



Prevalence of Overweight and Obesity in Indian Adolescent School Going Children : Its Relationship with Socioeconomic Status and Associated Lifestyle Factors

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Abstract

Aims and Objectives: Obesity and overweight have become a worldwide epidemic, and there is an urgent need to examine childhood obesity and overweight across countries using a standardized international standard. In the present study we have investigated the prevalence of obesity and overweight and their association with socioeconomic status (SES) and the risk factors like diet, physical activity like exercise, sports, sleeping habit in afternoon, eating habits like junk food, chocolate, eating outside at weekend, family history of diabetes and obesity.

Material and Methods: The study was carried out in 5664 school children of 12–18 years of age and having different SES. The obesity and overweight were considered using an updated body mass index reference. SES and life style factors were determined using pre-tested questionnaire.

Results: Age-adjusted prevalence of overweight was found to be 14.3% among boys and 9.2% among girls where as the prevalence of obesity was 2.9% in boys and 1.5% in girls. The prevalence of overweight among children was higher in middle SES as compared to high SES group in both boys and girls whereas the prevalence of obesity was higher in high SES group as compared to middle SES group. The prevalence of obesity as well as overweight in low SES group was the lowest as compared to other group. Eating habit like junk food, chocolate, eating outside at weekend and physical activity like exercise, sports, sleeping habit in afternoon having remarkable effect on prevalence on overweight and obesity among middle to high SES group. Family history of diabetes and obesity were also found to be positively associated.

Conclusion: Our data suggest that the prevalence of overweight and obesity varies remarkably with different socioeconomic development levels.

Introduction

I ncreasing rates of overweight and obesity has reached epidemic proportions in developed countries and is rapidly increasing in many middle-income and less-developed countries.¹ The proportion of children in the general population who are overweight and obese has doubled over the past two decades in developed and developing countries including India^{2,3} and have a rising prevalence of diabetes.^{4,5} Childhood obesity increases the risk of adult obesity as well as chronic health problems such as type II diabetes, hypertension and cardiovascular disease.⁶⁻⁸ Obesity and overweight have become a global epidemic, and it is still increasing in both industrialized and developing countries.⁹ Obesity and overweight are an increasingly prevalent nutritional disorder among children and adolescents in the world.^{10,11} Numerous health risks have been associated with adolescent overweight, including hypertension, respiratory disease, several orthopedic disorders, diabetes mellitus and elevated serum lipid concentrations.¹² Due to the difficulty of curing obesity and overweight in adults and the many long-term adverse effects of childhood obesity, the prevention of child obesity has been recognized as a public health priority.¹³ Increasing evidence shows that childhood obesity

and overweight have a profound influence on morbidity and mortality in adult life.¹³⁻¹⁵ It has been reported that population prevalence of overweight increased by 60–70%, obesity increased 2–4-fold during 1985–1997 in Australia,¹⁶ In British children from 1989 to 1998 there was a highly significant increasing trend in the proportion of overweight children (14.7% to 23.6%); and obese children (5.4% to 9.2%);¹⁷ the prevalence of child obesity and overweight has doubled in North America during the past two decades¹⁸ and in Thailand, the prevalence of obesity in schoolchildren has increased from 12% in 1991 to 16% in 1993.¹⁹ However, few studies have examined the worldwide situation regarding childhood obesity, particularly due to the fact that no standard or reference is agreed upon internationally. Different definitions have been used in studies to define childhood obesity and overweight.^{13,20,21} There has been a lack of consensus over the definitions, the current lack of consistency and agreement between different studies over the classification of obesity and overweight in children and adolescents makes it difficult to give an overview of the global prevalence of obesity and overweight. Thus, the world based standardized obesity and overweight classification system is urgently needed but now internationally based cutoff points have been published.²⁰ Various contributing factors to obesity and overweight are socio-economic group, family history and diet and life style of the children.²²⁻²⁴

There are some studies on adults which have examined the relationship between socioeconomic status (SES) factors and

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Table 1 : Demographic and anthropometric characteristics of study subjects

Age	Boys				Girls			
	%	Height (cm)	Weight (kg)	BMI (kg/m ²)	%	Height (cm)	Weight (kg)	BMI (kg/m ²)
12	86	154.4 ± 0.7	46.7 ± 0.7	19.9 ± 0.2	14	150.1 ± 1.1	44.6 ± 1.1	19.8 ± 0.5
13	57	151.6 ± 0.4	44.9 ± 0.4	19.5 ± 0.1	43	149.1 ± 0.4	43.4 ± 0.4	19.5 ± 0.2
14	63	154.6 ± 0.3	46.8 ± 0.3	19.6 ± 0.1	37	151.6 ± 0.3	44.0 ± 0.4	19.2 ± 0.2
15	48	155.0 ± 0.5	47.7 ± 0.4	19.8 ± 0.2	52	153.7 ± 0.3	46.2 ± 0.4	19.5 ± 0.2
16	57	160.0 ± 0.4	50.3 ± 0.5	19.7 ± 0.2	43	155.5 ± 0.3	45.4 ± 0.4	18.8 ± 0.1
17	48	160.0 ± 0.4	53.6 ± 0.5	20.9 ± 0.2	52	157.4 ± 0.3	47.9 ± 0.4	19.4 ± 0.2
18	52	158.3 ± 0.7	53.6 ± 0.7	21.4 ± 0.3	48	155.7 ± 0.9	49.0 ± 1.1	20.2 ± 0.4
Avg.		156.3 ± 0.5	49.1 ± 0.5	20.1 ± 0.1		153.3 ± 0.5	45.8 ± 0.3	19.5 ± 0.1

obesity, but less research has used data representing populations to examine the effects of these relationships of obesity and overweight on children are scanty.^{25-27,9} Among adults it is likely that causality operates in either direction.²⁹⁻³¹ We expected that it may be easier to test the direction of such causality with studies among children because usually the SES of children is determined by their parents' characteristics instead of being influenced by their own obesity status and the related social consequences. To our knowledge, limited efforts have been made to systemically examine the relationships between prevalence of childhood overweight and obesity and SES in west India using survey data in school going children.

Diet and lifestyle are ostensibly major contributors to weight problems and varies with different SES especially countries like India.³² Overweight and obesity are strongly associated with certain types of diets, such as those that include large amounts of fats, animal-based foods and processed foodstuffs.¹ Sedentary lifestyles are also an important factor, including spending no time for outdoor sports and participating in little or no physical activity during leisure time.^{33,34}

Our main objective was to examine the prevalence of childhood obesity and overweight in school children using internationally based cutoff points and compare the relationship between SES factors and associated dietary and life style factor obesity and overweight. On the basis of internationally based cutoff points we designed a study to determine the prevalence of overweight, obesity and its association with diet, sedentary life style, socio-economical status and physical activity in adolescent school children in India.

Subjects and Methods

The study included 5664 school children in the age group of 12–18 years; 3231 were boys and 2433 were girls. The schools were selected from different zones in the city to get an equal distribution of children by socio-economic state, ethnic variability and gender. Government schools for low-income group (n=2) and private schools attended by middle income (n=2) and high-income groups (n=2) were chosen. School authorities were requested to provide a list of children attending 8th to 12th standards. The Research Ethics Committee has approved the protocol for study. Informed consent was obtained from the school authorities to make anthropometric measurements and participation of schools was agreed with the health and education authorities in each school and also to collect data by questionnaire from the children. The questionnaire provided information on socioeconomic status and parents profession. The children were advised to take home the questionnaire to their parents to fill. Filled forms were returned the next day. Completed age of the children was noted. Standardized protocols were used for all interviews and examinations. Data on weight

and height were collected for each through direct physical examinations. Height and weight were measured using standard procedure and BMI (kg/m²) was calculated. Measurements were made by two trained technicians. The BMI of each child was determined and adjusted for expected BMI at age 18. The number of under weight, normal, overweight and obese was calculated.

Socioeconomic status of parents was classified as high socio-economic group, middle socio-economic group and lower socio-economic group based on the occupations of parents and family income which were found to be a reliable index of SES.^{22,35} Family income data were collected at the same time children's BMI measurements were collected. Trained interviewers administered the questionnaire to all children who attended school on the day of the survey. Children who were absent from school because of sickness or other reasons were not followed-up.

The questionnaire assessed life style, physical activity and social factors that influence physical and psychosocial health of representative samples of Children. Questionnaire items assessed were socioeconomic status, participation in sports, physical exercise, sleeping habit in afternoon, diet (having vegetarian or non vegetarian food), having junk food or not, chocolate eating habit, frequency of visiting restaurants per week. The present study also assessed family history of diabetes and obesity. Trained interviewers administered the questionnaire to all children who attended school on the day of the survey. Children who were absent from school because of sickness or other reasons were not followed-up.

Statistical Analysis

Body mass index (BMI, kg/m²) was calculated on measured height and weight and was used to identify underweight, overweight and obese conditions using age and sex appropriate normative cut points. We examined the prevalence of overweight and underweight in each gender by age group, sex, and SES. Group comparisons were performed using ANOVAs or χ^2 tests as appropriate. Influence of various factors on prevalence of underweight, normal, overweight and obesity were expressed in form of percentage.

Results

A total number of 5664 with age group between 12-18 years from different school were screened for their height, weight and body mass index. Out of 5664 children 3231 (57%) were boys and 2433 (43%) were girls (Table 1). The height, weight and BMI were higher in boys than girls (Table 1). However, these differences were not significantly different with respect to gender at any given age.

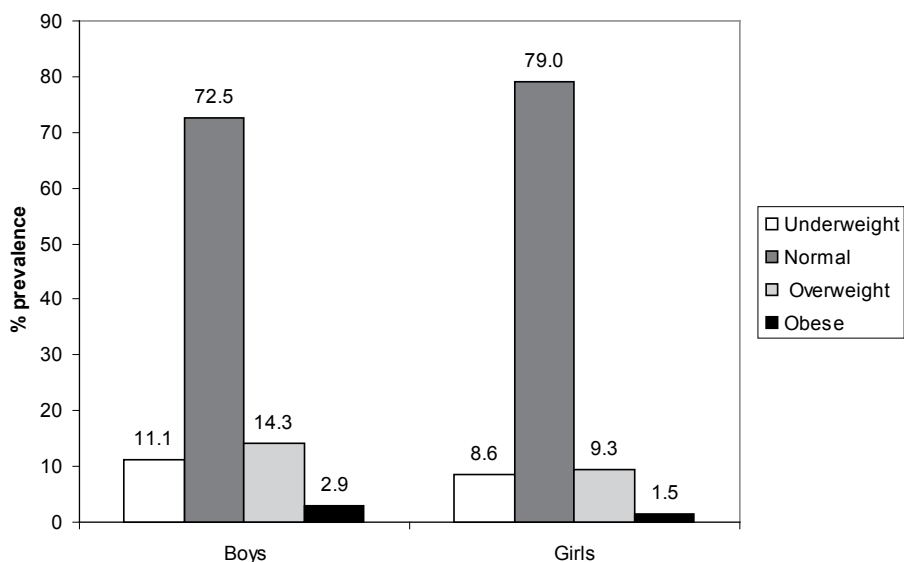


Fig. 1 : Overall distribution of boys and girls for prevalence of underweight, normal, overweight and obesity.

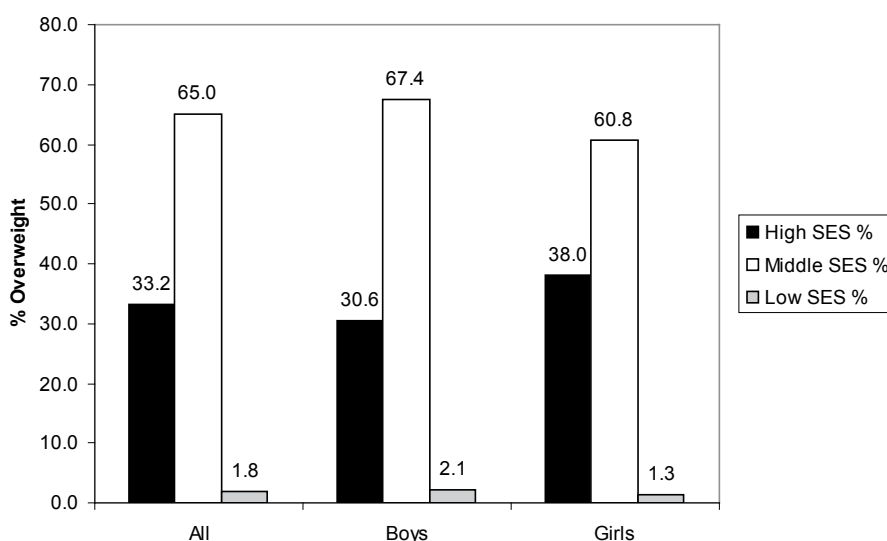


Fig. 2 : Overall prevalence (%) of overweight and its relationships with socioeconomic status (SES) among children.

Prevalence of overweight and obesity

The overall prevalence of boys and girls having normal BMI were 72.5% and 79.0 % respectively. The prevalence of overweight was 14.3 % (95% confidence interval (CI) 6.6- 24.5%) among boys and 9.3 % (CI 3.6-22.5%) among girls. Prevalence of obesity was 2.9 % (CI 0.0–4.0%) in boys and 1.5% (CI 0.0–5.0%) in girls. The prevalence of underweight is 11.1 % in boys and 8.6% in girls (Fig. 1). There was also a higher prevalence of overweight and obesity in boys compared with girls, but difference was not significant.

Comparison of relationships between overweight and obesity with SES

The over all prevalence of overweight and obesity and its relationships with socioeconomic status are presented in Fig 2, 3. The prevalence of overweight among children was high in middle SES as compared to high SES group in both the gender; however prevalence of overweight was the lowest in the low SES group. By contrast, prevalence of obesity was higher in high SES group as compared to middle SES group. Thus, socioeconomic status was related to children's risks of being obese or overweight

and high SES groups were at a higher risk of obesity, while middle SES groups were at higher risk of overweight. While no prevalence of obesity was found in children from low SES group.

Prevalence of overweight and obesity and its relationships with socioeconomic status by age, sex has been given in Table 2, 3. We found that similar significant associations between obesity and SES exist in both gender in each year of age. Children from middle SES groups were at higher risk of overweight, while those from high SES were at a higher risk of obesity at each year of age. The association between SES and prevalence of overweight and obesity was not significantly related to age. The impact on SES did not see to vary much by age.

Moreover our analysis stratified by gender indicates that boys and girls are at different risks even if they have the same SES (Table 2, 3). Girls from high SES group tend to have lower risk of obesity as compared to boys; similarly those from middle SES groups were found to have lower risk of overweight as compared to boys.

Obese and over weight children participated in sports less often than normal-weight and underweight participants, similarly obese and overweight children participated in physical

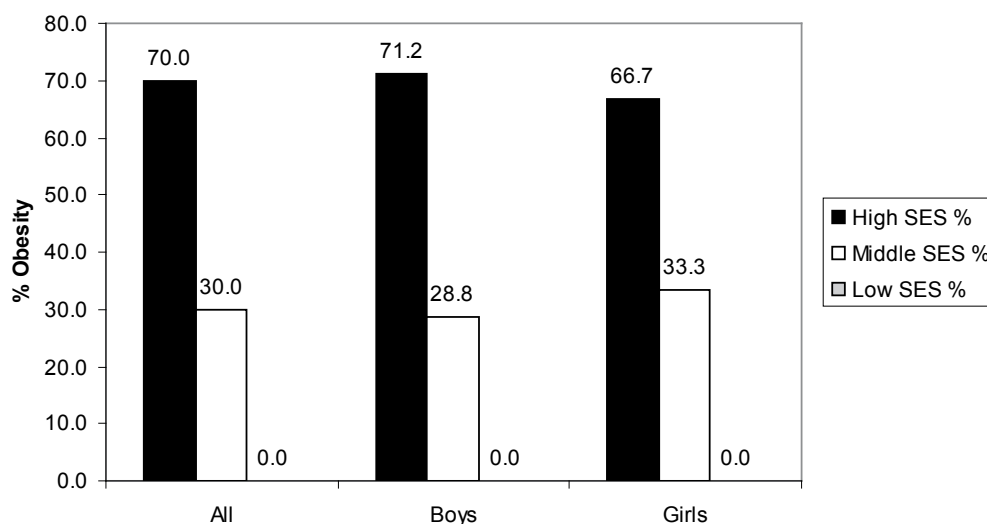


Fig. 3 : Overall prevalence (%) of obesity and its relationships with socioeconomic status (SES) among children.

Table 2 : Comparison of relationships between overweight and socioeconomic status (SES) by sex and age.

Age	Boys			Girls		
	High SES %	Middle SES %	Low SES %	High SES %	Middle SES %	Low SES %
12	11.1	88.9	0.0	50.0	50.0	0.0
13	3.8	92.3	3.8	41.0	56.4	2.6
14	39.1	58.7	2.2	25.0	75.0	0.0
15	15.4	84.6	0.0	26.3	73.7	0.0
16	46.9	50.0	3.1	40.0	60.0	0.0
17	42.9	57.1	0.0	50.0	50.0	0.0
18	25.0	75.0	0.0	50.0	50.0	0.0

Table 3 : Comparison of relationships between obesity and socioeconomic status (SES) by sex and age

Age	Boys			Girls		
	High SES %	Middle SES %	Low SES %	High SES %	Middle SES %	Low SES %
12	75.0	25.0	0.0	50.0	50.0	0.0
13	71.4	28.6	0.0	66.7	33.3	0.0
14	81.0	19.0	0.0	66.7	33.3	0.0
15	60.0	40.0	0.0	66.7	33.3	0.0
16	66.7	33.3	0.0	75.0	25.0	0.0
17	57.1	42.9	0.0	66.7	33.3	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0

exercise less often than normal-weight and underweight participants. The results showed physical activities did influence change in BMI. The obesity and overweight were some what more prevalent among children who were having sleeping habit in afternoon than normal, underweight children but, the difference was very slight between those who did or did not having sleeping habit in afternoon (Table 4, 5).

Vegetarian diet or non-vegetarian diet did not have any effect on prevalence of underweight, overweight and obesity, but junk food and chocolate eating habits have more prevalence of obesity and overweight than underweight indicates that caloric intake is associated with increase in BMI (Table 4, 5).

A gradation in restaurant visit per week was shown in both the gender in Table 4, 5 whereby obese and over weight children were more likely to visit restaurant more than once a week than their underweight and normal-weight counterparts.

BMI has a strong independent association with family history of diabetes and obesity. Children having family history of obesity were more likely to have more prevalence of obesity and overweight than those having family history of diabetes (Table 4, 5).

Discussion

There is wide spread reports regarding the trend of increasing prevalence of overweight and obesity among children and adolescents.³⁶⁻⁴⁰ The estimated prevalence of overweight among US children in 1999-2000 was more than 15%, and the value in Australia was almost 20%.⁴¹ In Brazil the prevalence of overweight among school children has tripled and increased

from 4% in the 1970s to 14% in late 1990s.⁴² In Egypt 14% of children were overweight or obese in 1997.⁴³ Worthy of mention, there are still controversies over the use of a series of universal BMI cut-offs to define obesity or overweight in different populations of either adults or children.^{42,44} A comparison of international references still shows lower prevalence of overweight in the Eastern world. For Asian and Caucasian populations it is suggested that different BMI cut-offs should be used for obesity. However, recent studies in India and other countries revealed that obesity is becoming a growing health problem among children and adolescents, especially in urban populations.⁴⁵

The present study showed that the prevalence of overweight was high among children, 14.3% in boys, 9.3% in girls. The obesity was seen in 2.9% of boys and 1.5% of girls. Our results are consistent with previous studies by Anand & Tandon, (1996) and Verma et al., (1994) in Northern Indian children and Ramachandran et al., (2002) in Southern Indian children. Our study is for the first time from Western part of India.

The relatively low prevalence of obesity among Indian children (3-2%) may be surprising, but the relatively high prevalence of overweight (14-9%) is alarming. Overweight children often become overweight adults⁴⁸ and overweight in adulthood is a health risk.⁴⁹ Several disorders have been linked to overweight and obesity in childhood. Obesity results in considerable morbidity and mortality, of which cardiovascular disease and type 2 diabetes mellitus, remains one of the principal causes.^{50,51}

In our study, the increase in the prevalence of overweight and obesity occurred at the age of 12 years and decreasing with

Table 4 : Characteristics of underweight, normal-weight, overweight and obese boys in years 12-18

Characteristics	Under weight	Normal	Overweight	Obese
Age (12-18)	11.1	72.5	14.3	2.9
Participates in sports				
Yes (%)	57.3	52.3	43.8	32.2
No (%)	36.8	35.9	56.3	67.8
Physical exercise				
Yes (%)	58.4	52.6	38.5	27.1
No (%)	41.6	47.4	61.5	72.9
Sleeping habit in afternoon (%)				
Yes (%)	41.9	46.2	54.9	59.3
No (%)	58.1	53.8	45.1	40.7
Diet habit				
Vegetarian (%)	96.0	95.7	91.7	89.8
Nonvegetarian(%)	4.0	4.3	8.3	10.2
Restaurant visit a week				
Visits more than once (%)	77.0	82.6	86.1	87.9
Visits once or no (%)	23.0	17.4	13.9	12.1
Takes junk food regularly (%)				
Yes (%)	46.9	57.3	63.9	67.8
No (%)	53.1	42.7	36.1	32.2
Chocolate eating habit				
Yes (%)	43.9	55.7	60.4	66.1
No (%)	56.1	44.3	39.6	33.9
Family history of diabetes (%)				
Yes (%)	18.8	20.7	23.6	23.7
No (%)	81.2	79.3	76.4	76.3
Family history of obesity (%)				
Yes (%)	23.6	26.2	35.3	39.0
No (%)	76.4	73.8	64.7	61.0

age which indicates that children at age of 12 are at high risk to become overweight or obese at adolescent while student at the age of 17 is at lower risk of overweight or obesity.

There was a higher prevalence of overweight and obesity in boys compared with girls. This indicates that gender difference was effect modifier which correlates well with previous reports.^{52,53} Differences in the increase in the prevalence of obesity observed between boys and girls could be explained by higher physical activity level of boys observed in this population.⁵⁴

It has been reported previously that BMI is influenced by different SES backgrounds.⁵⁵ We found that the prevalence of obesity differs remarkably with different socioeconomic development levels. Our results clearly show that higher prevalence of overweight and obesity is becoming a worldwide epidemic. The remarkable variation in the prevalence across populations suggests that social, economic, and environmental factors are important influences on the epidemic, although it maybe also true that genetic differences across populations also play a role.⁵⁶ Our analysis shows that childhood overweight and obesity is related to SES, although the relationships differ little among gender. We used family income as a primary indicator of SES. The prevalence of overweight among children was higher in middle SES as compared to higher SES group in both the gender. However prevalence of overweight was the lowest in the low SES group. By contrast, prevalence of obesity was higher in high SES group as compared to middle SES group. In developed countries such as the UK, an association between social deprivation and childhood obesity was strong, especially in the girls.⁵⁷ In our

Table 5 : Characteristics of underweight, normal-weight, overweight and obese girls in years 12-18.

Characteristics	Under weight	Normal	Overweight	Obese
Age (12-18)	8.6	79.0	9.3	1.5
Participates in sports				
Yes (%)	62.3	58.9	44.3	28.6
No (%)	37.7	41.1	55.7	71.4
Physical exercise				
Yes (%)	45.0	38.1	35.4	9.5
No (%)	55.0	61.9	64.6	90.5
Sleeping habit in afternoon (%)				
Yes (%)	38.6	45.1	54.4	69.6
No (%)	61.4	54.9	45.6	30.4
Diet habit				
Vegetarian (%)	97.4	95.7	93.7	95.2
Nonvegetarian(%)	2.6	4.3	6.3	4.8
Restaurant visit a week				
Visits more than once (%)	66.7	82.3	86.4	92.2
Visits once or no (%)	33.3	17.7	13.6	7.8
Takes junk food regularly (%)				
Yes (%)	45.9	53.4	63.3	76.2
No (%)	54.1	46.6	36.7	23.8
Chocolate eating habit				
Yes (%)	44.4	51.7	71.4	85.7
No (%)	55.6	48.3	28.6	14.3
Family history of diabetes (%)				
Yes (%)	18.2	21.3	24.1	23.8
No (%)	81.8	78.7	75.9	76.2
Family history of obesity (%)				
Yes (%)	33.3	23.3	35.4	47.6
No (%)	66.7	76.7	64.6	52.4

country, social deprivation resulted in lower BMI among the children. This difference may be due to the fact that criteria of social deprivation vary in developed and developing countries. Social deprivation results in unavailability of sufficient food and thus causes nutritional deficiencies. The low economic group probably reflects nutritional imbalance as a result of poverty.⁵⁸

Furthermore, our analysis stratified by sex and age further indicate that social, economic, and environmental factors may operate through complex pathways to influence childhood obesity. In general our findings regarding the relationships between obesity and SES are consistent with findings from many previous studies.^{26,27,43,59}

One possible explanation for the different SES-overweight and obesity relationship in developing countries such as India is that the influence of SES on people's lifestyles such as diet, food consumption patterns, and public services such as health care and transportation and physical activity may differ. Richer people have better access to meat and other energy-dense foods (which are much more expensive than other foods such as vegetables) than the poor. While Middle SES groups usually consume more vegetables and fruits, which are less energy-dense, than High SES groups.⁶⁰

Sedentary behavior and physical activity in children may be predictive of body mass in late adolescence. Sleeping habit in afternoon, decreased sports and exercise have also been implicated in childhood obesity because they reduce resting metabolism results in reduction of physical activity. A change in the volume of daily physical activity may account for imbalance

between energy intake and energy expenditure.⁶¹ Physical activity among children has been related to obesity through different mechanisms.⁶² In the present study physical activity in childhood attenuated BMI increases and these findings are consistent with studies that showed that body mass in children is influenced by the sleeping habit in afternoon, lack of physical exercise, and sports habit because sleeping habit in afternoon influenced BMI through displacing the time that could be spent playing sports or engaging in other forms of physical activity. Reduced levels of physical activity may also lead to lower energy expenditure, thus affecting resting metabolic rate and total energy expenditure. In our study we found that obesity and overweight have inverse relationship with physical activity. These data are consistent with previous studies in different countries.⁶³⁻⁶⁶ These data suggest that decrease in physical activity are due to expending less energy in activities of daily living, and at work. Thus an active lifestyle during childhood can play an important role in optimizing growth and development.⁶⁷ Comprehensive school and community programs to be developed to promote physical activity among children.

Questionnaires about type of diet either vegetarian or non vegetarian, frequency of visiting restaurants per week and habit of having junk food provide information about subsequent health outcomes. Such information in various studies in children permits individual diets to be related to subsequent health outcomes.⁶⁸ We focused our analysis on type of diet, junk food and chocolate eating habits and frequency of restaurant visit per week because that they have special roles in obesity. In the present study we found that junk food and chocolate eating habit have positive relation with prevalence of obesity and overweight. These results correlate well with previous reports which suggest that junk food (bakery items, pizza, burger, cheese, butter, oily items) chocolate intake tends to be more common among overweight and obese adolescents than among normal-weight adolescents.^{69,70} Junk food contains more amount of fat than carbohydrate and protein.⁷¹⁻⁷³ Fat is less satiating than carbohydrate and dietary fat is stored more efficiently than carbohydrate or protein which finally results in obesity or overweight.⁷⁴ Similarly irregular food intake deleteriously affects nutritional health, reduces energy levels and promotes the consumption of high caloric food later in the day.⁷⁵ In our study restaurant visit per week was positively associated with BMI. These results are consistent with other studies which show an association between frequency of restaurant visit and obesity.⁷⁶ A similar cohort study found that sedentary behaviors were associated with increases in BMI⁷⁷ and treatment studies have shown that decreases in sedentary behavior are linked with decreases in weight problems and body fat.^{78,79}

Appropriately, provisions of healthy foods options and physical activities for children are at the forefront of public health initiatives to curb an obesity pandemic. Thus, our data showed influences of sedentary behavior and physical activity on prevalence of underweight, overweight and obesity.

Prevalence of overweight and obesity are more in children with family history of diabetes and obesity.⁸⁰ In the present study we found that family history of obesity were more likely to have more prevalence of obesity and overweight than those having family history of diabetes. Our results correlates with previous study which suggest that family history of obesity have more prevalence to obesity than family history of diabetes.⁸¹ This indicates that children having family history of obesity are more likely to become obese or over weight.

Questionnaire enabled analyses of several contributing factors to changes in prevalence of underweight, overweight and obesity. An appropriate follow-up to this study could involve more frequent assessments to better reveal changes in BMI over time. In all, the study demonstrated that socioeconomic status, sedentary behavior and physical activity in children influenced prevalence of overweight and obesity. Prevention of obesity in children is easier than the adults. Based on the findings of this study it is recommended that consumption of high fat and high energy food (Junk foods) and visiting restaurants more than once in a week should be avoided by children. Sedentary life style should be discouraged. Increase physical activity like playing outdoor games, walking, cycling should be encouraged in children. Health education should be given to parents, teachers and children regarding dietary habit and sedentary life style (school based intervention).

Further research is needed to investigate whether the gap is due to the differences in children's social and economical factors, such as diet and physical activity, or sexual maturation is related to being fat, and adolescents in many developing countries. Our study has several limitations. Although study, however, was designed to monitor trends, provinces of different geography, economic development, public resources, and health indicators have been included and, in each province, communities of different SES levels were sampled.

Our data suggest that the prevalence of over weight and obesity varied remarkably with difference in SES development levels, this was associated with life style and dietary management.

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References

1. Chopra M, Galbraith S, Darnton-Hill I. A global response to a global problem: the epidemic of over nutrition. *Bull World Health Organ* 2002; 80: 952-958.
2. Bundred P, Kitchiner D, Buchan I. Prevalence of overweight and obese children between 1989 and 1998: population based series of cross sectional studies. *Br Med J* 2001; 322: 326-328.
3. Ogden CL, Flegal KM, Carroll MD, Johnson CL. Prevalence and trends in overweight among US children and adolescents, 1999-2000. *JAMA* 2002; 288:1728-1732.
4. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995-2025 prevalence, numerical estimates and projection. *Diabetes Care* 1998; 21:1414-1431.
5. Ramachandran A, Snehalatha C, Latha E, Vijay V, Viswanathan M. Rising prevalence of NIDDM in urban population in India. *Diabetologia* 1997; 40:232-237.
6. Guo SS, Chumlea WC. Tracking of body mass index in children in relation to overweight in adulthood. *Am J Clin Nutr* 1999; 70:1455-18.
7. Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics* 1998; 101:518-25.
8. Chinn S, Roberto JR. Prevalence and trends in overweight and obesity in three cross sectional studies of British children, 1974-1994. *Br Med J* 2001; 322:24-26.
9. Sundquist J, Johansson SE. The influence of socioeconomic status, ethnicity and lifestyle on body mass index in a longitudinal study. *Int J Epidemiol* 1998; 27:57-63.

10. Ross JG, Pate RR, Lohman TG, Christenson GM. Changes in the body composition of children. *J Phys Educ Rec Dance* 1987; 58:74-77.
11. Shear CL, Freedman DS, Burke GL, Harsha DW, Webber LS, Berenson GS. Secular trends of obesity in early life: the Bogalusa Heart Study. *Am J Public Health* 1988; 78:75-77.
12. Gortmaker SL, Dietz WH Jr, Cheung LW. Inactivity, diet and the fattening of America. *J Am Diet Assoc* 1990; 90:1247-1255.
13. Power C, Lake JK, Cole TJ. Measurement and long-term health risks of child and adolescent fatness. *Int J Obes Relat Metab Disord* 1997; 21:507-526.
14. Bray GA, Bouchard C, James WPT. *Handbook of Obesity*. New York: Marcel Dekker; 1998.
15. Must A, Strauss RS. Risks and consequences of childhood and adolescent obesity. *Int J Obes Relat Metab Disord* 1999; 23:S2-11.
16. Booth ML, Chey T, Wake M, Norton K, Hesketh K, Dollman J, Robertson I. Change in the prevalence of overweight and obesity among young Australians, 1969-1997. *Am J Clin Nutr* 2003; 77:29-36.
17. Bundred P, Kitchiner D, Buchan I. Prevalence of overweight and obese children between 1989 and 1998: population based series of cross sectional studies. *Br Med J* 2001; 322:326-328.
18. Troiano RP, Flegal KM. Overweight prevalence among youth in the United States: why so many different numbers? *Int J Obes Relat Metab Disord* 1999; 23:S22-27.
19. Mo-suwan L, Junjana C, Puetpaiboon A. Increasing obesity in school children in a transitional society and the effect of the weight control program. *SE Asian J Trop Med Public Health* 1993; 24:590-94.
20. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *Br Med J* 2000; 320:1240-1243.
21. Guillaume M. Defining obesity in childhood: current practice. *Am J Clin Nutr* 1999; 70:1265-1305.
22. Ramachandran A, Snehalatha C, Vinitha R, Megha T, Sathish Kumar CK, Sheeba L, Joseph S, Vijay V. Prevalence of overweight in urban Indian adolescent school children. *Diabetes Res Clin Pract* 2002; 57:185-190.
23. Moussa MA, Shaltout AA, Nkansa-Dwamena D, Mourad M, Alsheikh N, Agha N, Galal DO. Factors associated with obesity in Kuwaiti children. *Eur J Epidemiol*. 1999; 15:41-49.
24. Musaiger AO, Matter AM, Alekri SA, Mahdi AR. Obesity among secondary school students in Bahrain. *Nutr. Health* 1993; 9: 25-32.
25. Lahmann PH, Lissner L, Gullberg B, Berglund G. Sociodemographic factors associated with long-term weight gain, current body fatness and central adiposity in Swedish women. *Int J Obes Relat Metab Disord* 2000; 24:685-94.
26. Parsons TJ, Power C, Logan S, Summerbell CD. Childhood predictors of adult obesity: a systematic review. *Int J Obes Relat Metab Disord* 1999; 23:S101-107.
27. Sobal J, Stunkard AJ. Socioeconomic status and obesity: a review of the literature. *Psychol Bull* 1989; 105:260-75.
28. Taylor CB, Jatulis DE, Winkleby MA, Rockhill BJ, Kraemer HC. Effects of life-style on body mass index change. *Epidemiology* 1994; 5:599-603.
29. Sobal J. Obesity and socioeconomic status: a framework for examining relationships between physical and social variables. *Med Anthropol* 1991; 13:231-47.
30. Sobal J. Social and economic consequences of overweight in adolescence. *N Engl J Med* 1994; 330:647.
31. Stunkard AJ, Sorensen TIA. Obesity and socioeconomic status-a complex relation. *N Engl J Med* 1993; 329:1036-37.
32. Klesges RC, Klesges LM, Eck LH, Shelton ML. A longitudinal analysis of accelerated weight gain in preschool children. *Pediatrics* 1995; 95:126-30.
33. Varo JJ, Martinez-Gonzalez MA, De Irala-Estevez J, Kearney J, Gibney M, Martinez JA. Distribution and determinants of sedentary lifestyles in the European Union. *Int J Epidemiol* 2003; 32:138-146.
34. Flodmark CE, Lissau I, Moreno LA, Pietrobelli A, Widhalm K. New insights into the field of children and adolescents' obesity: the European perspective. *Int J Obes Relat Metab Disord* 2004; 28:1189-1196.
35. Baker PC, Mott FL. *NLSY child handbook 1989: a guide and resource document for the National Longitudinal Survey of Youth 1986 child data*. Columbus: Ohio State University; 1989.
36. Mo-suwan L, Junjana C, Puetpaiboon A. Increasing obesity in school children in a transitional society and the effect of the weight control program. *SE Asian J Trop Med Public Health* 1993; 24:590-94.
37. Troiano RP, Flegal KM, Kuzmarski RJ, Campbell SM, Johnson CL. Overweight prevalence and trends for children and adolescents: the national health and nutrition examination surveys, 1963 to 1991. *Arch Pediatr Adolesc Med* 1995; 149:1085-91
38. Wabitsch M, Kunze D, Keller E, Keiss W, Kromeyer-Hauschild K. Ever more children and adolescents are overweight. How can the obesity epidemic be stopped? *MMW Fortschr Med* 2002; 144:30-34.
39. Wang Y, Wang JQ. A comparison of international references for the assessment of child and adolescent overweight and obesity in different populations. *Eur J Clin Nutr* 2002; 56: 973-82.
40. Chatterjee P. India sees parallel rise in malnutrition and obesity. *Lancet* 2002; 360:1948.
41. Baur LA. Child and adolescents obesity in the 21st century: an Australian perspective. *Asia Pac J Clin Nutr* 2002;11: S524-S528.
42. Wang Y, Monteiro C, Popkin BM. Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China, and Russia. *Am J Clin Nutr*. 2002; 75:971-977.
43. Ibrahim B, Sallam S, El Tawila S, El Gibaly O, El Sahn F, Lee SM, Mensch B, Wassef H, Bukhari S, Galal O. *Transitions to Adulthood: A National Survey of Egyptian Adolescents*. Cairo: New York, New York, Population Council, 1999.
44. Deurenberg P, Yap M, van Staveren WA. Body mass index and percent body fat: a meta analysis among different ethnic groups. *Int J Obes Relat Metab Disord* 1998; 22:1164-1171.
45. Callahan ST, Mansfield MJ. Type 2 diabetes mellitus in adolescents. *Curr Opin Pediatr*. 2000; 12:310-315.
46. Anand NK, Tandon L. Prevalence of hypertension in school going children. *Indian Pediatr* 1996; 33: 377-381.
47. Verma M, Chhatwal J, George SM. Obesity and hypertension in children. *Indian Pediatr* 1994; 31:1065-1069.
48. Serdula MK, Ivery D, Coates RJ, Freedman DS, Williamson DF, Byers T. Do obese children become obese adults? a review of the literature. *Prev Med* 1993; 22:167-177.
49. Pi-Sunyer FX. Health implications of obesity. *Am J Clin Nutr* 1991; 53:1595-16035.
50. Berenson GS, Svinivasan SR, Bao W, Mewman WP 3rd, Tracy RE, Wattigney WA. Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. *N Engl J Med* 1998; 338:1650-1656.
51. Fagot-Campagna A. Emergence of type 2 diabetes mellitus in children: epidemiologic evidence. *J Pediatr Endocrinol Metab* 2000; 13:1395- 1405.
52. Rothman KJ, Greenland S. *Modern Epidemiology*. Philadelphia, PA: Lippincott-Raven, 1998.
53. Popkin BM, Udry JR. Adolescent obesity increases significantly in second and third generation US immigrants: the National Longitudinal study of Adolescent Health. *J Nutr* 1998; 128:701-706.
54. Lafay L, Oppert J, Charles MA, Borys JM, Ducimetière P. Evaluation of walking and running pattern using electronic pedometers in a community: The Fleurbaix Laventie Ville Santé II (FLVS II) study. *Int J Obes Relat Metab Disord*. 2000; 24: S157.
55. Lusky A, Lubin F, Barell V, Kaplan G, Layani V, Lev B, Wiener M. Body mass index in 17-year-old Israeli males of different ethnic

- backgrounds; national or ethnic-specific references? *Int J Obesity* 2000; 24:88-92.
56. Goldblatt PB, Moore ME, Stunkard AJ. Social factors in obesity. *JAMA* 1965; 192:1039-1044.
 57. Kinra S, R.P. Nelder, G.J. Lewendon, Deprivation and child hood obesity: a cross sectional study of 20 973 children in Plymouth, United Kingdom, *J. Epidemiol. Community Health* 54 (2000) 456-460.
 58. Qamra SR, Mehta S, Deodhar SD. A mixed longitudinal study on the pattern of pubertal growth. Relationship to socio economic status and calorie intake-IV, *Indian Pediatr* 1991; 28:147-156.
 59. McMurray RG, Harrell JS, Deng S, Bradley CB, Cox LM, Bangdiwala SI. The influence of physical activity, socioeconomic status, and ethnicity on the weight status of adolescents. *Obes Res* 2000; 8:130-139.
 60. Ge K, Zhai F, Yan H. *The Dietary and Nutritional Status of Chinese Population (1992 National Nutrition Survey)*. Beijing: People's Medical Publishing House; 1996.
 61. Rosenbaum M, Leibel R, Hirsch J. Obesity. *N Eng J Med* 1997; 337: 396-407.
 62. Gortmaker S, Dietz W, Cheung L. Inactivity, diet and the fattening of America. *J Am Diet Ass* 1990; 90:1247-1255.
 63. Hernaandez B, Gortmaker SL, Colditz GA, Peterson KE, Laird NM, Parra-Cabrera S. Association of obesity with physical activity, television programs and other forms of video viewing among children in Mexico City. *Int J Obesity* 1999; 23:845-854.
 64. Ross EA, Carlos JC, Susan JB, Lawrence JC, Michael P. Relationship of Physical Activity and Television Watching With Body Weight and Level of Fatness Among Children. *JAMA* 1998; 279:938-942.
 65. Tremblay MS, Willms JD. Is the Canadian childhood obesity epidemic related to physical inactivity? *Int J Obesity* 2003; 27:1100-1105.
 66. Prentice AM, Jebb SA. Obesity in Britain: gluttony or sloth? *BMJ* 1995; 311:437-439.
 67. Cooper DM. Evidence for and mechanisms of exercise modulation of growth. *Med Sci Sports Exerc* 1994; 26:733-740.
 68. Rockett HR, Colditz GA. Assessing diets of children and adolescents. *Am J Clin Nutr* 1997; 65:1116S-1122S.
 69. Klesges RC, Klesges LM, Eck LH, Shelton ML. A longitudinal analysis of accelerated weight gain in preschool children. *Pediatrics* 1995; 95:126-130.
 70. Wolfe WS, Campbell CC, Frongillo Jr EA, Haas JD, Melnik TA. Overweight schoolchildren in New York State: prevalence and characteristics. *Am J Public Health* 1994; 84:807-813.
 71. Birch LL, Fisher JO. Development of eating behaviors among children and adolescents. *Pediatrics* 1998; 101:539-549.
 72. Rolls BJ, Kim-Harris S, Fischman MW, Foltin RW, Moran TH, Stoner SA. Satiety after preloads with different amounts of fat and carbohydrate: implications for obesity. *Am J Clin Nutr* 1994; 60:476-487.
 73. Blundell JE, Burley VJ, Cotton JR, Lawton CL. Dietary fat and the control of energy intake: evaluating the effects of fat on meal size and postmeal satiety. *Am J Clin Nutr* 1993; 57:772S-778S.
 74. Poppitt SD. Energy density of diets and obesity. *Int J Obes* 1995; 19:S20-S26.
 75. Tanasescu M, Ferris AM, Himmelgreen DA, Rodriguez N, Perez-Escamilla R. Biobehavioral Factors Are Associated with Obesity in Puerto Rican Children. *J Nutr* 2000; 130:1734-1742.
 76. Berkey CS, Rockett HR, Field AE, Gillman MW, Frazier AL, Camargo Jr CA, et al. Activity, dietary intake, and weight changes in a longitudinal study of preadolescent and adolescent boys and girls. *Pediatrics* 2000; 105:56-65.
 77. Leonard HE, Rocco AP, Constance CG, Joan D. Decreasing Sedentary Behaviors in Treating Pediatric Obesity. *Arch Pediatr Adolesc Med* 2000; 154:220-226.
 78. Elgara FJ, Roberts C, Moorec L, Tudor-Smith C. Sedentary behaviour, physical activity and weight problems in adolescents in Wales. *Public Health* 2005; 119: 518-524.
 79. Robinson TN. Reducing children's television viewing to prevent obesity: a randomized controlled trial. *JAMA* 1999; 282:1561-1567.
 80. Sinha R, Fisch G, Teague B, et al. Prevalence of impaired glucose tolerance among children and adolescents with marked obesity. *N Engl J Med*. 2002; 346:802-810.
 81. King H, Fitch C, Collins C, Koki G, King LF, Hey woof P. Glucose tolerance in Papua New Guinea: ethnic difference associated with environmental and behavioral factors and the possible emergence of glucose intolerance in highland community. *Med J Aust* 1989; 151:204-210.

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