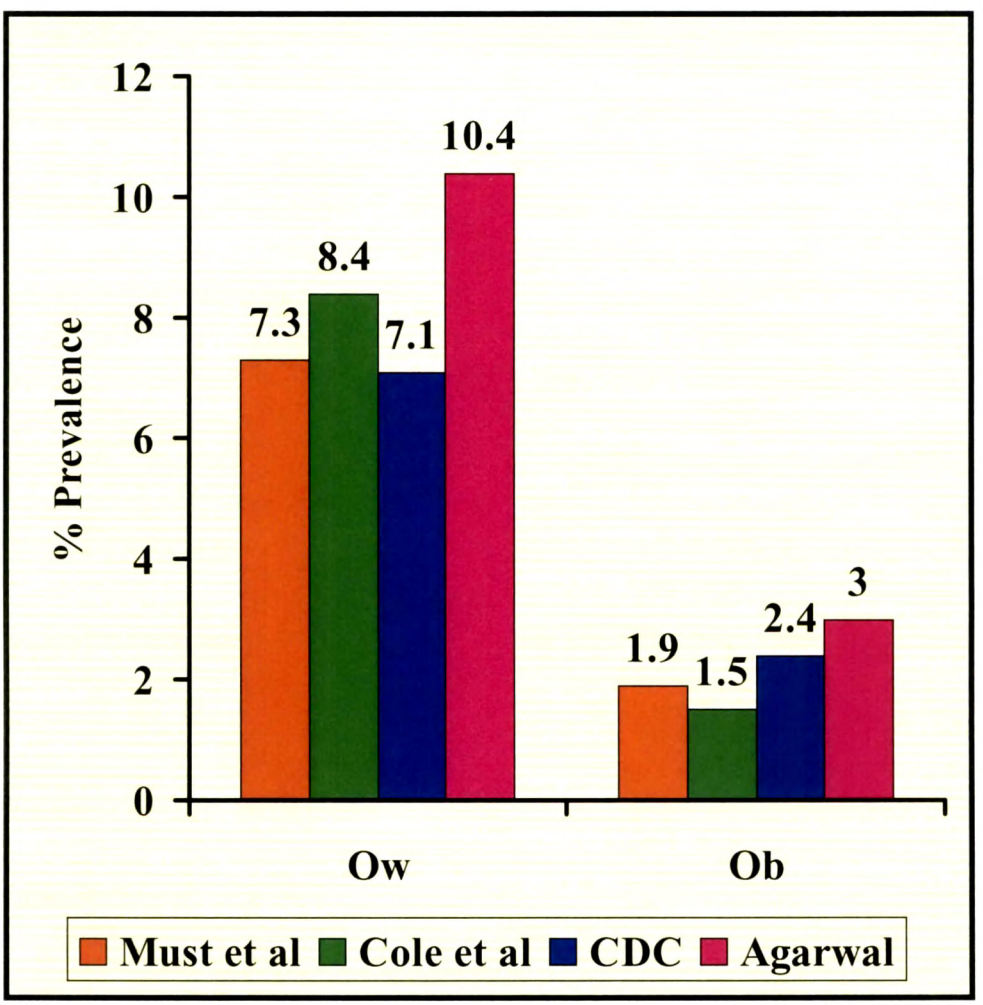


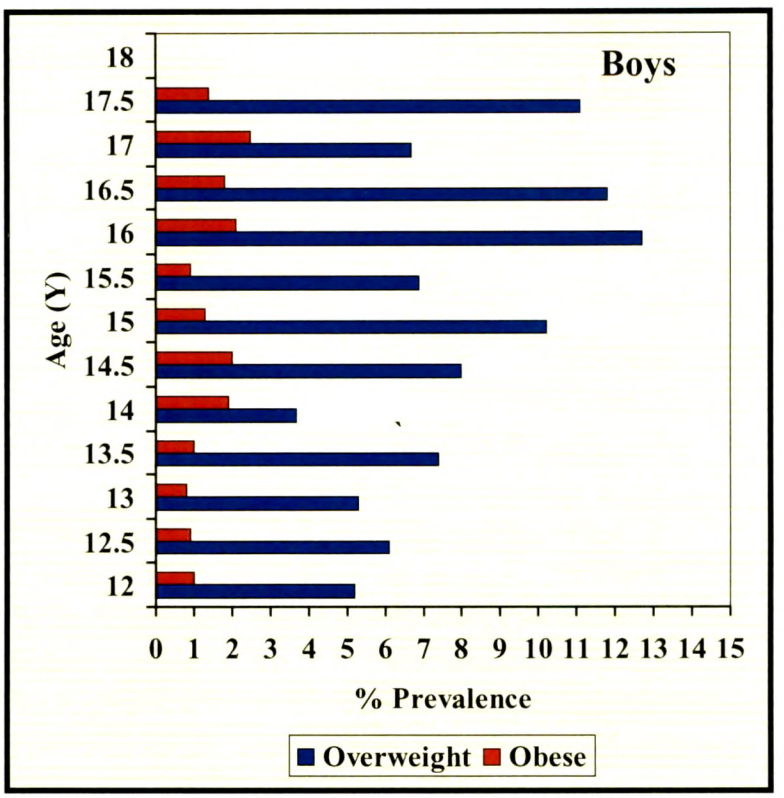
TABLE 4.8

COMPARISON OF CUT OFF POINTS GIVEN BY MUST et al, COLE et al, CDC AND AGARWAL STANDARDS

Age (y)	Must et al Standards				Cole et al Standards				CDC Standards				Agarwal Standards			
	M		F		M		F		M		F		M		F	
	Ow	Ob	Ow	Ob	Ow	Ob	Ow	Ob	Ow	Ob	Ow	Ob	Ow	Ob	Ow	Ob
12	21.1	24.9	22.2	25.9	21.2	26.0	21.7	26.7	21.9	24.1	20.2	22.9	19.8	23.8	21.9	25.7
12.5	-	-	-	-	21.6	26.4	221	27.2	21.4	24.6	20.6	23.4	-	-	-	-
13	21.9	25.9	23.1	27.1	21.9	26.8	22.6	27.8	21.8	25.1	21.0	23.8	20.4	25.3	22.6	27.1
13.5	-	-	-	-	22.2	27.3	22.9	28.2	22.2	25.6	21.2	24.2	-	-	-	-
14	22.8	26.9	23.9	27.9	22.6	27.6	23.3	28.6	22.6	26.0	21.6	24.6	21.1	25.3	23.0	27.4
14.5	-	-	-	-	22.9	27.9	23.7	28.9	23.0	26.4	23.6	27.6	-	-	-	-
15	23.6	27.8	24.3	28.5	23.3	28.3	23.9	29.1	23.4	26.8	24.0	28.0	22.0	27.3	23.6	27.7
15.5	-	-	-	-	23.6	28.6	24.1	29.3	23.8	27.2	24.3	28.7	-	-	-	-
16	24.5	28.5	21.7	29.1	23.9	28.8	24.3	29.4	24.2	27.5	24.6	28.9	22.7	27.6	23.7	27.4
16.5	-	-	-	-	24.19	29.1	24.5	29.6	24.6	27.8	24.9	29.2	-	-	-	-
17	25.3	29.3	25.2	29.7	24.5	29.4	24.7	29.7	24.8	28.2	25.1	29.5	24.4	27.8	23.0	25.9
17.5	-	-	-	-	24.7	29.7	24.8	29.8	25.2	28.6	25.4	30.0	-	-	-	-
18	25.9	30.0	25.6	30.2	25.0	30.0	25.0	30.0	25.6	28.8	25.6	30.3	23.6	28.0	23.2	-

FIGURE 4.4

AGE WISE PREVALENCE OF OVERWEIGHT AND OBESITY



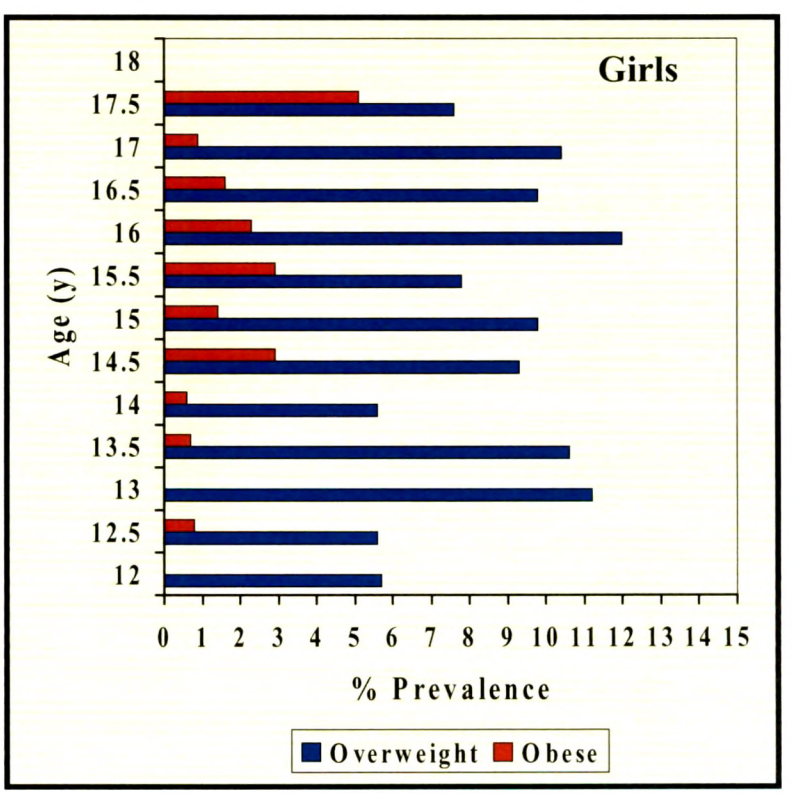


TABLE 4.9

CLASS WISE PERCENT PREVALENCE OF OVERWEIGHT AND OBESITY BY COLE et al STANDARDS

Class	N	Overweight	Obese
8	795	51 (6.0)	7 (0.8)
9	830	66 (7.3)	11 (1.2)
10	706	66 (8.4)	11 (1.4)
11	1040	100 (8.5)	31 (2.6)
12	933	118 (11.1)	13 (1.2)

Values in parenthesis indicate percentage

School Wise Prevalence

Undernutrition and overnutrition

An analysis was carried out to find out the prevalence of stunted, underweight and thin children. Table 4.10 gives the school wise comparison of prevalence of undernutrition and overnutrition. The prevalence of thinness ranged from 3.4% to 46.1%, for stunting it was from 4.1% to 32.5% and for underweight it was 3.4% to 36.0% respectively. The prevalence of undernutrition was on higher side in school where prevalence of overnutrition was less. Figure 4.5 depicts the prevalence of undernutrition and overnutrition. It is apparent that a double burden of undernutrition and overnutrition co-exists in the school children. This stresses the necessity for an appropriate school based intervention programme for health promotion of children and adolescents.

Overnutrition

In all, 10 schools from various zones in urban Vadodara were enrolled for the present study. Table 4.11 shows school wise prevalence of overweight and obesity. The prevalence of overweight ranged from 4.6% to 24.9% and that of obesity ranged from 0.6% to 5.3%. The lowest and highest prevalence of overweight was in school 9 and school 10 respectively while that of obesity was in school 4 and school 10 respectively.

Measurement of Agreement (Kappa Index) between Various Standards

It has been recommended that age and sex specific BMI cut off values should be used to classify children into cverweight/obese (WHO 1997). There are different classifications available to identify overweight and obese children at population level. Based on a study on a large sample size from six different western countries, Cole et al were the first authors to present BMI cut off values for children and adolescents related to adult BMI. These were later recommended by IOTF for meaningful comparison among different population.

Hence the comparison between Cole et al, CDC, and Must et al standards with Agrawal standards was carried out to measure the agreement using kappa index. The kappa index of measurement of agreement (KIA) measures the

TABLE 4.10

SCHOOL WISE PERCENT PREVALENCE OF UNDERNUTRITION AND OVERNUTRITION

School	N	Thinness[a]		Stunting[b]		Underweight[c]		Overweight[d]		Obese[e]	
		Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
School 1	1005	33.7	18.0	7.0	11.0	18.7	17.3	7.3	7.4	1.8	1.6
School 2	425	34.5	16.5	13.5	14.6	26.6	20.9	6.7	9.5	3.4	3.8
School 3	195	22.3	16.9	8.5	26.8	12.8	9.9	8.5	9.9	2.1	-
School 4	701	46.1	26.7	11.9	14.0	25.5	18.6	3.4	5.2	0.4	2.3
School 5	282	20.3	7.2	6.3	4.3	8.4	4.3	13.3	12.2	2.8	2.2
School 6	763	44.8	16.6	26.1	32.5	36.0	34.3	4.0	7.1	1.5	1.2
School 7	204	25.8	15.1	15.2	9.4	19.9	18.9	7.9	1.9	3.3	1.9
School 8	453	38.4	22.0	17.9	23.2	22.3	28.4	6.3	7.0	0.9	0.6
School 9	479	37.2	20.6	15.3	13.8	26.1	21.6	3.1	3.7	1.5	1.4
School 10	301	9.6	3.4	6.4	4.1	4.5	3.4	26.9	17.9	4.5	6.9
Total	4808	36.1	17.5	14.1	15.5	23.7	19.5	6.9	8.0	1.8	2.0

a – Thinness < 5th percentile BMI (Must et al)

b – Stunting NCHS ≤ 2 SD height for age

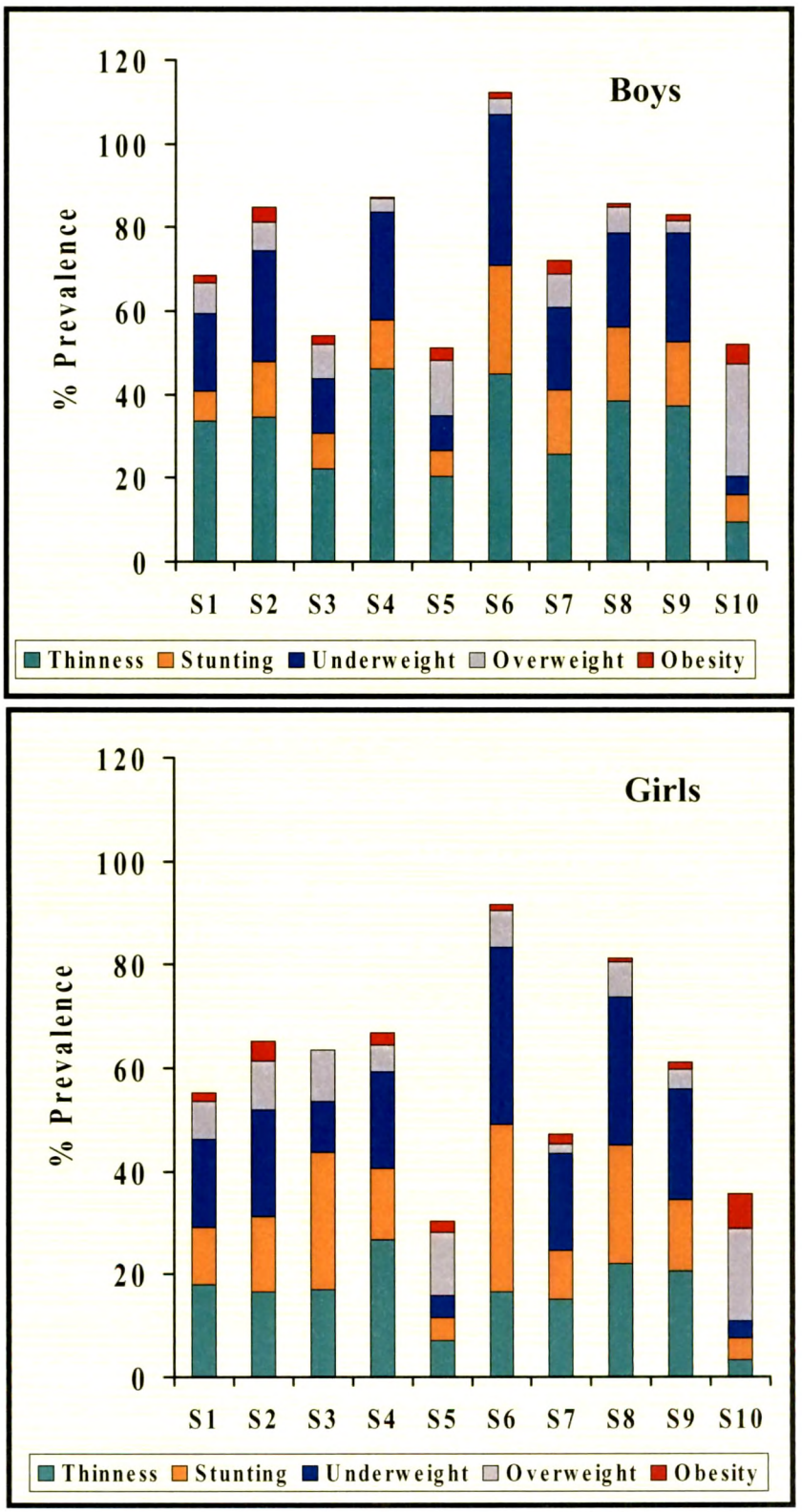
c – Underweight NCHS ≤ 2 SD weight for age

d – Overweight > 85th percentile BMI (Must et al)

e – Obesity > 95th percentile BMI (Must et al)

FIGURE 4.5

SCHOOL WISE PREVALENCE OF UNDERNUTRITION AND OVERNUTRITION



Thinness < 5th percentile BMI (Must et al)
Stunting NCHS ≤ 2 SD height for age
Underweight NCHS ≤ 2 SD weight for age
Overweight > 85th percentile BMI (Must et al)
Obesity > 95th percentile BMI (Must et al)

TABLE 4.11

SCHOOL WISE PERCENT PREVALENCE OF OVERWEIGHT AND OBESITY BY COLE et al STANDARDS

School	N	Overweight	Obesity	Overweight and Obesity
School 1	1005	9.1	1.0	10.1
School 2	425	8.7	3.1	11.8
School 3	195	9.1	1.2	10.3
School 4	701	5.0	0.6	5.6
School 5	282	13.1	1.4	14.5
School 6	763	5.0	1.3	6.3
School 7	204	9.3	2.5	11.8
School 8	453	7.1	0.7	7.8
School 9	479	4.6	1.3	5.9
School 10	301	**24.9**	**5.3**	**30.2**
Total	4808	8.4	1.5	9.9

concordance using 3 X 3 tables for two different classifications. A value of zero indicates no concordance while one indicates perfect concordance. The more the concordance, higher is the kappa value. The kappa values less than 0.40 indicates weak concordance, from 0.40 and 0.75 reasonable or good concordance and those higher than 0.75 excellent concordances.

For comparison for each child or adolescent two different nutritional classifications were made, one according to the cut off values based on western population (Cole et al, CDC and Must et al standards) and the other according to the cut off values based on Indian population (Agarwal standards). The comparisons were made using 3 X 3 tables. The children were classified into non overweight/obese, overweight and obese either by Cole et al/CDC/Must et al standards in columns and that of Agarwal standards in the rows. The kappa values for various standards are presented in Table 4.12.

It is apparent that the overall concordance between various standards was found to be good. When Cole et al and Agarwal standards were compared the kappa value of 0.768 suggested the excellent concordance between them. When examined separately for boys and girls the kappa value for girls was higher than that of boys (0.822 V/s 0.732). Although majority of the children (88%) were classified as non overweight/obese by both the methods, there were differences between methods in the number of children classified as overweight/obese. Ninety one children classified as overweight by Cole at al standards were considered as non overweight/obese by Agarwal standards. Sixty nine non overweight/obese children classified by Cole at al standards were considered as overweight by Agarwal standards (Table 4.13). The differences in the identification of children into categories of overweight and obese makes it necessary to determine the specific cut off limits linked with morbidity and mortality end points.

However the good concordance by kappa index between the values proposed by Cole et al and Agarwal standards for the nutritional classification of

TABLE 4.12

KAPPA INDEX VALUES FOR COMPARISON OF DIFFERENT STANDARDS

Comparison	Kappa Value	Concordance
Cole - Agarwal standard	0.768	Excellent
Must - Agarwal standard	0.745	Good
CDC - Agarwal standard	0.787	Excellent

TABLE 4.13

MEASUREMENT OF AGREEMENT BETWEEN COLE et al AND AGARWAL et al STANDARDS

Agarwal Standard	Cole et al Standard			
	Non Ow/Ob	Overweight	Obese	Total
Non Ow/Ob	4115	91	0	4206
Overweight	69	330	2	401
Obese	0	71	73	144
Total	4184 (88.1)	492 (10.4)	75 (1.6)	4751

Kappa value = 0.768

children from Vadodara, Gujarat supports use of both the standards. Therefore population studies of prevalence based on these references can be compared.

BMI Percentiles

Percentile tables/curves are used to monitor growth. The percentile refers to the position of an individual on a given reference distribution. Based on the data obtained different age and sex specific BMI percentiles are developed for 12-17 years at 6 months interval (Table 4.14). The sample size in the age group of 18 years was too less to develop the percentile values. Figure 4.6 shows the age and sex specific percentile curves for the age group of 12-17 years at 6 months interval.

Discussion

From the public health viewpoint, the prevalence of childhood obesity and its concomitant health risk is increasing all over the world particularly in the developing countries. In some countries, undernutrition predominates among children while in other countries obesity among children and adolescents is increasing. Studies on Indian school children have reported the increasing prevalence of overweight and obesity. However there is currently a lack of adequate baseline data on the extent of the problem of overnutrition in urban school children and adolescents in western part of India particularly in Gujarat. Hence a study was carried out to examine the emerging problem of overnutrition in school children aged 12-18 years to provide baseline information.

According to WHO (1995), the adolescents are persons aged 10-19 years. However the present study covered the children in the age group of 12-18 years as it focused on the secondary and higher secondary division children (8^{th}-12^{th} classes). The mean age of boys was 14.69 $\pm$ 1.46 years and 15.04 $\pm$ 1.48 years for the girls. The mean BMI was higher in girls (19.03 $\pm$ 3.65) than boys (18.01 $\pm$ 3.53). Simple measurements of height and weight serve as reliable measure to evaluate the growth of a child and also to detect gross abnormalities even when no other clinical sign of illness is manifested (Khadgawat et al 1998). The overall BMI observed in present study was compared with BMIs from other

TABLE 4.14

MEAN BMI AND PERCENTILE VALUES OF CHILDREN

(12-17 YEARS)

Boys

Age (y)	N	Mean	SD	5	10	25	50	75	85	90	95
12	97	15.75	2.93	12.07.	12.96	13.92	15.01	16.97	18.40	20.27	22.38
12.5	229	16.63	2.88	13.01	13.79	14.59	16.00	18.09	19.29	20.27	22.43
13	244	16.68	2.96	12.79.	13.51	14.57	16.20	18.36	19.56	20.64	22.19
13.5	298	17.50	3.01	13.79	14.42	15.43	16.88	18.97	20.14	21.37	24.11
14	269	17.24	3.33	13.39	14.00	15.24	16.61	18.59	19.74	20.83	23.14
14.5	300	17.80	3.39	13.79	14.52	15.62	16.93	19.17	20.77	23.01	24.26
15	315	18.40	3.57	14.69	15.05	15.82	17.42	19.82	21.86	23.72	25.93
15.5	334	18.32	3.26	14.50	14.88	16.14	17.74	19.83	21.61	23.05	25.24
16	292	19.23	3.84	14.57	15.24	16.450	18.07	21.30	23.88	24.89	26.85
16.5	279	19.40	3.93	14.88	15.62	16.59	18.19	21.46	23.84	24.91	27.02
17	119	19.60	3.63	15.00	15.41	17.31	19.05	21.22	22.58	24.39	27.76

Girls

Age (y)	N	Mean	SD	5	10	25	50	75	85	90	95
12	35	16.27	2.62	12.60	13.24	14.88	15.68	17.01	18.40	19.88	22.81
12.5	125	17.38	2.97	13.32	14.06	15.35	16.67	19.04	20.24	21.33	23.31
13	125	18.04	3.18	13.96	14.27	15.81	17.48	19.48	21.33	23.14	24.97
13.5	151	18.17	3.29	13.79	14.41	15.82	17.31	20.09	21.77	23.43	24.56
14	160	18.48	3.28	14.32	14.99	16.00	18.01	20.57	22.21	22.94	23.57
14.5	172	19.25	3.93	14.18	15.16	16.54	18.40	21.12	23.24	24.44	27.11
15	215	19.15	3.48	14.72	15.61	16.44	18.55	21.08	22.89	24.22	26.22
15.5	245	19.40	3.88	14.61	15.18	16.66	18.55	21.33	22.77	24.30	26.94
16	216	19.81	3.72	15.43	15.82	17.32	18.92	21.22	24.17	25.56	27.64
16.5	245	19.67	3.55	15.24	16.01	17.34	18.99	21.09	23.07	24.89	27.05
17	115	19.95	3.49	15.27	15.99	17.15	19.50	21.84	23.60	25.24	27.03

FIGURE 4.6

PERCENTILE CURVES OF BOYS AGED 12-17 YEARS

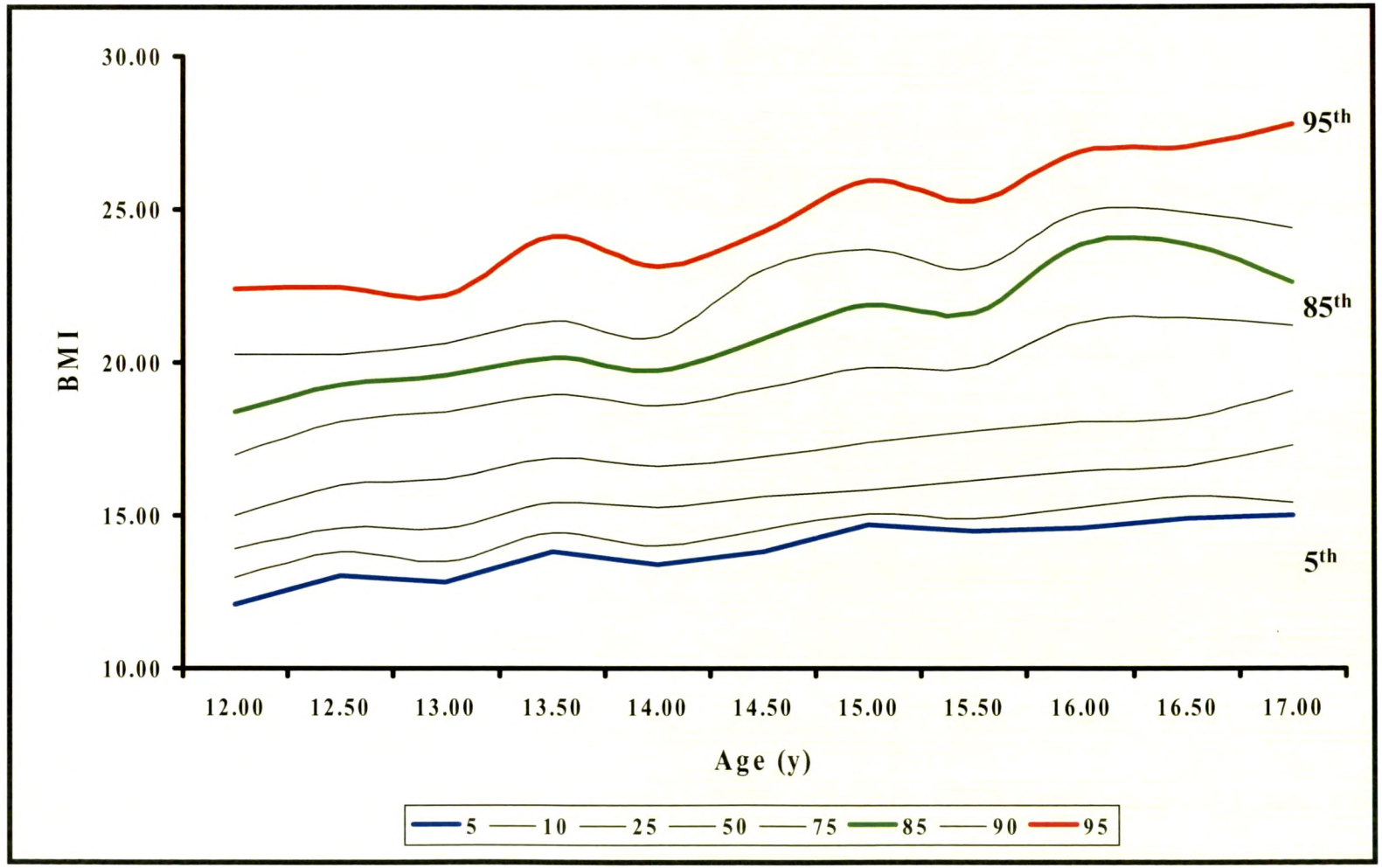
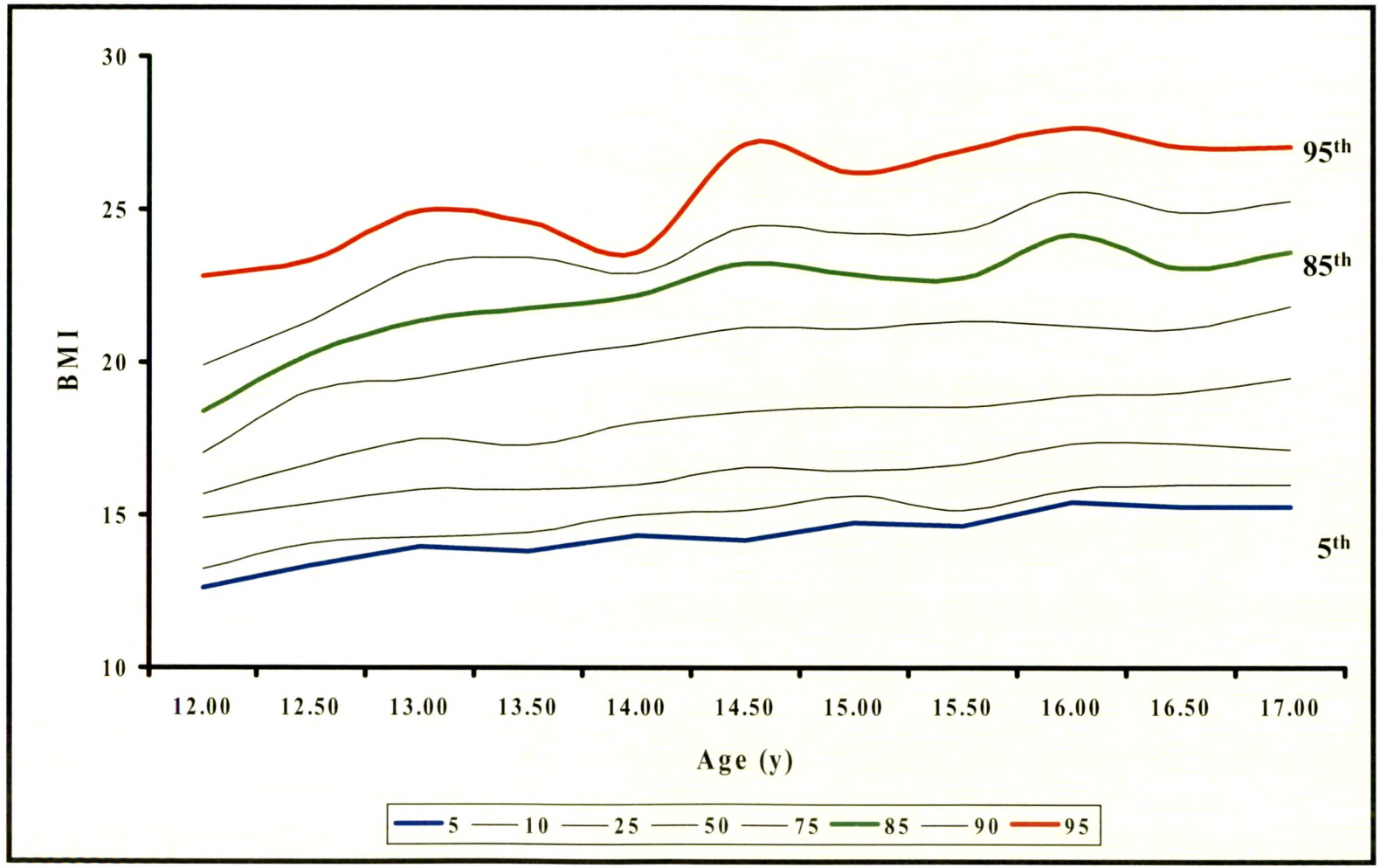


FIGURE 4.6

PERCENTILE CURVES OF GIRLS AGED 12-17 YEARS



countries (Table 4.15). As is evident from the table, the mean BMI of both boys and girls of the present study are higher than other countries except US. This indicates the emerging problem of overnutrition in school children of urban Vadodara.

The magnitude of the problem of overweight and obesity in urban school children of Vadodara was assessed using various BMI for age standards. The overall prevalence of overweight ranged from 7.1% to 10.4% and that of obesity from 1.5% to 3.0% by different standards. It revealed that prevalence of overweight and obesity was found to be highest when assessed by Agarwal standards, which are based on Indian affluent school children. It is apparent that each of these reference standards varies in its assessment. This emphasizes the need for a suitable indicator with acceptable cut off points for the evaluation of nutritional status among children and adolescents.

In the present study, the children were classified into non overweight/obese, overweight and obese categories based on Cole et al standards for risk analysis. Based on Cole et al standards the overall prevalence of overweight and obesity was 8.4% and 1.5% respectively. The prevalence of overweight and obesity based on Cole et al standards from other departmental studies are compared with the present study (Figure 4.7). The prevalence of overweight and obesity was found to be higher in 6-12 years age group than 12-18 years age group. This increasing trend of overweight and obesity in young children is a matter of concern and calls for an effective and sustainable school based health promotion programme to reverse the trend.

One of the biological risk factor is age. It is reported that overweight and obesity is increasing in all ages. The present study also supports this observation. Various studies have documented that females have higher risk of becoming overweight/obese. Present findings also show that overweight and obesity was more common in girls than boys.

India being a developing country in socio-economic transition, double burden of undernutrition as well as overnutrition is present in children and

TABLE 4.15

COMPARISON OF BMI

PRESENT Vs OTHER STUDIES

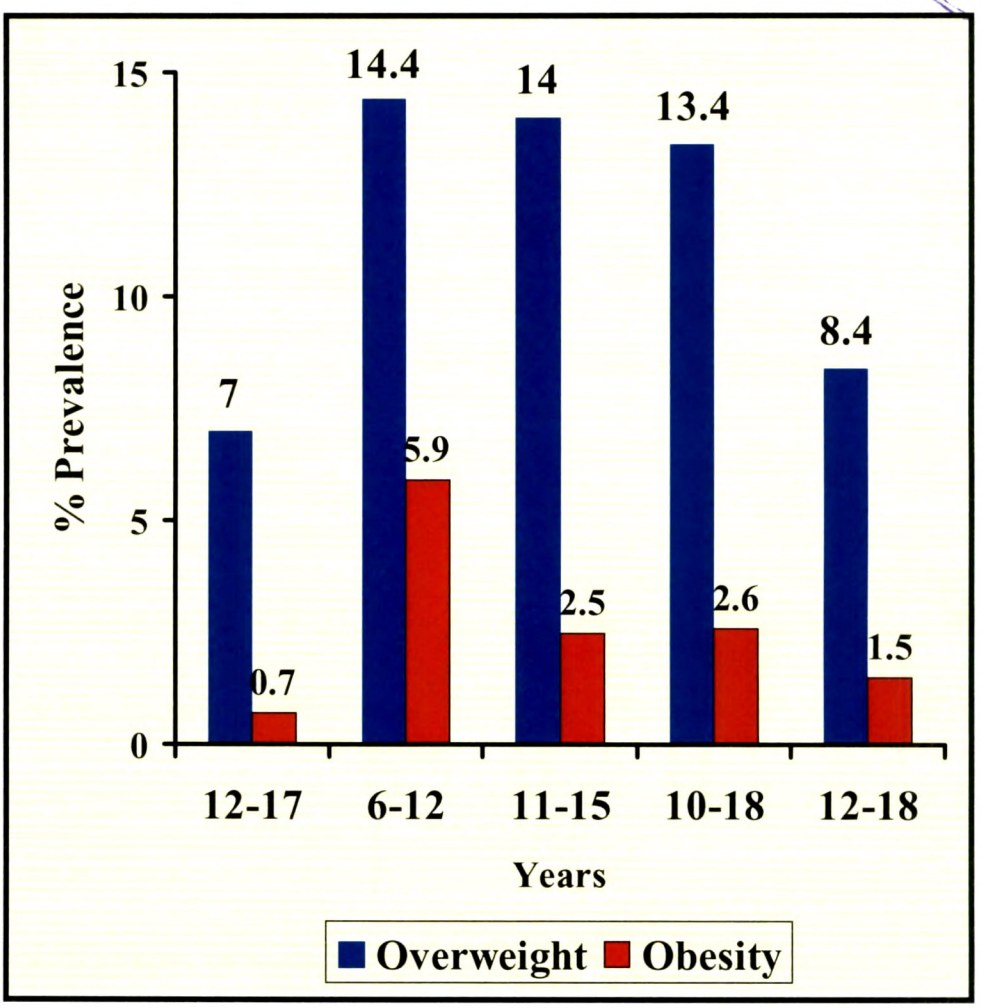
Country	Boys			Girls		
	Mean Age (y)	Mean BMI	Sample Size	Mean Age (y)	Mean BMI	Sample Size
Singapore	13.7	16.5	1606	13.9	17.2	1499
Thailand	13.4	16.6	1377	13.5	17.6	1394
Somalia	14.3	16.6	389	14.2	18.3	304
US	14.5	20.6	1506	14.5	20.8	1381
India						
Surat	12.1	14.4	1092	11.8	15.4	1158
Vadodara*	14.7	18.0	2868	15.0	19.0	1910

Source : Thakor et al 2000, Municipal schools

* Present study

FIGURE 4.7

PREVALENCE OF OVERWEIGHT AND OBESITY IN CHILDREN : DEPARTMENTAL STUDIES



Source :

12-17 y - Parikh 2002

6-12 y - Akolkar 2003

11-15 y - Venugopal 2004

10-18 y - Mani et al 2004

12-18 y – Present study

adolescents. The present study analysed the data for co-existence of undernutrition and overnutrition. The overall prevalence of underweight as assessed by NCHS $\leq$ 2 SD weight for age ranged from 3.4% to 36.0% in different schools. The prevalence of thinness, stunting and underweight was found in sizeable number of school children. This finding has important programmatic implications. Nutrition intervention to remedy the rate of undernutrition and at the same time nutrition education and promotion of physical activities to prevent increasing obesity are apparently called for.

A specific definition of childhood obesity is still not available and there are various methodological issues in the assessment of overweight or obese status in children. Different classifications are available to identify overweight and obese children at population level. For meaningful comparison of prevalence data, measurement of agreement between various standards was carried out using kappa index of agreement. It suggested the good concordance between various standards. Hence population studies of prevalence based on these references can be compared.

The overweight and obesity rates are influenced by the reference and the type of indicator used. WHO (1997) has pointed out that though BMI has often been used in nutritional assessment there is still no consensus about cut off points to classify children as overweight/obese. Several researchers have developed various BMI percentiles over the years. Rosner et al (1998) have documented significant ethnic variation in BMI. Agarwal et al (2003) have reported that ethnic group specific standards are more appropriate for comparing health compromised children, in a country like India where the problem is more pronounced for undernutrition than overnutrition. Also heterogenicity of the Indian population and regional differences in growth calls for the development of population specific growth standards for school children. Till today, age and sex specific BMI standards on acceptable number of subjects for this region are not available.

In view of this, the present study made an attempt to develop various BMI percentiles. The percentiles developed by Agarwal et al (2003) for affluent Indian

school children are higher for 5th to 95th percentiles as compared to the percentiles based on this study. Hence it is necessary to establish reference standards for BMI for identifying school children at health risk.

Highlights

- The prevalence of overweight is increasing at an alarming rate in school children of urban Vadodara.
- The prevalence of overweight and obesity was 8.4% and 1.5% respectively based on Cole et al standards.
- The prevalence of overweight and obesity was 7.1% and 2.4% respectively by CDC standards.
- When the population specific Agarwal standards were applied to classify children, the prevalence was 10.4% and 3% respectively.
- The burden of undernutrition and overnutrition co-exists in urban school children of Vadodara.
- The overall concordance between various standards was found to be good. However, the concordance between the values proposed by Cole et al and Agarwal standards for the nutritional classification of children from Vadodara, Gujarat by kappa index supports the use of both the standards.
- Various age and sex specific BMI percentiles were developed as a reference for growth standard for school children of urban Vadodara.

SECTION III

Influence of Risk Factors

The prevalence of overweight and obesity was looked in relation to per capita income level, heredity, type of diet, the school meal programme, and life style related factors such as mode of transport used, physical activity pattern and TV/video viewing and use of computer.

Per capita income level

Table 4.16 shows prevalence of overweight and obesity in relation to per capita income. The prevalence of overweight was found to increase two fold and obesity nearly three fold with the increase in per capita income. The difference was much significant ($p < 0.1$) in the younger age group compared to older age group.

Heredity

It is a well established fact that heredity is one of the key risk factors for developing overweight/obesity in children. Table 4.17 shows the prevalence of overweight and obesity in relation to family history of obesity. Nearly 20% of the children reported family history of obesity. The prevalence of overweight and obesity together in children was found to be 40.5% when only the mothers were overweight/obese, 23.8% when only the fathers were overweight/obese and 37.8% when both the parents were overweight/obese. Based on these observations the relative risk of a child being overweight/obese was 2.90 when either parent had history of overweight/obesity and 13.82 when both the parents had history of overweight/obesity. Thus heredity was found to be the most profound risk factor.

Type of diet

Table 4.18 shows the prevalence of overweight and obesity in relation to type of diet. Among the children who were vegetarian 91.4% were non overweight/obese, 7.5% overweight and 1.1% obese whereas in case of children who were non/ovo vegetarian, 88.3% children were non overweight/obese, 9.6% overweight and 2.1% obese. The prevalence of overweight and obesity was

TABLE 4.16

PER CAPITA INCOME AND

PREVALENCE OF OVERWEIGHT AND OBESITY

Per Capita Income (Rs.)	Non Ow/Ob	Overweight	Obesity	χ^2
12-15 years				
N	3023	247	44	
< 2000	1721 (56.9)	81 (32.8)	12 (27.3)	67.269***
≥ 2000	1302 (43.1)	166 (67.2)	32 (72.7)	
16-18 years				
N	1281	154	29	
< 2000	597 (46.4)	45 (29.2)	6 (20.7)	23.502***
≥ 2000	684 (53.4)	109 (70.8)	23 (79.3)	

*** $p < 0.0001$ Values in parenthesis indicate percentage

TABLE 4.17

HEREDITY AND PREVALENCE OF OVERWEIGHT AND OBESITY

Family History of Ow/Ob	N	Non Ow/Ob	Overweight	Obesity	Ow/Ob
Father	390	326 (7.6)	57 (14.2)	7 (9.6)	64 (23.8)
Mother	367	263 (6.1)	91 (22.7)	13 (17.8)	104 (40.5)
Both the parents	93	44 (1.0)	27 (6.7)	22 (30.1)	49 (37.8)
Siblings	38	29 (0.7)	5 (1.2)	4 (5.5)	9 (6.7)
None	3890	3642 (84.6)	221 (55.1)	27 (37.0)	474 (92.1)

Values in parenthesis indicate percentage

Relative Risk 2.90 - Either parent overweight/obese χ^2 value=604.532***

13.82 - Both parents overweight/obese $p < 0.0001$

TABLE 4.18

TYPE OF DIET AND PREVALENCE OF OVERWEIGHT AND OBESITY

Category	Type of Diet	
	Vegetarian	Non/Ovo Vegetarian
N	2839	1939
Non Overweight/Obese	2592 (91.4)	1712 (88.3)
Overweight	215 (7.5)	186 (9.6)
Obese	32 (1.1)	41 (2.1)

Values in parenthesis indicate percentage

higher in children consuming non/ovo vegetarian diet than those consuming vegetarian diet. The Chi square values were found to be non significant for association between type of diet and prevalence rates. Thus it can be concluded that the type of diet did not significantly affect the prevalence of overweight and obesity in children.

The school meal programme

Out of the selected 10 schools for survey, two schools had school meal programme for the children. Table 4.19 shows the prevalence of overweight and obesity in relation to school meal programme. The prevalence of overweight/obesity was almost three fold in children with school meal programme compared to children without school meal programme (Figure 4.8). The Chi square value was 120, which was significant ($p < 0.0001$). The school authorities should ensure providing nutritious supplementary food to inculcate healthy eating practices among children.

Life style related factors

Sedentary life style is one of the major determinants in developing overweight/obesity in children and adolescents. Development of overweight/obesity in early childhood can be attributed to factors such as low physical activity during school years, more TV viewing, excessive playing of video/computer games etc. Hence in the present study the mode of transport, physical activity pattern and TV viewing were looked in relation to the prevalence of overweight/obesity.

The mode of transport to school

Table 4.20 shows the prevalence of overweight and obesity in relation to mode of transport used by school children. Almost 50% overweight and obese children were using their two wheelers for commuting to school compared to 21.7% non overweight/obese children.

Physical activity pattern

Table 4.21 shows the prevalence of overweight and obesity in relation to physical activity pattern of the children. The overweight/obese children were less involved in physical activities that promote healthy life style like brisk walking, jogging, cycling, outdoor games, pulls ups and yoga/karate than non overweight/obese children. Also various physical activities carried out daily by

TABLE 4.19

SCHOOL MEAL PROGRAMME AND PREVALENCE OF OVERWEIGHT AND OBESITY

Category	With School Meal Programme	Without School Meal Programme
N	583	4195
Non overweight/Obese	451 (77.4)	3853 (91.8)
Overweight	112 (19.2)	289 (6.9)
Obese	20 (3.4)	53 (1.3)

Values in parenthesis indicate percentage

χ^2 value = 120.262***

$p < 0.0001$

FIGURE 4.8

SCHOOL MEAL PROGRAMME AND PREVALENCE OF OVERWEIGHT AND OBESITY IN CHILDREN

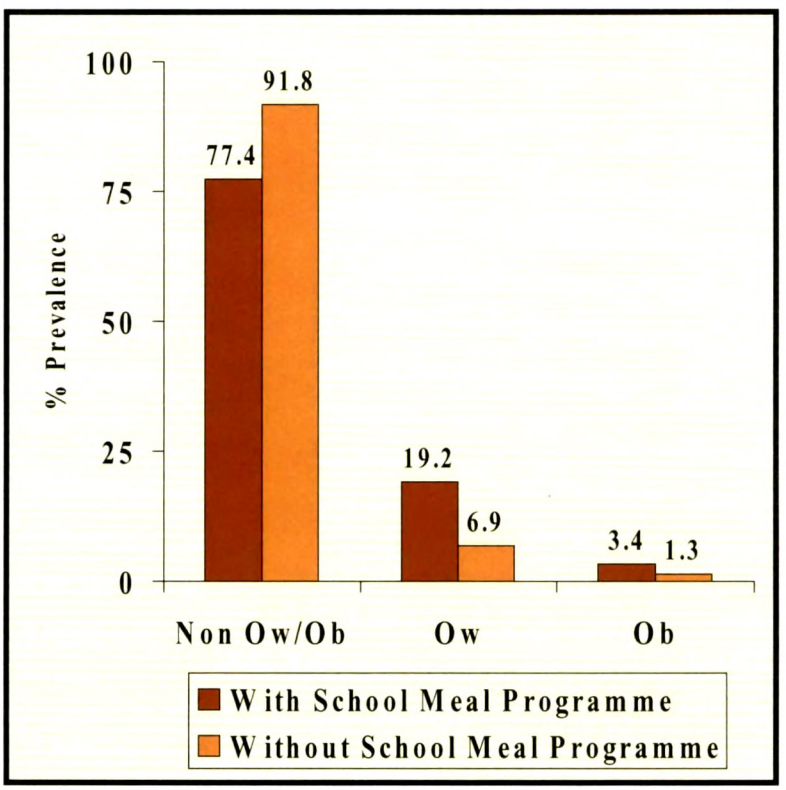


TABLE 4.20

MODE OF TRANSPORT TO SCHOOL AND PREVALENCE OF OVERWEIGHT AND OBESITY IN CHILDREN

Mode of Transport	Non Ow/Ob	Overweight	Obese
N	4304	401	73
Auto rickshaw	267 (6.2)	33 (8.2)	6 (8.2)
Bus	556 (12.9)	66 (16.5)	8 (11.0)
Cycle	2228 (51.8)	101 (25.2)	22 (30.1)
Two wheeler	933 (21.7)	195 (48.6)	37 (50.7)
Others (walking)	320 (7.4)	6 (1.5)	-

Values in parenthesis indicate percentage

TABLE 4.21

PHYSICAL ACTIVITY AND PREVALENCE OF OVERWEIGHT AND OBESITY IN CHILDREN

Physical Activity	N	Non Ow/Ob	Overweight	Obese
Brisk walking	2225	2055 (92.4)	145 (6.5)	25 (1.1)
Jogging	1543	1446 (93.7)	83 (5.4)	14 (0.9)
Cycling	3888	3596 (92.5)	250 (6.4)	42 (1.1)
Cricket etc.	2833	2584 (91.2)	217 (7.7)	32 (1.1)
Pull-ups	978	921 (94.2)	48 (4.9)	9 (0.9)
Yoga/Karate	353	333 (94.3)	17 (4.8)	3 (0.8)

Values in parenthesis indicate percentage

children are shown in Table 4.22. It was found that higher percentage of non overweight/obese boys were engaged in one or the other physical activity on daily basis, with cycling being the predominant one. The comparison between boys and girls showed that nearly 50% of overweight girls were going for brisk walk daily as compared to boys. Boys played outdoor games and did pulls ups whereas girls were engaged in yoga/karate. Very few obese children were involved in daily physical activities.

TV/video viewing and use of computer

Table 4.23 shows the prevalence of overweight and obesity in relation to TV/Video viewing and use of computer. Obese children used to spend much higher time on TV/video viewing and computer per week as compared to non overweight/obese children. Higher percentage of obese children were engaged in TV/video viewing and computer daily as compared to non overweight/obese children (Figure 4.9). Thus it can be concluded that habit of TV/video viewing and use of computer, which enhances sedentary life style, could contribute to overweight and obesity.

Nutrient Intake

Table 4.24 gives the nutrient intake of the children based on 24-hour dietary recall method. The mean calorie intake and carbohydrate intake was significantly higher in case of overweight and obese children as compared to the non overweight/obese children. The mean intake of fat ranged from 73 g to 104 g with increase in the gradation of obesity and was significantly higher for overweight and obese children. The intake of beta carotene varied widely amongst the children. The intake of vitamin C was more than the recommended allowance among all the children. Figure 4.10 shows the percent calorie contributed by the proximate principles. Carbohydrates contributed 47.1%, protein 10.3% and fat 36.1% of the total calories. The energy intake was highly correlated with the fat intake (r=0.77) and also with the type of fat (saturated fat r=0.46). The percent calories contributed from carbohydrate and protein was comparable within the groups. Figure 4.11 shows contribution of fat to the total calories in younger and older age groups. The percentage of overweight and obese children in both younger as well as older age groups with $\geq$ 30% calories

TABLE 4.22

PHYSICAL ACTIVITIES CARRIED OUT BY CHILDREN ON DAILY BASIS

Physical Activity	% of Children					
	Non Ow/Ob		Overweight		Obese	
	Boys	Girls	Boys	Girls	Boys	Girls
Brisk walking	30.3	27.9	1.7	1.0	0.3	0.3
Jogging	12.6	11.0	0.5	0.4	-	-
Cycling	67.8	56.4	2.8	3.1	0.6	0.5
Cricket	26.5	3.6	0.8	-	0.1	-
Pull-ups	16.9	1.8	0.5	0.2	0.1	0.1
Yoga/Karate	4.0	6.5	0.1	0.5	-	-

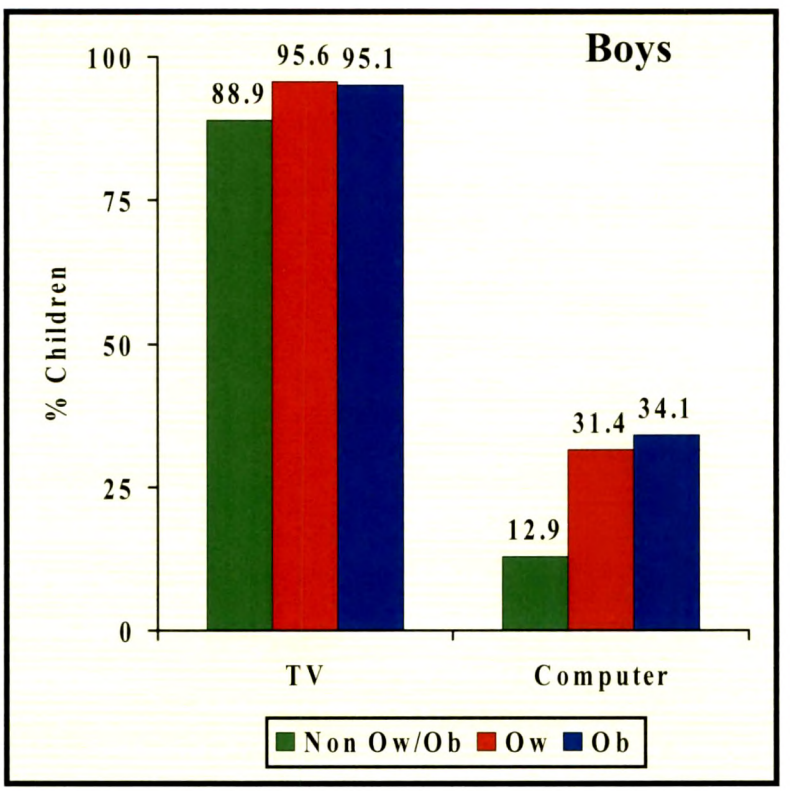
TABLE 4.23

AVERAGE TIME SPENT ON TV, VIDEO AND COMPUTER/WEEK (MEAN ± SD, MINUTES)

Variable	Non Ow/Ob	Overweight	Obese
N	4304	401	73
TV viewing	65 ± 34	83 ± 40	89 ± 41
Video	3 ± 18	4 ± 19	0.4 ± 3.5
Use of computer	17 ± 21	23 ± 26	30 ± 26
TV + Video + Computer	86 ± 48	112 ± 56	120 ± 47

FIGURE 4.9

DAILY USE OF TV/COMPUTER BY CHILDREN



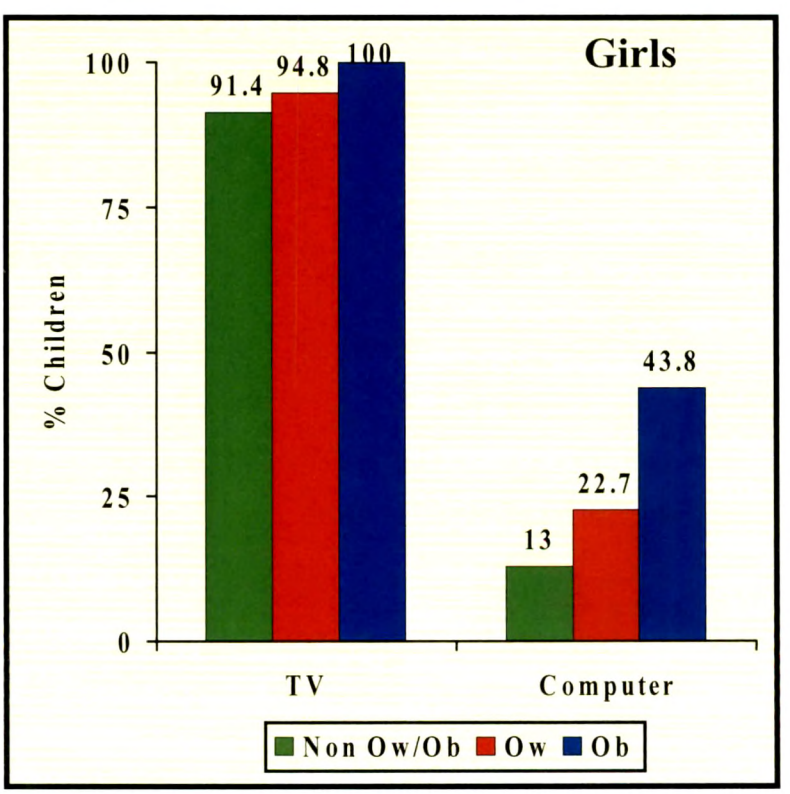


TABLE 4.24

MEAN NUTRIENT INTAKE OF THE CHILDREN

Nutrient	Non Ow/Ob	Overweight	Obese	Total	' F' Value
Calories (kcal)	1967 ± 439	2325 ± 458	2521 ± 607	2251 ± 520	18.53***
Protein (g)	58.3 ± 17.7	55.7 ± 15.0	61 ± 19.6	57.5 ± 16.8	1.56
Carbohydrate (g)	249.7 ± 72.1	256.9 ± 67.8	306.9 ± 110.4	263.6 ± 80.4	7.26**
Total fat (g)	73.S ± 21.9	95.5 ± 26.2	103.9 ± 27.0	90.3 ± 27.5	22.32***
Saturated fat (g)	7.9 ± 11.6	21.6 ± 15.3	26.2 ± 18.2	18.3 ± 16.4	22.85***
Unsaturated fat (g)	33.0 ± 18.2	39.5 ± 21.1	41.0 ± 22.3	37.8 ± 20.6	2.62
Invisible fat (g)	28.4 ± 14.3	34.2 ± 14.9	34.1 ± 14.7	32.3 ± 14.8	3.48*
Crude fibre (g)	8.1 ± 10.3	6.3 ± 7.0	6.5 ± 3.3	6.9 ± 7.7	1.06
Vitamin C (g)	73.7 ± 59.1 (6.8-300)	81.1 ± 75.1 (7.4-402.3)	67.6 ± 49.9 (11.9-228.1)	76.5 ± 66.5 (6.8-402.3)	0.65
Beta carotene (μg)	1490 ± 1878 (136.9-14552)	2207 ± 2550 (94.3-14822)	1675 ± 1661 (239.5-9654)	1895 ± 2238 (94.3-14822)	2.35

*** $p < 0.0001$

** $p < 0.001$

* $p < 0.05$

Correlation between energy intake and fat intake r = 0.769**

Correlation between energy intake and saturated fat intake r = 0.405**

FIGURE 4.10

PERCENT CALORIES FROM PROXIMATE PRINCIPLES

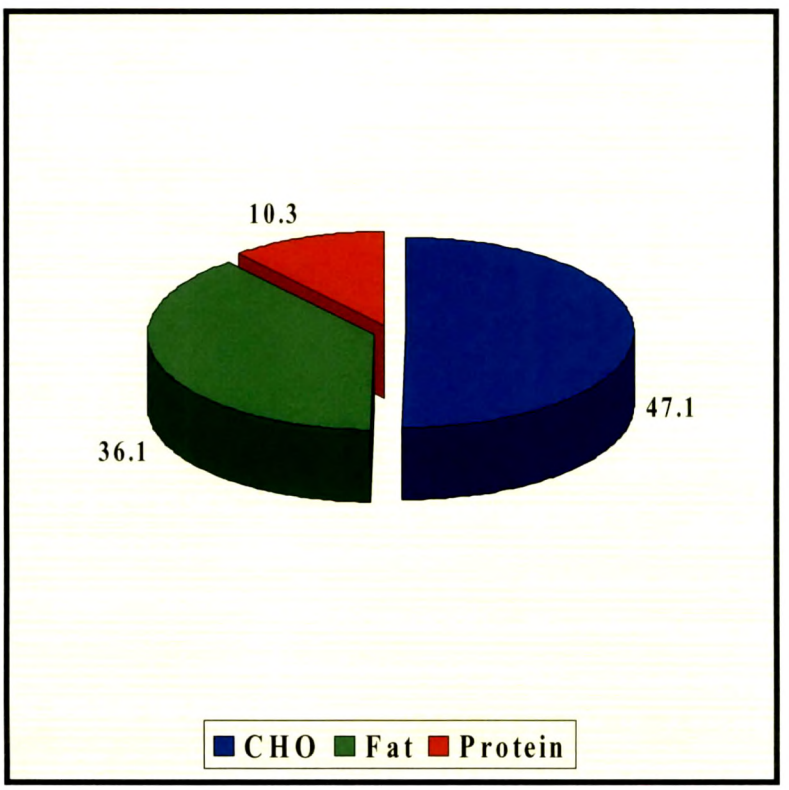
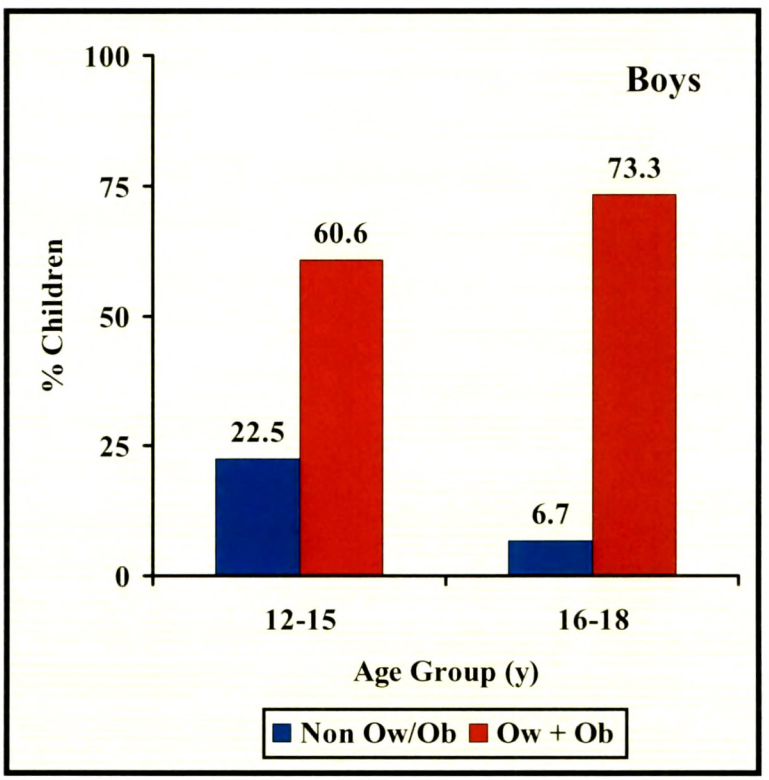
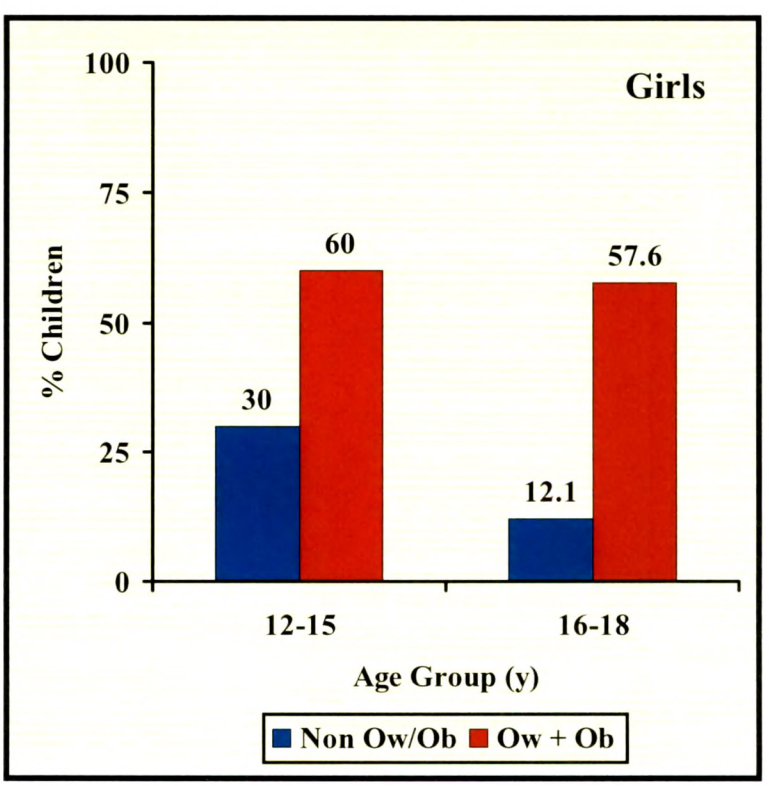


FIGURE 4.11

CONTRIBUTION OF ≥ 30% CALORIES FROM FAT IN CHILDREN





from fat ranged from 57.6%-73.3%, where as it ranged from 6.7%-30.0% for non overweight/obese children. A total of 83.5% of overweight and obese children had energy intake > 100% RDA (Table 4.25). The percentage of overweight children whose energy intake was > 100% RDA were more than non overweight/obese children (Table 4.26). Also percentage of these children increased with the increase in the age from 12-17 years except at the age of 14 years. The highest percentage of the overweight children with energy intake > 100% RDA was at 17 years of age and was 77.8% (Figure 4.12).

Energy Intake and Energy Expenditure

The energy expenditure of the children was calculated using equation for predicting BMR (kcal/24 hr) proposed by FAO/WHO/UNO (1985). The mean energy intake and energy expenditure values obtained for the children are given in Table 4.27. Figure 4.13 shows the energy intake V/s energy expenditure for boys and girls. The energy expenditure of the overweight and obese boys was found to be significantly lower as compared to their energy intake. The correlation between energy intake and expenditure for boys was $r=0.26$ ($p < 0.01$). When energy intake and energy expenditure per kg body weight were analysed for children in relation to gradation of obesity, it was found that the mean energy intake and energy expenditure per kg body weight was equal in case of non overweight/obese children while it was much higher in overweight and obese children than non overweight/obese children (Figure 4.14). Excess energy intake and less energy expenditure in children play a vital role in the development of overweight and obesity. Figure 4.15 depicts the percent prevalence of overweight and obesity in relation to the dietary risk factors associated with it. All the risk factors were dominant in the overweight and obese children.

Fasting Blood Sugar and Lipid Profile

The fasting blood sugar and lipid profile values for the children is given in Table 4.28.

TABLE 4.25

ENERGY INTAKE AS % RDA AND GRADATION OF OBESITY

Energy Intake as % RDA	Non Ow/Ob	Overweight	Obese
N	65	111	38
>100%	16 (16.5)	56 (57.7)	25 (25.8)
91-100%	11 (24.4)	26 (57.8)	8 (17.8)
80-90	17 (47.2)	17 (47.2)	2 (5.6)
< 80 %	21 (58.3)	12 (33.3)	3 (8.4)

Values in parenthesis indicate percentage

TABLE 4.26

ENERGY INTAKE > 100 % OF RDA IN RELATION TO AGE

Age (y)	% Children		
	Non Ow/Ob	Overweight	Obese
12	25.0	50.0	25.0
13	25.0	58.3	16.6
14	35.3	41.2	23.5
15	11.4	60.0	28.6
16	5.0	60.0	35.0
17	11.1	77.8	11.1

FIGURE 4.12

ENERGY INTAKE > 100% OF RDA IN RELATION TO AGE

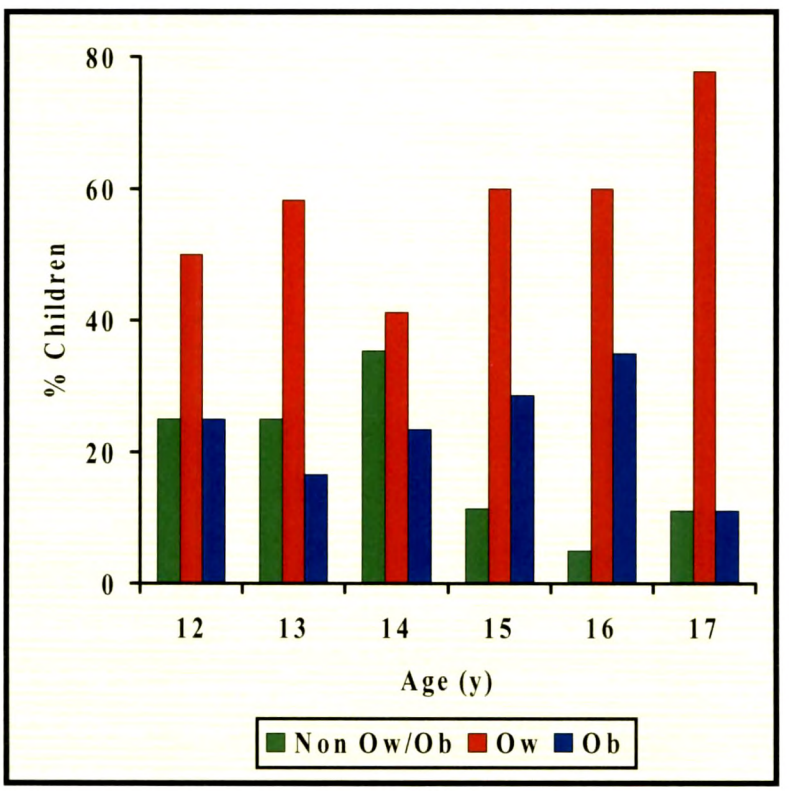


TABLE 4.27

ENERGY EXPENDITURE AND ENERGY INTAKE OF CHILDREN

Variable	Non Ow/Ob	Overweight	Obese	Total
Energy expenditure				
Boys	2213 ± 245	2239 ± 221	2053 ± 357	2200 ± 261
Girls	1793 ± 173	1789 ± 178	1738 ± 181	1781 ± 176
Total	1980 ± 295	2012 ± 301	1879 ± 313	1979 ± 304
Energy intake				
Boys	2102 ± 375	2474 ± 382	2624 ± 790	2392 ± 505
Girls	1857 ± 461	2177 ± 481	2436 ± 405	2123 ± 502
Total	1966 ± 439	2324 ± 457	2520 ± 607	2250 ± 520

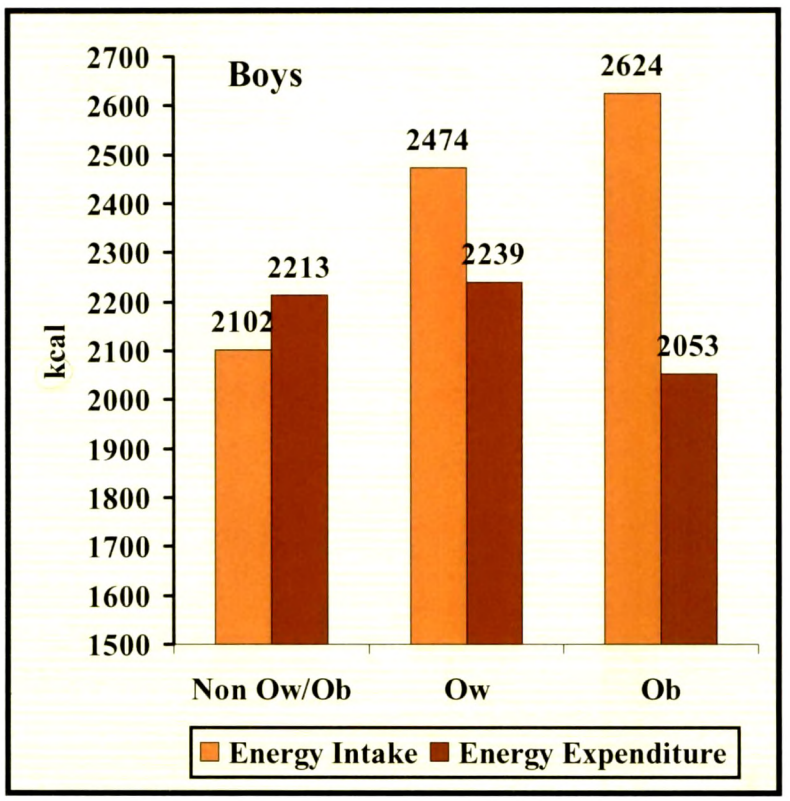
r = 0.2568* for boys

r = 0.0018 for girls

r = 0.2786** for total

FIGURE 4.13

ENERGY INTAKE AND ENERGY EXPENDITURE IN CHILDREN



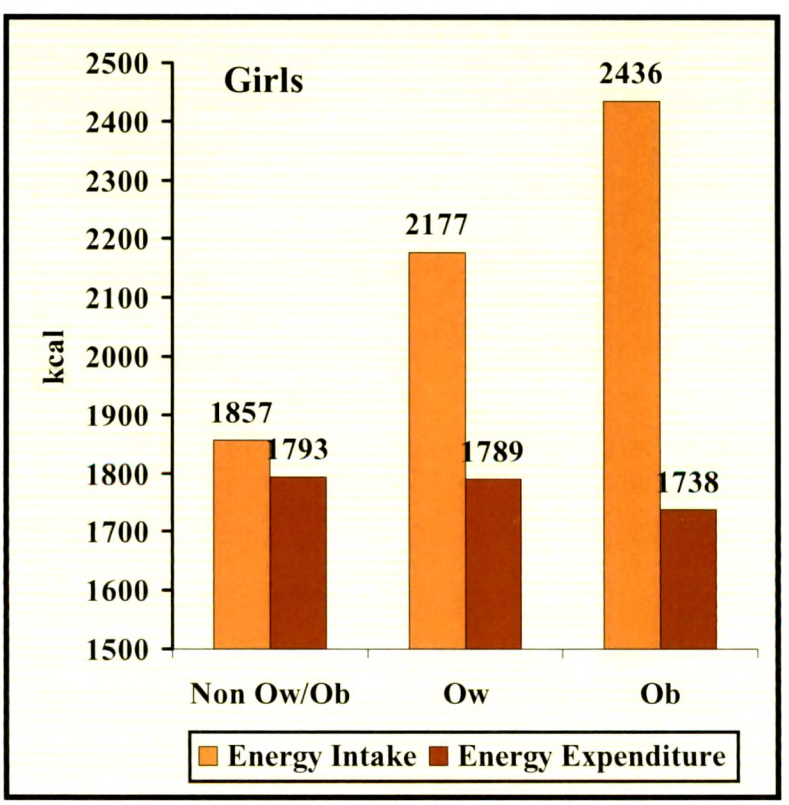


FIGURE 4.14

ENERGY INTAKE AND ENERGY EXPENDITURE PER KG BODY WEIGHT OF CHILDREN

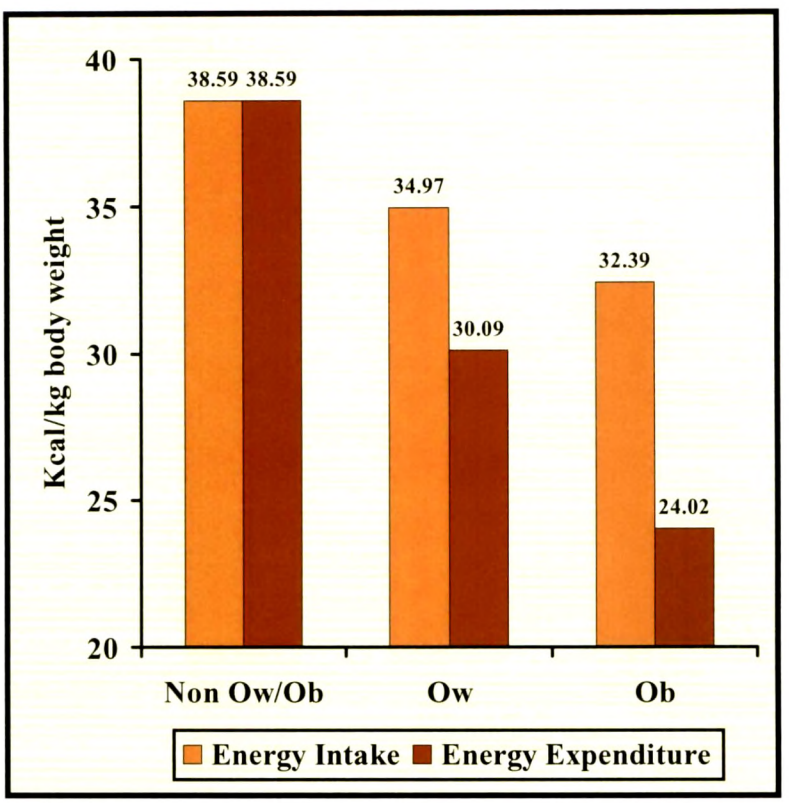


FIGURE 4.15

PRESENCE OF DIETARY RISK FACTORS IN CHILDREN

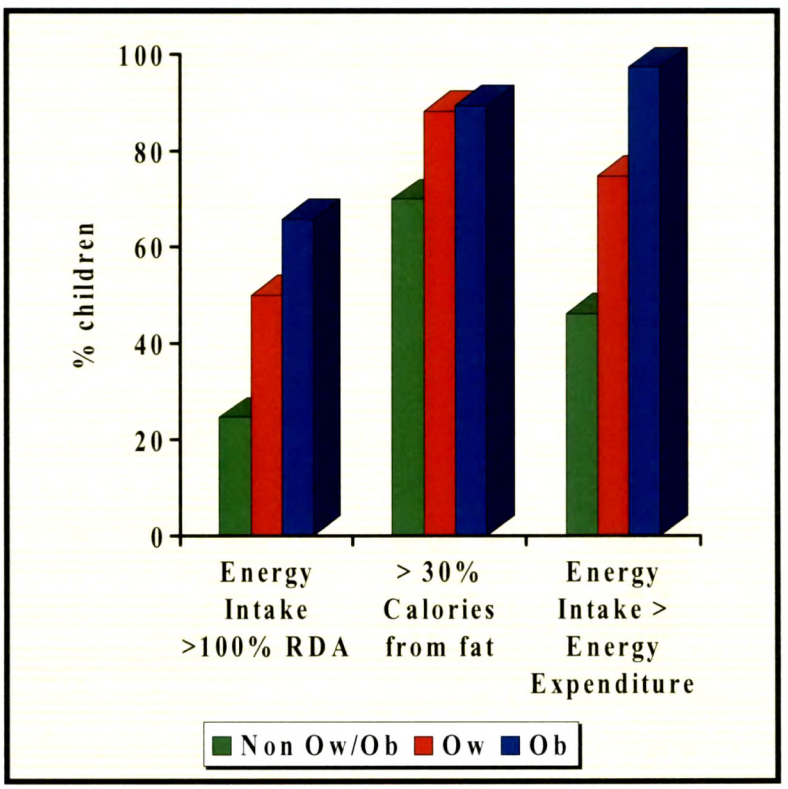


TABLE 4.28

FASTING BLOOD SUGAR AND LIPID PROFILE

Boys

Parameter	Non Ow/Ob	Overweight	Obese	Total	'F' Value
N	29	49	17	95	
FBS	79.58 ± 11.39	83.20 ± 9.71	84.01 ± 11.74	82.24 ± 10.65	1.35
TC	158.04 ± 31.10	166.34 ± 24.80	172.45 ± 28.46	164.90 ± 27.67	1.61
HDL-C	46.45 ± 9.33	44.80 ± 9.30	40.28 ± 5.03	44.50 ± 8.86	2.61
LDL-C	86.20 ± 31.80	89.22 ± 20.82	101.85 ± 24.42	89.80 ± 25.92	2.58
VLDL-C	27.85 ± 5.60	31.39 ± 6.31	31.00 ± 5.73	30.24 ± 6.15	3.32*
Non HDL-C	111.52 ± 32.42	119.77 ± 21.68	132.32 ± 27.72	119.42 ± 27.29	3.11*
TG	139.27 ± 27.99	156.93 ± 31.55	154.98 ± 28.66	151.19 ± 30.74	3.32*

Girls

Parameter	Non Ow/Ob	Overweight	Obese	Total	'F' Value
N	36	48	18	102	
FBS	78.98 ± 9.31	82.96 ± 15.60	82.72 ± 12.29	81.51 ± 13.12	1.04
TC	160.66 ± 23.36	164.29 ± 28.25	172.34 ± 31.72	164.43 ± 27.32	1.10
HDL-C	47.32 ± 12.61	44.79 ± 9.03	47.74 ± 13.14	46.14 ± 11.03	0.68
LDL-C	85.09 ± 21.60	90.44 ± 27.03	92.53 ± 31.88	89.02 ± 26.15	0.56
VLDL-C	28.09 ± 4.96	30.04 ± 5.25	31.32 ± 5.23	29.58 ± 5.24	2.72
Non HDL-C	112.96 ± 23.45	120.70 ± 28.34	123.84 ± 34.97	118.66 ± 28.09	1.04
TG	140.47 ± 24.82	150.22 ± 26.27	156.60 ± 26.17	147.90 ± 26.19	2.73

*$p < 0.05$

Fasting blood sugar

The mean FBS values of all the children were within the normal range indicating normal glucose metabolism.

Lipid profile

Boys

The TC values were higher in overweight and obese boys compared to non overweight/obese boys. The HDL-C values decreased with the increase in the gradation of obesity. The negative correlation between HDL-C values and BMI was found to be r=0.29 ($p < 0.01$). The values for VLDL-C, non HDL-C and TG coupled with lower HDL-C were significantly higher in overweight and obese boys compared to non overweight/obese boys. The correlation between BMI and VLDL-C, LDL-C, Non HDL-C and TG was 0.26 ($p < 0.1$), 0.23 ($p < 0.05$), 0.27 ($p < 0.01$) and 0.26 ($p < 0.01$) respectively. There was a significant increase in the atherogenic indices represented by TC/HDL-C, TC/LDL-C and LDL-C/HDL-C in overweight and obese boys (Figure 4.16).

Girls

The TC and TG values were higher in obese girls compared to non overweight/obese girls. The atherogenic indices represented by TC/HDL-C, TC/LDL-C and LDL-C/HDL-C were within the normal range for all the girls.

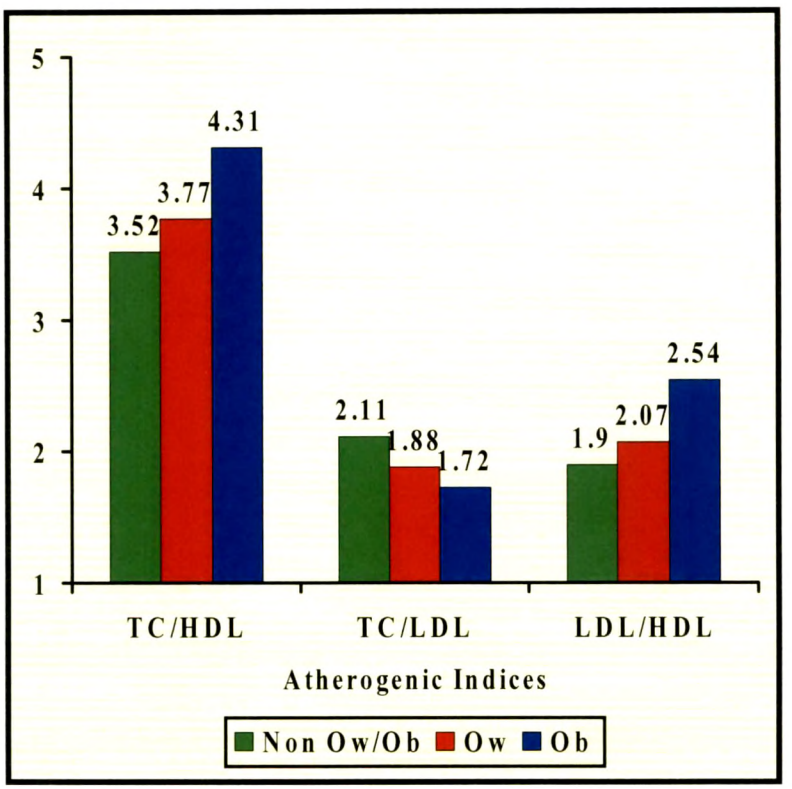
Thus from the above data it can be said that aberrations were found in the lipid profile in boys. The TC, TG and LDL-C values were higher in case of obese children in the older age group compared to younger age group. However the difference was not significant (Figure 4.17).

Diet and Lipid Profile

The lipid profile of the children in relation to the type of diet is given in Table 4.29. The TC and TG values were found to be higher in overweight and obese children consuming non/ovo vegetarian diet but it was not significant. The HDL-C values were lower in overweight and obese children. Thus it can be said that in the long run, the type of diet may influence lipid profile of the children.

FIGURE 4.16

ATHEROGENIC INDICES FOR BOYS



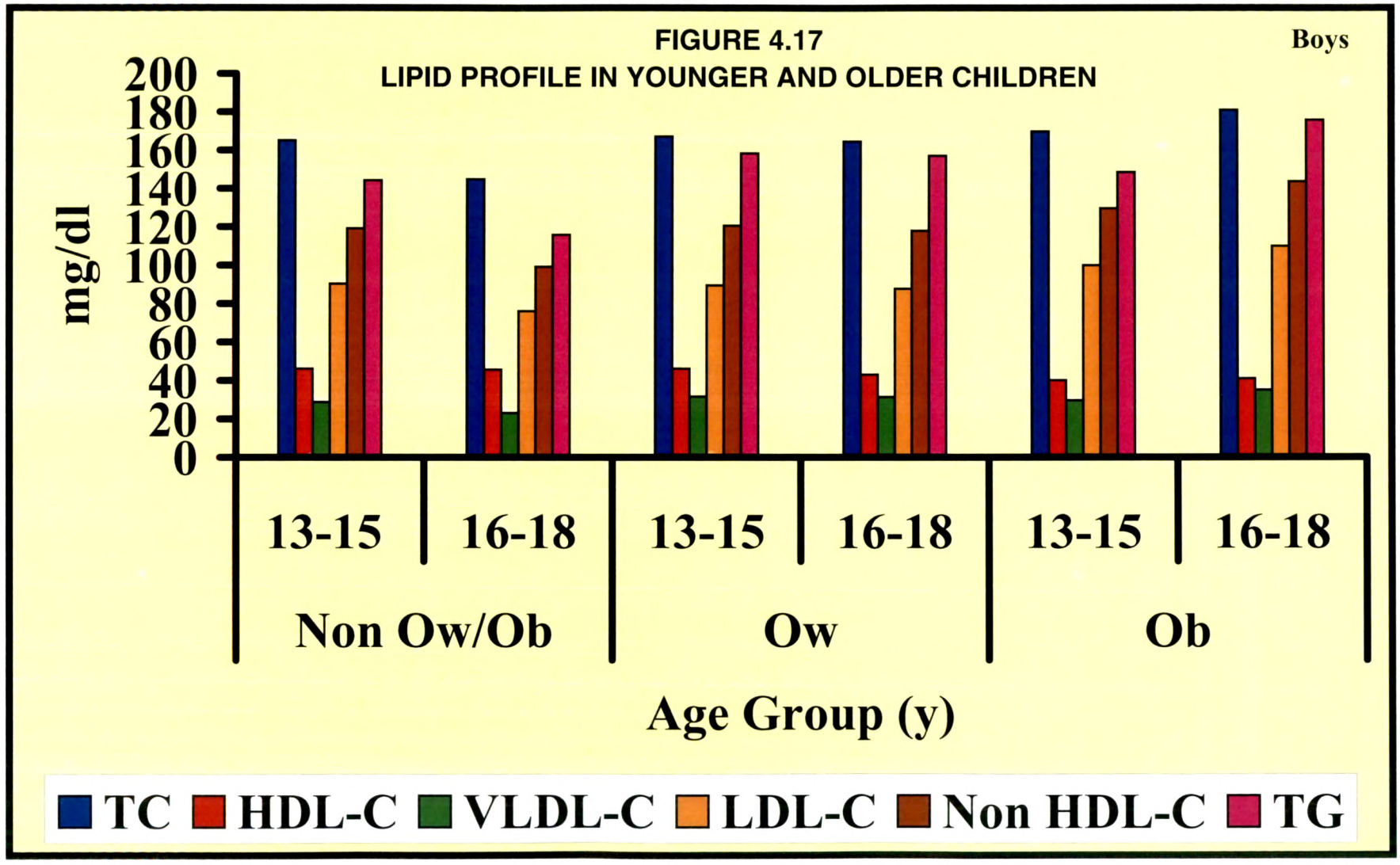


FIGURE 4.17
LIPID PROFILE IN YOUNGER AND OLDER CHILDREN
Boys
mg/dl
200
180
160
140
120
100
80
60
40
20
0
13-15
16-18
13-15
16-18
13-15
16-18
Non Ow/Ob
Ow
Ob
Age Group (y)
TC
HDL-C
VLDL-C
LDL-C
Non HDL-C
TG

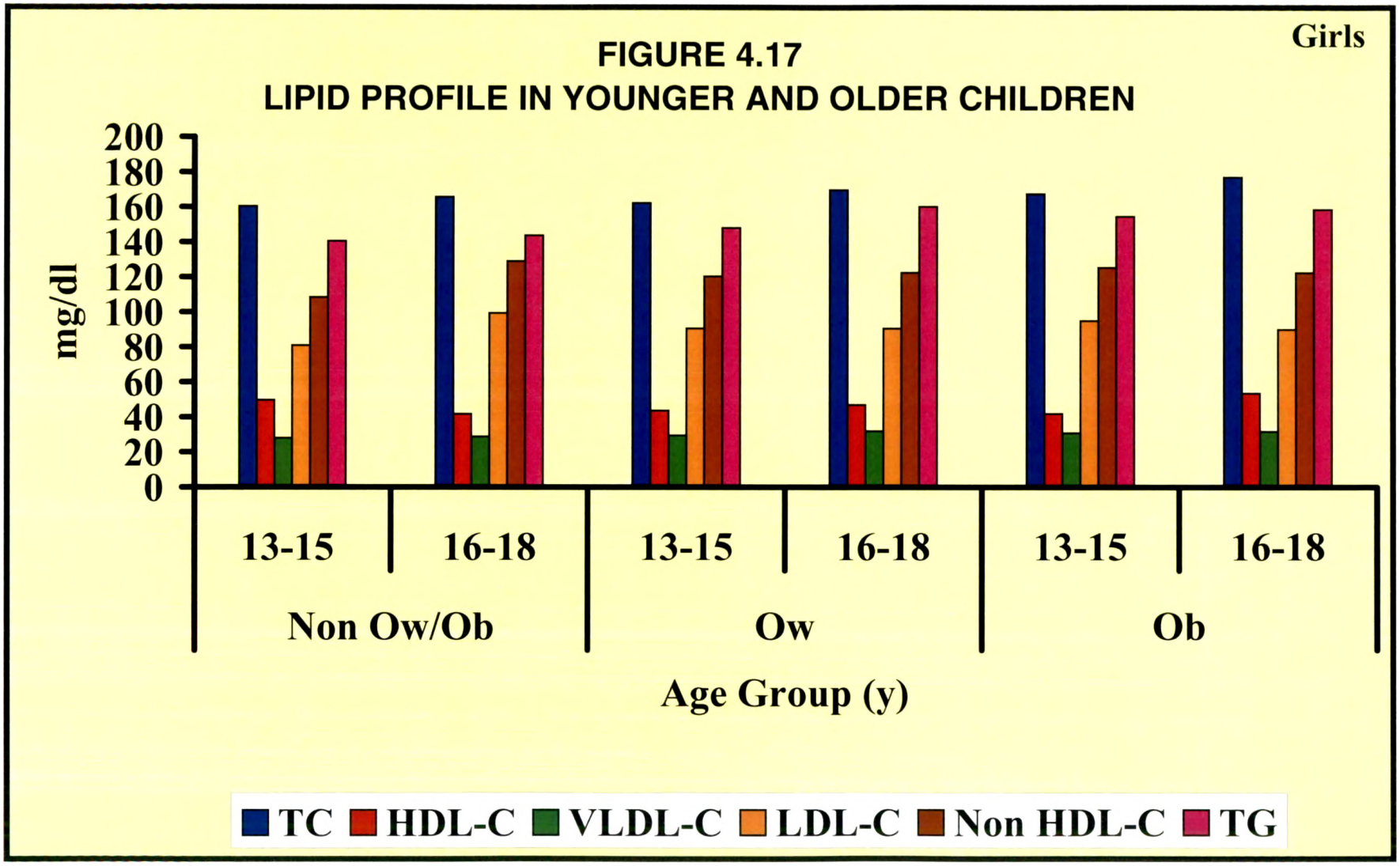

Girls
FIGURE 4.17
LIPID PROFILE IN YOUNGER AND OLDER CHILDREN
mg/dl
200
180
160
140
120
100
80
60
40
20
0
13-15
16-18
13-15
16-18
13-15
16-18
Non Ow/Ob
Ow
Ob
Age Group (y)
TC
HDL-C
VLDL-C
LDL-C
Non HDL-C
TG

TABLE 4.29

LIPID PROFILE IN RELATION TO THE TYPE OF DIET

Parameter	Type of Diet			
	Vegetarian		Non/Ovo Vegetarian	
	Non Ow/Ob	Ow + Ob	Non Ow/Ob	Ow + Ob
N	40	63	25	69
TC	162.2 ± 27.09	168.2 ± 31.77	155.1 ± 26.52	166.2 ± 22.94
HDL-C	46.35 ± 10.40	45.42 ± 10.95	47.73 ± 12.21	43.82 ± 7.84
LDL-C	87.52 ± 26.33	93.52 ± 29.51	80.03 ± 27.15	90.20 ± 20.98
VLDL-C	28.09 ± 4.50	30.10 ± 6.20	27.83 ± 6.29	31.52 ± 5.15
Non HDL-C	115.20 ± 26.92	123.50 ± 31.23	108.10 ± 29.14	121.20 ± 22.74
TG	140.40 ± 22.48	150.50 ± 30.99	139.10 ± 31.47	157.60 ± 25.74
TC/HDL	3.63 ± 0.91	3.88 ± 0.97	3.44 ± 0.99	3.87 ± 0.78
TC/LDL	1.93 ± 0.34	1.94 ± 0.69	2.18 ± 0.89	1.88 ± 0.26
LDL/HDL	2.00 ± 0.79	2.18 ± 0.84	1.81 ± 0.81	2.14 ± 0.67

Since fat intake is known to alter the lipid profile, the data on lipid profile was analysed in relation to quantity of fat intake, which is presented in Table 4.30. The TC, HDL-C and LDL-C values of the children were found to be similar for those who consumed < 60 g fat and also those who consumed ≥ 60 g fat. The VLDL-C and TG values were higher in overweight and obese children who consumed ≥ 60 g fat than those who consumed < 60 g fat. Further, the atherogenic lipoprotein non HDL-C values were significantly higher in overweight and obese children consuming ≥ 60 g fat/day than non overweight/obese children consuming the same quantity of fat (122 mg/dl V/s 112 mg/dl, $p < 0.05$). This observation places the overweight and obese children at greater risk of CVD.

Waist Circumference and Lipid Profile

Table 4.31 gives lipid profile in relation to waist circumference. The children having greater than 95th percentile of WC had higher values for TC, LDL-C, non HDL-C and TG. There are several epidemiological studies that support the hypothesis that the relationship between adiposity and risk diseases begins early in life (Owens et al 1998 and Goran et al 1999). Hence in the present study an attempt was made to assess the relevance of WC in identifying children with higher cardiovascular risk. The findings revealed that the children with WC > 95th percentile were more likely to have multiple risk factors for developing cardiovascular diseases than children with WC < 95th percentile (Table 4.32).

Physical Activity and Lipid Profile

Several studies have documented that low physical activity during adolescent years is one of the risk factors for lipid aberrations. Hence the effect of doing any type of exercise on lipid profile was studied. It was observed that only TG values among overweight/obese children were higher who did not do any exercise as compared to those who did some exercise (Figure 4.18). Thus it can be concluded that at this age exercise may not bring about alterations in lipid profile.

TABLE 4.30

LIPID PROFILE OF THE CHILDREN BASED ON TOTAL FAT INTAKE

Parameter	Fat Intake				't' Value
	< 60 g		≥ 60 g		
	Non Ow/Ob	Ow + Ob	Non Ow/Ob	Ow + Ob	
N	21	7	44	125	
TC	157.8 ± 23.66	161.0 ± 41.54	160.3 ± 28.53	157.5 ± 26.62	1.52
HDL-C	47.60 ± 16.26	52.28 ± 12.83	46.60 ± 8.10	44.19 ± 9.15	1.50
LDL-C	83.97 ± 24.88	85.42 ± 40.69	84.69 ± 27.73	92.13 ± 24.56	1.61
VLDL-C	28.24 ± 6.74	28.53 ± 4.45	27.87 ± 4.39	30.97 ± 5.74	3.26**
Non HDL-C	112.40 ± 26.01	114.20 ± 42.93	112.20 ± 28.87	122.70 ± 26.18	2.15*
TG	141.20 ± 33.72	142.60 ± 22.23	139.30 ± 21.60	154.80 ± 28.72	3.26**
TC/HDL	3.67 ± 1.19	3.35 ± 1.10	3.50 ± 0.82	3.90 ± 0.86	
TC/LDL	2.02 ± 0.45	2.63 ± 2.00	2.04 ± 0.70	1.87 ± 0.27	
LDL/HDL	2.01 ± 0.98	1.78 ± 0.97	1.89 ± 0.72	2.18 ± 0.74	

Fat intake ≥ 60 g/day is significantly different for corresponding non ow/ob at **p < 0.001 and *p < 0.05

TABLE 4.31

LIPID PROFILE OF CHILDREN BASED ON WAIST CIRCUMFERENCE

Parameter	< 95th Percentile	> 95th Percentile	't' value
N	115	82	
TC	160.5 ± 26.82	170.5 ± 27.34	2.56*
HDL-C	45.78 ± 10.15	44.74 ± 9.95	0.68
LDL-C	85.96 ± 26.05	94.32 ± 25.22	2.15
VLDL-C	28.93 ± 5.04	31.26 ± 6.27	2.88*
Non HDL-C	114.84 ± 27.22	125.03 ± 27.28	2.47*
TG	144.64 ± 25.21	156.29 ± 31.37	2.88*
TC/HDL	3.65 ± 0.98	3.93 ± 0.88	2.05
TC/LDL	1.98 ± 0.52	1.90 ± 0.61	0.98
LDL/HDL	1.99 ± 0.79	2.21 ± 0.74	1.90

* $p < 0.01$

TABLE 4.32

WAIST CIRCUMFERENCE AND PRESENCE OF RISK FACTORS

Risk Factors	< 95th Percentile	> 95th Percentile
N	121	93
0	49 (40.5)	26 (28.0)
1	55 (45.5)	46 (49.5)
2	12 (9.9)	15 (16.1)
3	4 (3.3)	5 (5.4)
4	1 (0.8)	1 (1.1)

Values in parenthesis indicate percentage

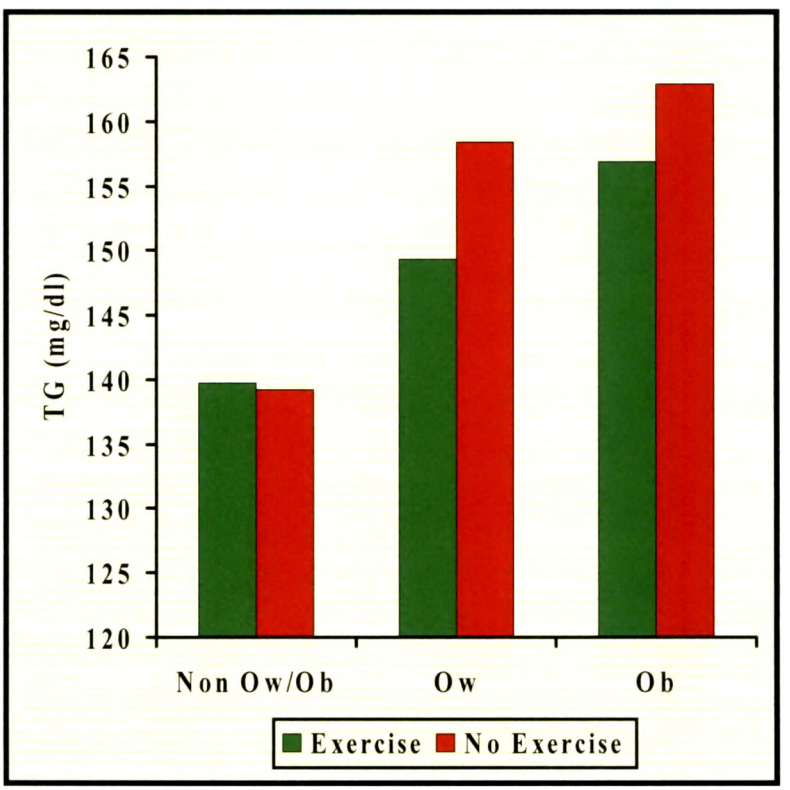
Risk Factors

HDL-C < 35 mg/dl TC > 180 mg/dl

LDL-C > 130 mg/dl Family History of obesity

FIGURE 4.18

EFFECT OF EXERCISE ON TRIGLYCERIDE LEVELS IN CHILDREN



DISCUSSION

After mapping the prevalence of overweight and obesity in children it is equally important to know the risk factors responsible for the same. The risk factors are characteristics or conditions whose presence leads to the chance of developing a disease or a condition. The relationship is one probability. The presence of multiple such factors has an increased effect on the risk.

In the present study the prevalence of overweight and obesity in school children was looked in relation to per capita income, heredity, type of diet, school meal programme, life style related factors, nutrient intake, energy intake and energy expenditure, and fasting blood sugar and lipid profile.

Gopalan (1998) reported that income plays an important role in prevalence of overnutrition in adults. In the present study the number of overweight and obese children were significantly higher in per capita income $\geq$ Rs. 2,000 group. Similar trends were observed by Parikh (2002) and Akolkar (2003) also.

Heredity also plays a significant role in the development of overnutrition. Various studies have documented that children of obese parents are more prone to development of overweight/obesity. In this study based on family history of obesity, the percent prevalence of overweight and obesity together was found to be higher when the mothers of the children were overweight/obese as compared to fathers.

The association between the type of diet and weight gain has received much attention by various obesity research groups. The classification of children with relation to their nutritional status and their type of diet reveals the higher prevalence of obesity in children consuming non/ovo vegetarian diet.

The school meal programme in private schools is generally implemented with an objective to provide nutritious foods to inculcate healthy eating practices right from the early childhood to improve nutritional status. The findings of present study indicated that the school meal programme had some influence on

the prevalence of overweight/obesity, as it was significantly higher in children from schools with school meal programme. This observation suggests the need for formulating appropriate dietary guidelines for school meal programme.

A life style characterised by lack of physical activity and excessive inactivity (particularly TV viewing) might cause obesity in children (Ebbling et al 2002). The availability of sedentary activities such as TV, video games, computer and Internet has emerged considerably. The opportunities for physical activity have decreased for various reasons. Physical education is typically considered less important than academic disciplines. Also a large number of students in a class and non availability of adequate sports equipments cause a hindrance to successful physical education programme implementation. Even after school hours, absence of playgrounds and extra academic assignments discourage physical activities. Moreover today's lifestyle prefers more convenience, the car to walking, lift to a staircase and the remote control to manual adjustments. Visiting fast food restaurants is on a rise leading to maximum energy intake with a minimum exertion.

It has been proved that regular physical activity monitors unhealthy weight gain, whereas sedentary life styles particularly sedentary occupations and inactive recreations such as viewing TV promote it. The studies aimed at reducing sedentary behaviours have focused primarily on reducing TV viewing in children (WHO 2003). The physical activity is any body movement produced by skeleton muscles that results in energy expenditure. It is prerequisite for health as it increases energy expenditure, improves blood circulation and tones up the muscles. Regular exercise helps the body to make the best use of fats and sugars.

In view of this, an attempt was made to analyse the daily activity pattern of school children in relation to their nutritional status. For the purpose of this study physical activity is an umbrella that includes exercise, incidental activities and sports. In this regard the findings of the present study indicated that more number of overweight and obese children rode in vehicles to school. Also they were less

involved in physical activities like brisk walking, jogging and outdoor games. The daily physical activities were found dominant in non overweight/obese children. Similar trends were observed by Florentino (2002) in the school children of Manila, Philippines.

The effect of TV viewing on obesity risks is of particular interest. In the present study it was found that higher percentage of obese children was involved in daily TV viewing and use of computer than non overweight/obese children. Obarzanek (1994) also reported the direct association between the TV watching and BMI in black and white girls aged 9-10 years.

Obesity is caused due to imbalance between energy intake and energy expenditure. Also a high intake of energy dense foods, which are high in fat, sugar or starch, promotes weight gain. In the present study dietary analysis of the children showed that fat contributed 36% of the total calories in the diet. Osganian et al (1996) from the CATCH study reported similar observations. Also much higher percentage of overweight and obese children had $\geq$ 30% calories coming from fat compared to non overweight/obese children which is a cause for concern. More number of overweight children had energy intake > 100% RDA. Gazzaniga and Burns (1993) have recently reported a significant relationship between percent body fat and dietary fat as percent energy intake in 9-11 years old children. Thus the findings of the present study support the perception that dietary fat is associated with body fatness in children.

The analysis of energy expenditure of children in relation to energy intake revealed that mean energy intake and energy expenditure per kg body weight was equal in case of non overweight/obese children but was much higher in overweight and obese children. This implies that the children should be encouraged to participate in various physical activities to maintain good health. Thus excess energy intake, more percentage of calories coming from fat and positive energy balance plays an instrumental role in developing and maintenance of overweight and obesity in children.

Visceral fat, which is not obvious in clinical examination, is the most metabolically active fat in the body and can undergo lypolysis quickly. Excess consumption of fat is deposited in adipose tissues and the active lipolytic action of adipocytes may get reflected in the circulating lipid. It is therefore essential to look into metabolic aberrations with respect to lipid profile in overweight and obese children. An analysis of biochemical estimations in the present study indicated a disturbed lipid profile with respect to TC, which is on the increasing trend, and HDL-C, which is on the decreasing trend. There was a significant increase in the atherogenic indices represented by TC/HDL-C, TC/LDL-C and LDL-C/HDL-C in overweight and obese boys. If this trend continues, it would increase their probability of adverse health consequences in their later life. This finding is in agreement with the study on the school children of urban Vadodara (Mani et al 2004).

Lipid profile of the children is more dependent on diet (Kumar et al 2003). Lipid profile was also analysed in relation to type of diet and amount of fat consumed by the children. It revealed that TG values were higher in overweight and obese children consuming non/ovo vegetarian diet than the children consuming vegetarian diet. VLDL-C and TG values were found to be higher in children consuming $\geq$ 60 g fat.

Recently waist circumference has been advocated to be a good indicator of body fatness distribution as it is highly correlated with BMI, visceral fatness and total body fat (Katzmerzyk et al 1999). Few studies are available on the relationship between waist circumference and cardiovascular risk factors in the prepubertal children (Freedman et al 1999, Chu et al 1998 and Savva et al 2000). In the present study a good correlation between BMI and waist circumference in boys and girls was seen ($r=0.87$ and $r=0.86$, $p < 0.001$). An assessment of body fat distribution to identify children with the risk of adverse lipid profile was carried out which revealed that children having > 95th percentile of WC had higher values of TC, LDL-C, non HDL-C and TG and multiple risk factors for developing cardiovascular diseases. The findings of present study are in line with the results reported by Maffies et al (2001) on prepubertal children.

Regular exercise has been shown to improve control of lipid abnormalities, diabetes mellitus, hypertension and obesity with greatest benefits realised by sedentary individuals who begin to exercise (Bray 2000). The analysis of lipid profile in relation to exercise revealed that exercise did not influence the aberrations in lipid profile in these children.

From various studies carried out worldwide and the risk factor analysis in this study, it is clear that among modifiable risk factors energy intake was one of the determinants of BMI in children. Hence school based and family based intervention programmes focusing on decreased dietary fat consumption, increased consumption of fruits and vegetables, increased physical activity and limited TV viewing time should be encouraged to arrest the increasing trend of overnutrition and its consequences in school children of urban Vadodara.

Highlights

- The per capita income of Rs. 2,000 and above exhibited a higher prevalence of overweight and obesity.
- Heredity was found to be the most profound risk factor for developing obesity.
- The type of diet did not affect the prevalence rate but had influenced TC and TG values.
- The school meal programme showed influence on prevalence of overweight and obesity.
- The life style related factors like mode of transport, physical activity and TV viewing showed influence on prevalence of overweight and obesity.

- A majority of overweight and obese children had energy intake > 100% DA and ≥ 30% calories coming from fat.

- Energy expenditure was lower than energy intake in overweight and obese children.

- Aberrations in lipid profile with respect to TC, HDL-C and atherogenic indices were observed in boys.

- The quantity of fat influenced the TG and VLDL-C values in overweight and obese children.

- The children with WC > 95th percentile had multiple risk factors for developing cardiovascular diseases.

SECTION IV

Trends in BMI at 6,12 and 24 Months of Interval

The children who were found to be overweight and obese at the baseline were followed up for their anthropometric measurements at 6, 12 and 24 months interval. Table 4.33 depicts the number of overweight and obese children found at each interval. At the base line the overweight children were in the age group of 12.0-17.5 years studying in 8th-12th classes. The obese boys were in the age group of 12-17 years whereas girls belonged to age group 12.5-17.0 years from 8th-12th classes. All the children who were found to be overweight/obese at the baseline were also found to be overweight/obese at the final follow up at 24 months interval. The mean increase in BMI was 1.3 and 1.0 for overweight boys and girls respectively while it was 1.7 and 0.8 for obese boys and girls respectively (Figure 4.19). There was a negligible rise in WHR in all the children.

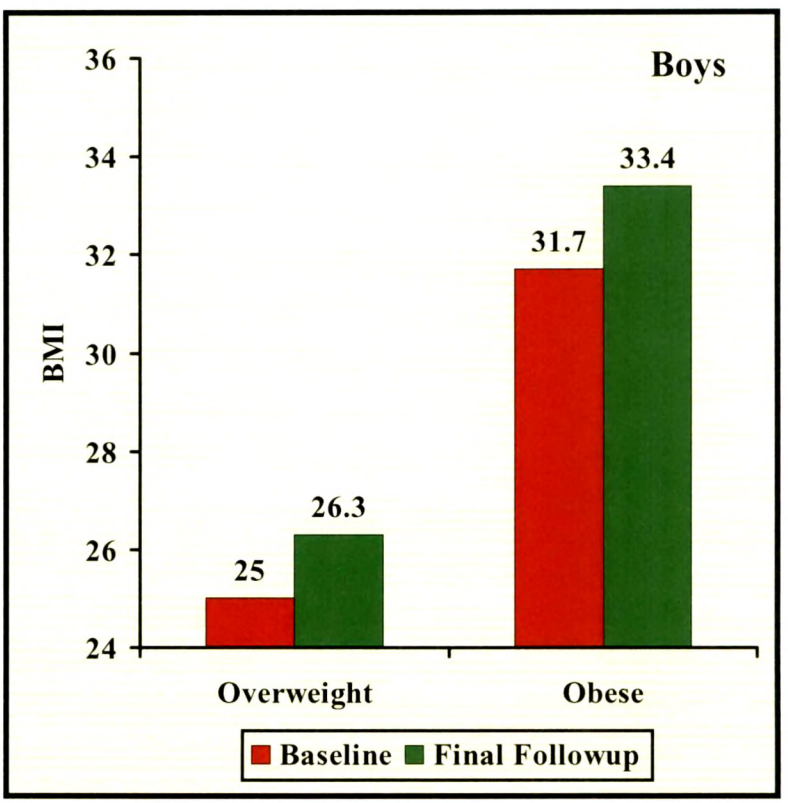
TABLE 4.33

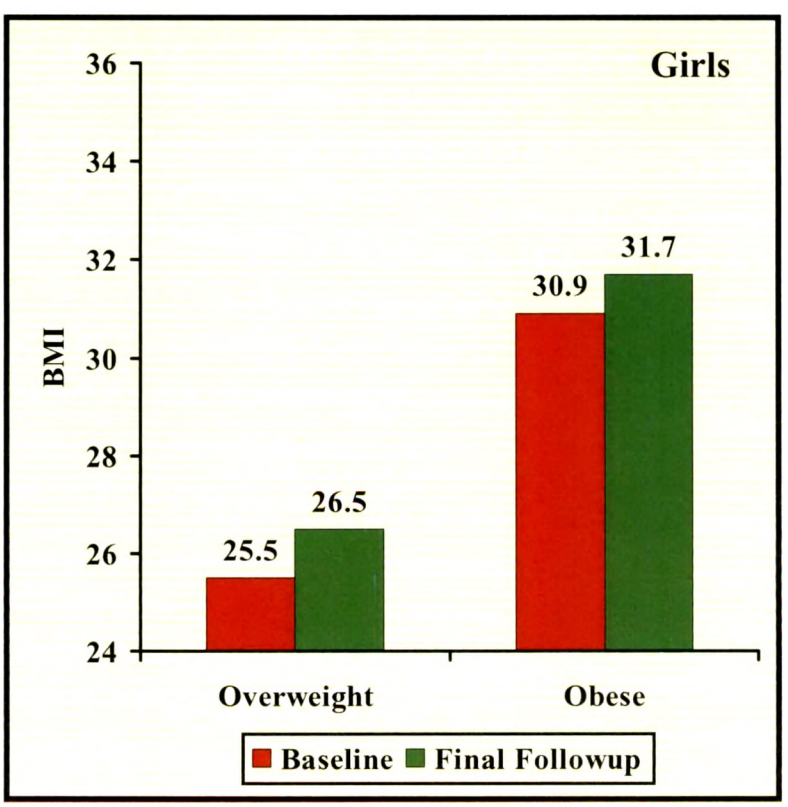
NUMBER OF OVERWEIGHT AND OBESE CHILDREN AT EACH EXAMINATION

Examination	Overweight			Obese		
	Boys	Girls	Total	Boys	Girls	Total
1	119	96	215	19	14	33
2	119	96	215	19	14	33
3	110	90	200	18	14	32
4	91	82	173	16	12	28

FIGURE 4.19

MEAN INCREASE IN BMI OF CHILDREN





Discussion

The cross sectional design to study the growth of a child of any age is simple and requires less time and lay out. However the dynamics of growth cannot be completely appreciated by this method. The longitudinal design is based with many problems such as high manpower, finances, dropouts, prolonged time and perseverance on the part of researchers. These manifold problems reduce its applicability particularly in time bound studies. The disadvantage of these two designs led Tanner (1951) to develop third method termed as Mixed Longitudinal or Linked Cross Sectional Design. This method allows amalgamation and analysis of data in such a way so as to obtain information equivalent to the longitudinal observations.

In view of this the tracking of weight status of children at intervals of 6, 12 and 24 months using the mixed longitudinal design was assessed. It revealed that all the children who were identified as overweight/obese at the baseline maintained their weight status even after 2 years at the final follow up. Similar trends were observed by Salbe et al (2002). This observation calls for an immediate action programme to prevent the global epidemic of overweight and obesity in school children.

Multiple Regression Analysis

The step wise multiple regression analysis was carried out with BMI as a dependant variable. When BMI was considered, heredity, energy intake, sex and age were seen to enter the equation as independent variables. The total variations explained by these variables were 24.5% and the rest were by unknown factors. The percent fraction of each variable are shown in Table 4.34 and also presented graphically in Figure 4.20. The F values of the variables were found to be statistically significant at $p < 0.01$.

The equation arrived at was

$$BMI = 9.266 + 0.434(age) + 1.458(sex) + 0.002(energy\ intake) + 2.316(heredity)$$

The energy intake entered in one of the regression equation as independent variable. Therefore it is advisable to plan proper intervention

TABLE 4.34

DETERMINANTS OF BMI

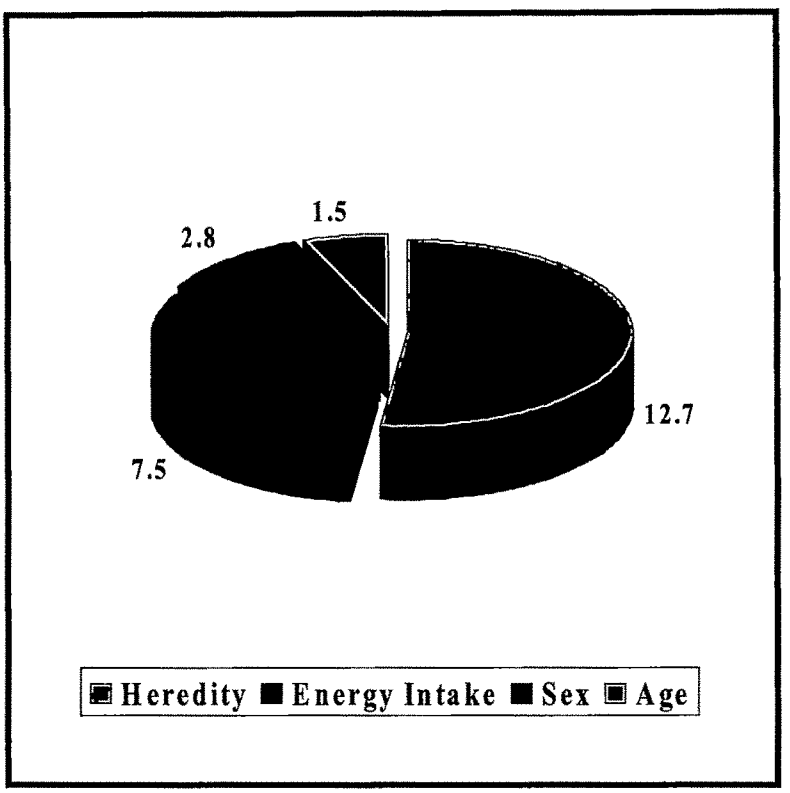
Variables	Adjusted R^2	SE	Variation Explained (%)	'F' Value
Heredity	0.12790	3.76	12.7	30.039****
Energy intake	0.20252	3.60	7.5	26.140****
Sex	0.23094	3.53	2.8	20.819****
Age	0.24589	3.50	1.5	17.139****
Total			24.5	

**** $p < 0.0001$

BMI = 9.626+0.434(age) + 1.458(sex) + 0.0024(energy intake) + 2.316(heredity)

FIGURE 4.20

DETERMINANTS OF BMI



- programmes to emphasis healthy eating practices to alter the trend of overweight and obesity in children and adolescents.

Highlights

- The overweight and obese children maintained their weight status after two years at the time of final follow up.

- The step wise multiple regression analysis for BMI showed that heredity, energy intake, sex and age entered the equation as independent variables.