SUMMARY AND CONCLUSIONS

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The epidemic of obesity is now no longer restricted to only industrialised countries. The rates of overweight and obesity are found to increase rapidly in developing countries too. The prevalent rates differ among different countries but one point of similarity is the sharp increase of overnutrition among all the countries. Overweight and obesity indicates rapidly growing threat to health of population and to an increasing number of countries worldwide. Obesity is a major contributor to various chronic degenerative diseases of which the related health costs are substantial. Obesity is found to escalate especially in children and adolescents from the last few years.

The comprehension that obesity demands effective preventive measures has developed in the last few years only. However lack of thorough and authoritative evidences regarding the causative factors for the same till today has left us ill equipped to deal with this epidemic. Moreover the large scale dimension of this phenomenon further increases complexity of its preventive action.

The research exhibits poor evidence regarding requisite behaviour modifications with respect to dietary practices and physical activity to prevent unhealthy weight gain in children. The problem calls for further research to measure the magnitude of childhood obesity and elucidate the behavioural determinants of weight gain and obesity. Certain environmental changes may be necessary with regard to life style that influence important obesity risk factors to reverse the obesity epidemic.

Childhood obesity tends to predict adult obesity. The available data indicates that overweight children are more likely to become obese adults. It can be easily predicted that the physical, psychosocial and economic consequences of obesity will increase considerably in the near future. Hence it is absolutely necessary that 'the battle of the bulge' must intensify as health care providers unite together in a valiant endeavour to curb excessive weight gain initiating from childhood.

The present study was planned to map the prevalence of overweight and obesity in school children and to study the risk factors associated with it. The study was carried to assess the prevalence of overweight and obesity among school children in the younger age group (12-15 years) and older age group (16-18 years) of urban Vadodara. The correlation between energy intake and energy expenditure was analysed on the basis of diet history of the children. The effect of lifestyle factors such as dietary practices and activity pattern on the prevalence of obesity were examined. Metabolic aberrations with respect to lipid profile in relation to gradation of obesity were assessed. Finally age and sex specific BMI percentile curves were developed.

The study was conducted in the 10 private schools of urban Vadodara. The study population comprised of total of 4808 children studying in 8^{th}–12^{th} classes. Of the 4808 children enrolled, 2890 (60.1%) were boys and 1918 (39.9%) were girls.

The study was divided into three phases. Phase I comprised of collection of information on school profile, background information and anthropometric measurements of the children. The children were classified into non overweight/obese, overweight and obese categories based on Cole et al standards. Phase II included compilation of dietary information and activity pattern on the sub sample of 214 children. Their fasting blood sample was drawn to measure biochemical parameters - FBS and lipid profile. In phase III, the overweight and obese children were followed up at 6, 12 and 24 months of intervals after their classification at baseline to track their weight status. For collection of data standard methods were used. The data collected was processed on an IBM PC/XT compatible system and subjected to statistical analysis using Statistical Package for Social Sciences (SPSS/PC$^+$).

Out of the selected 10 schools, there were 4 English medium and 6 Gujarati medium schools. For commutation, 4 schools offered school bus facility. 9 out of 10 schools taught computer as one of their subjects. Eight schools had playground, two schools had school meal programme, 5 schools had

canteen facilities and eight schools had annual health check up programme for children.

Out of the total children, ninety two percent of the children followed Hindu religion. Seventy one percent belonged to nuclear family type and eighty two percent belonged to middle and high income group. Fifty percent of the children's fathers and 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 whereas eighty three percent of the children's mothers were housewives.

The mean age of the boys and girls was 14.0 and 14.1 years respectively in the younger age group while it was 16.5 and 16.6 years respectively in 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. The overall BMI was significantly higher ($p < 0.001$) in girls than boys. 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 BMI ranged from 15.75 to 20.11, WHR ranged from 0.72 to 0.82 and WC ranged 57.96 to 70.95 in the age range of 12-18 years.

The prevalence of overweight and obesity in the children was determined using age and sex specific cut off points given by Must et al standards (1991), Cole et al standards (2000) recommended by IOTF, CDC standards (2000) and Agarwal standards (2003).

The overall prevalence of overweight ranged from 7.1% to 10.4% and that of obesity from 1.5% to 3.0% based on Must et al, Cole et al, CDC and Agarwal standards. The overall prevalence of overweight was 8.4% and that of obesity was 1.5% by Cole et al standards. Different standards gave different values for the prevalence of overweight and obesity. The overall prevalence of overweight and obesity based on Must et al, Cole et al and CDC Standards were comparable. The prevalence rates by Agarwal standards (cut off points based on

Indian children) were comparatively higher. Each of these reference standards varies in their assessment of overweight and obesity, which makes comparison of cross sectional prevalence data difficult. So cut off points of various standards were compared which revealed that cut off points given by Agarwal standards were lower than that of other three standards.

On age wise analysis the prevalence of overweight ranged from 3.7% to 12.7% and that of obesity from 0.6% to 5.1% in the age group of 12-18 years.

The children enrolled in the study were from 8^{th}-12^{th} classes. 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 study was conducted in 10 schools. Both the forms of malnutrition - undernutrition and overnutrition were found in the schools. School wise analysis showed that prevalence of overweight ranged from 4.6%t to 24.9% and obesity from 0.6% to 5.3%.

WHO (1997) recommended that age and sex specific BMI cutoff values should be used to classify children into overweight/obese. However, there is lack of uniformity in various reference standards and their cut off points. Hence the prevalence rates of Must et al, Cole et al and CDC standards were compared with Agarwal standards to measure the agreement between them using kappa index. The overall concordance between these standards was found to be good. Therefore the prevalence data of population studies can be analysed using any of these standards. However the differences in the identification of overweight and obese children by these standards makes it necessary to determine a specific cut off limit linked with morbidity and mortality end points.

Percentile tables/curves are used to monitor growth. The age and sex specific BMI percentile values were calculated based on frequency procedures from the data obtained and 5^{th}, 10^{th}, 25^{th}, 50^{th}, 85^{th}, 90^{th} and 95^{th} percentile curves

developed for children in the age range of 12-17 years. The percentile values of the present study were found to be lower than that reported by Agarwal et al (2003).

For the risk factor analysis, children were classified into non overweight/obese, overweight and obese based on Cole et al standards. The prevalence of overweight and obesity was looked in relation to per capita income level, heredity, type of diet, 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. The energy intake and energy expenditure of the children were also compared in relation to their gradation of obesity. Their metabolic aberrations with regard to fasting blood sugar and lipid profile were studied.

Income is considered as one of the influencing factors in the development of overnutrition. The per capita income of Rs. 2000 and above exhibited a higher level of overweight and obesity in children.

Heredity is another factor in the development of overweight and obesity in children. The family history of obesity proved to be a profound risk factor in the present study. The relative risk of being overweight or obese was much higher in a child with both parents overweight or obese than either parent being overweight or obese.

In the present study, higher percentage of children consuming non/ovo vegetarian diet was found to be obese than children consuming vegetarian diet. The type of diet did not affect the overall prevalence of overweight and obesity in children. The school meal programme also influenced the prevalence rate. The schools with school meal programme had higher percentage of overweight/obese children as compared to schools without such programme.

A life style characterised by lack of physical activity and excessive inactivity (particularly TV viewing) might also cause obesity in children. It was found that more number of overweight and obese children rode in one vehicle or

other to school. They were less involved in physical activities like brisk walking, jogging and outdoor games. A higher percentage of obese children were involved in daily TV viewing and use of computer than non overweight/obese children.

Obesity is caused due to imbalance between energy intake and energy expenditure. The dietary analysis of the children showed that fat contributed 36% of the total calories in the diet. Higher percentage of overweight and obese children had ≥ 30% calories coming from fat compared to non overweight/obese children. More percentage of overweight children had energy intake >100% RDA. Overweight and obese children reported lower energy expenditure than their energy intake. 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 suggests that excess energy intake and physical inactivity were associated with body fatness in children.

The biochemical estimations revealed a disturbed lipid profile of the children with respect to TC, which was on the increasing trend, and HDL-C, which was 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. In case of girls, only TC and TG values were higher in obese girls. Lipid profile was analysed in relation to type of diet and amount of fat consumed by the children. TG values were found to be higher in overweight and obese children consuming non/ovo vegetarian diet. Non HDL-C, VLDL-C and TG values were found to be higher in children consuming ≥ 60 g fat.

Waist circumference is also a good indicator of body fatness distribution as it is highly correlated with BMI. In the present study a good correlation was seen between BMI and waist circumference in children. An assessment of body fat distribution to identify children with the risk of adverse lipid profile 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 analysis of lipid profile in relation to exercise revealed that exercise did not influence the aberrations in lipid profile in these children.

The tracking of weight status of children at intervals of 6, 12 and 24 months after baseline data collection was assessed using the mixed longitudinal design. 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. 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.

The step wise multiple regression analysis carried out with BMI as a dependant variable indicated that heredity, energy intake, sex and age entered the equation as independent variables. The total variation due to these variables was 24.5%.

CONCLUSIONS

- This is the first such large scale research study on nutritional assessment of private school children representing schools from different zones of urban Vadodara in western part of Gujarat, India. It provides important baseline data on magnitude of the problem of childhood obesity and risk factors associated with it.

- The overall prevalence of overweight was 8.4% and that of obesity was 1.5% using Cole et al standards.

- Different standards used to map the prevalence of overweight and obesity gave different values. The overall concordance between various standards was found to be good. Hence population studies of prevalence based on these references can be compared.

- The school wise analysis of prevalence data revealed the co-existence of undernutrition and overnutrition in all the schools selected for the study.

- Based on the data obtained, age and sex specific BMI percentiles were calculated for 12-17 years at 6 months interval and percentile curves were developed.

- The per capita income and heredity factors were found to contribute significantly to the prevalence.

- The life style related factors like mode of transport used, physical activity and TV viewing and use of computer showed considerable influence on prevalence.

- The energy expenditure was found to be lower than energy intake in overweight and obese children.

- 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.

- The overweight and obese children maintained their weight status even 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.

- This study has important programmatic implications. Nutrition interventions to remedy the rate of undernutrition and school based intervention programmes focusing on promotion of increase physical activity and healthy dietary practices among children can prevent the development of global epidemic of childhood obesity.