Magnitude and Determinants of Overweight and Obesity in 6-12 year old school children of Vadodara City

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Abstract

Childhood obesity forms a link between adult obesity and cardio-vascular risk. Thus we conducted a school-based cross-sectional survey to estimate the prevalence of obesity in 6-12 year-old children of Vadodara City and to investigate the role of associated risk factors. Background information and anthropometry (1067), diet history and activity pattern (n=140), serum glucose and lipids (n=36) were studied on children. Prevalence of over-weight and obesity as per IOTF, CDC and Must et al standards were 20.3%, 21.6% and 23.4% respectively. Risk factor analysis revealed that heredity and income of parents con-tributed significantly to the prevalence of obesity. BMI of obese children's parents were sig-nificantly higher than normal BMIchildren's parents. Mean calorie intake was higher in obese and overweight children as compared to normal children. Energy expenditure pattern and lipid profile were not significantly different between normal, overweight or obese chil-dren. Thus obesity is a problem even in the lower age-groups and large-scale intervention strategies, focusing on improving modifiable risk factors, especially type of diet (with re-gard to calorie & and fat intake) and physical activity should be designed to arrest the trend.

Keywords: Overweight, Obesity, School Children, BMI, Energy Expenditure
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Introduction

Pediatric population today is facing a new health hazard called childhood obesity that threatens to become the big-gest challenge to health providers across the globe [1]. This chronic neurochemical disease has multiple etiologi-cal factors and risk-factors. The severity of obesity and age of onset affect the likelihood of persistence of obesity into adulthood and thus entrainment of obesity induced morbidities [2]. Economic prosperity has fueled a sharp rise in the percentage of overweight children and adoles-cents around the world, especially affluent populations. However information on extent of obesity in younger children in Baroda city was scant and hence this study was carried out to map the prevalence of obesity in school children (6-12years) and to investigate the role various risk factors of obesity.

Materials and Methods

The first phase of the study was a cross sectional school-based survey (carried out in 2004) for studying the preva-lence of obesity. Using an estimated prevalence of 10% of obesity, at 95% LOS and 10% CI, the required sample size for prevalence was found to be 377. Thus a sample of 1067 subjects (575 males and 492 females), in the age-group of 6-12 years were enrolled from co-ed primary schools, for mapping the prevalence of overweight and obesity. The schools (n=3) were selected so as to repre-sent the middle income and high income groups and prior consent was taken from subjects' parents. In the second phase, those parents who gave consent for risk factor analysis were enrolled. In all there were 51 cases of overweight, 52 obese subjects and they were compared against 37 normal weight controls for investigation of risk factors of obesity in the subjects. Parents of only 36 sub-jects gave permission to draw the blood sample.

For the cross-sectional survey; weight, height, waist and hip circumference and background information were studied. All anthropometric measurements were taken using the standard protocol. Weight was measured with a standardized bathroom weighing scale to the nearest 0.1kg. Height, waist and hip circumference were measured with a fiber-glass tape to the nearest 0.1cm [3]. Background information was obtained using a structured questionnaire. BMI was computed by dividing the weight in kilo-grammes by height in meters squared. Prevalence of overweight and obesity was ascertained using following standards: Must et al standards (1991) [4], International Obesity Task Force (IOTF) standards, given by Cole et al (2000) [5] and CDC standards (2002) [6]

Dietary intake through 24 hour dietary recall (based on consent), were studied for 51 overweight and 52 obese children and 37 normal weight children and nutrient in-take was calculated using food composition tables from "Nutritive Value of Indian Foods"[7]. Activity pattern was also studied in these subjects, through a self-administered pre-tested structured questionnaire which consisted of an exhaustive list of activities relevant to the study subjects. These activities were classified into light, moderate and heavy as per the description of FAO/WHO expert committee's report on energy requirement (1985) [8] , respective energy expenditure factors were assigned to them and energy expenditure was calculated using the FAO/WHO predictive equation. A deduction of 5% was made in the BMR values so obtained in order to adapt these for Indian population, as per the ICMR (1998) [9] report. Serum estimations of glucose and lipids were made from venous blood samples collected from 36 will-ing subjects (12 normal, 10 overweight, 14 obese), after 12 hours of overnight fasting. Glucose was analyzed us-ing GOD-POD method, total cholesterol by CHOD-POD method;HDL by selective immuno-precipitation and tria-cylglycerols by enzymatic colorimetric method [10].

Analyses were carried out in SPSS package. For quantifi-able variables, descriptive statistics (means and standard deviation) were calculated. In case of categorical vari-ables, frequency distribution was computed. Comparison of means was done using't' test and difference in propor-tions were compared by 'chi-square' test. Regression analysis was done to find out the determinants of obesity.

Results

Majority (83.5%) of the subjects studied belonged to high income group. More than half of them (53%) belonged to a nuclear family. The mean BMI of boys and girls were almost same (16.76 and 16.74 respectively). The waist circumference (WC) was 52.2cm and 51.3cm respectively in boys and girls. Boys had a higher mean Waist to Hip Ratio (WHR) as compared to the girls (0.83 vs. 0.80). Table 1 shows the comparative prevalence of overweight and obesity based on different standards (it varied be-tween 20.3 to 23.3%). Gender variation in prevalence rates was not seen, except in case of those computed us-ing CDC standards, where BMI was higher in boys (22.9%) as compared to girls (20.1%). The mean BMI for normal subjects (Table 2) was around 15.4. The BMI range for overweight subjects was 19.92 to 20.68 and for obesity it ranged from 22.78 to 24.64.

Table 1. Prevalence of Overweight and Obesity According to Various Standards

Standards	Males (N=575)			Females (N=492)			Total (N=1067)		
	Ow	Ob	Total (%)	Ow	Ob	Total (%)	Ow	Ob	Total (%)
Must et al	63 (11)	70 (12.2)	23.3	67 (13.6)	49 (10)	23.5	130 (12.2)	119 (11.2)	23.3
CDC	63 (11)	69 (11)	22.9	62 (12.6)	37 (7.5)	20.1	125 (11.7)	106 (9.9)	21.6
IOTF	79 (13.7)	39 (6.8)	20.5	75 (15.2)	24 (4.9)	20.0	154 (14.4)	63 (5.9)	20.3

( ) Values in parenthesis are percentages; Ow: overweight, Ob: obese

Table 2. Mean BMI of Obese and Overweight Subjects According to Different Standards

Standards	Males (N=575)			Females(N=492)			Total(N=1067)		
	N	Ow	Ob	N	Ow	Ob	N	Ow	Obese
Must et al	15.23 ± 1.75	20.04 ± 1.56	23.55 ± 3.13	15.55 ± 2.09	19.82 ± 2.48	21.68± 2.92	15.38 ± 1.92	19.92 ± 2.08	22.78±3.16
CDC	15.22 ± 1.74	20.03 ± 1.40	23.71 ± 3.02	15.61 ±2.05	20.22 ± 1.93	22.95± 2.60	15.41 ± 1.90	20.12 ± 1.68	23.44±2.89
IOTF	15.34 ± 1.85	20.72 ± 1.67	25.46 ± 2.48	15.60 ±2.04	20.63 ± 2.11	23.3±2.70	15.46 ± 1.94	20.68 ± 1.89	24.64±2.75

N: normal weight, Ow: overweight, Ob: obese

Table 3. Determinants of Body Mass Index in the Subjects

Variables	Adjusted r^2	Standard Error	Variation Explained (%)	F value
WC	0.1689	2.69	61.8	49.717***
TC	0.6845	2.45	6.6	33.542***
EE	0.7270	2.28	4.3	27.630***

WC: Waist Circumference, TC: Total Cholesterol, EE: Energy Expenditure

Table 4. Determinants of Waist Circumference in the Subjects

Variables	Adjusted r^2	Standard Error	Variation Explained (%)	F value
BMI	0.1689	5.48	61.9	49.717***
EE	0.7069	4.81	8.81	37.178***
TC	0.7622	4.33	5.51	33.054***
Sex	0.7969	4.00	3.4	30.428***
WHR	0.8400	3.55	4.4	32.501***

*** Significant at p<0.001

BMI: Body Mass Index, EE: Energy Expenditure, TC: Total Cholesterol, WHR: Waist to Hip Ratio

Determinants of Obesity in the Subjects

The variables that were studied for the influence on obe-sity in the subjects included family income, birth weight, heredity and diet. Majority of the subjects were from high income group having per capita income (PCI)>Rs.5000. The

prevalence of obesity was twice as high in this group (4.6%) as compared to subjects having PCI<Rs.5000 (2.5%). Similar trends were seen with regard to the preva-lence of overweight and the difference was statistically significant ($\chi 2=11.52$, $p<0.01$).

With regard to birth weight, the mean birth weight of sub-jects in categories of normal BMI, overweight and obese did not show significant variation (Normal: 2.95+0.49, Ow: 2.99+0.49, Ob: 3.01+0.55). However, the prevalence of overweight and obesity in subjects with birth weight >2.5kg was 19.1% as against 16% in those having birth weight <2.5kg. BMI of 1067 parents was studied in rela-tion to the children's BMI. Parents' BMI was signifi-cantly higher for high BMI children compared to normal-BMI children ($p<0.001$). Relative risk of children being overweight/obese when either of parents was over-weight/obese was 2.19 and it was 1.91 when both are overweight/obese. Overweight/obesity was higher in non-vegetarian subjects compared to vegetarians (24% vs. 19%), however the chi-square values were not significant. Mean carbohydrate and protein intakes were significantly higher in overweight/obese subjects as compared to nor-mal weight subjects ($p<0.001$). Percent calories from fat were on the higher side in all subjects while Iron and β-carotene intakes were inadequate. Energy expenditure (EE) of overweight/obese subjects was lower compared to intake; however the difference was statistically non-significant.

Fasting blood sugar levels were normal for all the subjects and the lipid profile also did not show any aberrations. The HDL-C tended to decrease with increase in grada-tions of obesity. Non-HDL fractions and atherogenic in-dices were comparable in all three groups. With respect to the type of diet,VLDL-C and Triacylglycerol (TAG) val-ues were significantly higher in overweight/obese sub-jects. Further, HDL-C also tended to be low in these chil-dren, indicating the role of diet in precipitating athero-genicity.

Contribution of sedentary lifestyle in overweight/obesity was evident from the TV viewing and video, computer games pattern of subjects. Ninety seven percent of obese subjects as against 87% of overweight and 84% of normal subjects viewed TV on a daily basis. Similar trend was seen in children who played videogames daily (26% vs. 19.2% vs. 5.6%).

Multiple regression analysis revealed that when BMI was considered as outcome variable, WC, TC and energy ex-penditure entered the equation as independent variables and 72% of total variation was explained by these (Table 3). Considering WC as dependent variable (Table 4), BMI, EE, TC, sex, and WHR found to be independent factors and explained total 84% of the variation and all variables were significant ($p<0.001$). Hence WC was found to be better in explaining causative factors of over-weight/obesity in 6-12year children than WHR. Thus lifestyle factors which influence WC and lipids were found to be important determinants influencing BMI in young children.

Discussion

In the present study, the prevalence of overweight and obesity was found to be 20.3%, which translates to nearly 1/5th of the age-group facing the problem of overnutrition. Several large scale studies in India [11 -13] have reported similar findings. Prevalence in China [14] was found to be much less than the prevailing rates reported in various Indian regions (4% vs.7-15%). Regarding obesity, most of the findings in India [11-13] have consistently reported the prevalence to be around 6% in various states in India, as opposed to only 0.9% in China [14].

Prevalence of obesity (Table 1) was highest when com-puted using CDC and Must et al standards (9.9% and 11.2% respectively) while those calculated using IOTF were lower (6%). Pandit et al [15] reported that over-weight/obesity prevalence rates computed using CDC and Agarwal standards were comparable and higher than those with IOTF standards in 6-17year old children. Vidal et al [16] and Willows et al [17] have also reported that when compared to CDC, IOTF standards provide a con-servative estimate of overweight/obesity prevalence in 5 year old children, which substantiates the present study findings.

Central obesity (using 95th percentile as cut-off) was found in 7% of the subjects in the present study, with fe-males having higher prevalence than that of male sub-jects. Misra et al [18] however reported higher prevalence of 17% in post-pubertal children of New Delhi. Non-HDL fractions and atherogenic indices were normal in all the subjects and no variation with regard to presence of obesity or gender was observed. Uzunlulu [19] found higher levels of non-HDL cholesterol among Turkish girls as compared to boys. Misra et al [20], reported higher total cholesterol and LDL cholesterol among boys as compared to girls, whereas, serum triacylglycerols were significantly higher in girls.

The fasting blood sugar levels did not show any aberra-tions in the present study subjects. Dabelea et al [21] also reported incidence of type 2 diabetes to be very infrequent among children (17.0 to 49.4 per 100,000 person-years), however still, prevalence was highest for American Indi-ans, than any other ethnic group/race. In a survey of chil-dren in UK, Ehtisham et al [21] reported that 22.3% chil-dren had type-2 diabetes and 17.85% had Maturity Onset Diabetes in Young. In contrast to type 1, type 2 patients presented later (12.8 v 9.3 years), were usually female, overweight, or obese (92% vs. 28%), and a greater pro-portion were of ethnic minority origin (56% v 22%), which included children of Indian origin.

Prevalence of obesity was looked into in relation to in-come, birth weight, heredity and type of diet. Among these variables, income and heredity contributed signifi-cantly to the prevalence. Kumar et al [22] also reported family history of obesity and excess TV viewing as poten-tial influencing factors of childhood obesity in a study on affluent school children in Davangere. In a prospective case-control design, an 8 year longitudinal study on Aus-tralian children [23] also found that parental Obesity and TV viewing hours spent by the children strongly influ-ence overweight/obesity in children.

Conclusions

Thus from the present study it can be concluded that the prevalence of overweight and obesity is high in young children, and the difference in child growth standards contributes only a minute variation in the face of such high prevalence. The non-modifiable risk factors (espe-cially heredity) exert heavy influence on the prevalence of high BMI in children. The modifiable risk factors (energy expenditure, sedentary lifestyle, and most importantly, type of diet and fat intake) are of prime importance, in order to gain control on the ever-escalating rate of obesity and there is a need to focus on interventions to keep a check on the problem. Further longitudinal research is required to gain better insight on the aberrations in lipid and glucose metabolism in pediatric populations affected by overweight/obesity especially in Indian context.

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