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Childhood Obesity and Its Associated Factors among School Children in Udupi, Karnataka, India

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Background: Childhood obesity has become a serious public health problem in many low-and-middle income countries. This study aims to determine the prevalence and assess the factors associated with obesity among school children.

Methods: A cross-sectional school-based study was conducted among the 1185 secondary school students in Udupi, India. Data were collected using self-administered questionnaires. Weight and height were measured and Body Mass Index (BMI) was calculated. The z-score was calculated, and BMI was categorized based on its distribution by gender and age according to the World Health Organization (WHO). The BMI categories were reported as frequencies and percentages. Chi-square tests, followed by multiple logistic regressions, were used at 5% level of significance to identify factors associated with overweight and obese children.

Results: The overall prevalence of overweight and obese children was found to be 10.8% and 6.2%, respectively. Both 'overweight' and 'obese' were found more frequently among males (11.0% and 7.1%, respectively) than females (10.6% and 5.4%, respectively). Attending private schools, (AOR: 2.87, CI: 1.55-5.31), identifying as Muslim (AOR: 2.26, CI: 1.39-3.67), and having a father with a business occupation (AOR: 2.43, CI: 1.05-5.62) were found to be significantly associated with overweight/obese status.

Conclusion: We found a high prevalence of overweight and obese children in our study. Since obesity in adulthood has its onset in childhood, it is important to have effective implementation of school health activities to reduce and curb the burden of childhood obesity.

Key Words: Childhood obesity, Schoolchildren, Adolescent, Karnataka

INTRODUCTION

Overweight and obese are the terms used to describe body weight in excess of what is considered healthy for a particular height [1,2]. According to the World Health Organization (WHO), for children aged 5-19 years, overweight is defined as a Body Mass Index (BMI)-for-age greater than one standard deviation, and obese as a BMI-for-age greater than two standard deviations above the WHO growth reference median [1].

A sedentary lifestyle with low energy expenditure and consumption of high-calorie foods with low nutritional value are assumed to be the two most important factors responsible for the increasing rate of childhood obesity [3]. Overweight children have greater chances of becoming overweight or obese as they enter adulthood and are at a

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greater risk for chronic disease conditions in adulthood [1,2].

Globally, the prevalence of overweight individuals, including children aged 5-17 years is 10%; however, this prevalence varies according to region [4,5]. Different studies showed that the prevalence of overweight and obese status was below the level of 2.3% in Asia and in sub-Saharan Africa [6,7]. However, the sustained economic growth and increasing economic stability in Asia over the last three decades has enhanced the changing lifestyles leading to nutritional issues and the occurrence of chronic disease [8]. Strong evidence of an increasing trend for childhood obesity in low-and-middle income countries has been reported [9], although obesity was once considered a problem exclusive to high-income countries. In addition, the prevalence of obesity is higher in urban settings of many low-and-middle income countries [6,9,10].

India being a developing country, is also facing problem of the double burden of disease, in which one end includes childhood and adolescent obesity and other end consists of infectious disease, malnutrition and underweight [3,9]. The prevalence of obesity among adolescent in India is increasing significantly in recent years from 9.8% in 2006 to 11.7% in 2009 [11]. In our study, we decided to study any differences in the prevalence of childhood obesity based on types of schools, educational and occupational status of both the parents (father and mother). Thus, this study aims to determine the prevalence of overweight and obese children and to assess the factors associated with obesity among school children in Udupi, India.

MATERIALS AND METHODS

1. Study setting, design, and sampling

Information for this study was collected as a part of a larger study to assess the prevalence of hypertension. This was a cross-sectional study conducted from March to August 2012 in Udupi Taluk of the Udupi District, in the state of Karnataka, India, which was selected using stratified cluster random sampling. The sample size was calculated using the formula [$n = \{Z_{\alpha}^2 \times P (1 - P) / d^2\}$]. Considering an expected population parameter [12] ($p = 5.9\%$) with 95% confidence level, 2% absolute error (d), a non-response rate of 10% and a design effect of 2 due to cluster sampling, the sample size was calculated to be 1174. A list of all schools and the number of students studying at the secondary level (classes 8-10) in each school was obtained from the Block Education Office, Udupi Taluk. First, the schools were stratified into government, private aided and private unaided schools. For each stratified group, the schools were selected using simple random sampling; students from each stratum were selected using a proportionate allocation technique based on the number of students in each stratum. A complete enumeration of students from classes 8-10 was considered for the study. However, students absent on that day were excluded from the study. Schools were selected until the minimum required number of students in each group was obtained. Because of considering complete enumeration of students from class (8-10), the data were collected from 1185 students; thus, the final sample size of the study was 1185. A total of nine schools were selected for the study, of which three were government schools, two were private aided and four were unaided schools. The proportion of the distribution of students in the school strata was the same as in the school list obtained from the Block Education Office in Udupi Taluk, India.

2. Data collection and measurement

Data collection was carried out during a single visit. A semi-structured questionnaire was used. The questionnaire included information on demographic characteristics, dietary habits, and anthropometric measurements. Before completing the questionnaire, a brief orientation was provided regarding the study objectives and how to complete the questionnaire. The information on socio-demographic characteristics, dietary patterns, and frequency of consumption of junk food items relied on a self-report from students using an anonymous self-administered questionnaire.

The definitions of study variables were as follows:

An education level of parents (both the father and the mother) were divided into illiterate, primary level, secondary level, and higher secondary and above. Similarly, parent occupation was classified as, 'Professional' (highly educated jobs), 'skilled' (jobs that required a certain amount of training), 'unskilled' (jobs that required no special training), 'business' (jobs where an individual owned an enter-

prise), 'unemployed' (included only participants' fathers who did not have a job). Mothers who were unemployed and performing household chores were categorized as 'housewife'. A diet derived from plants and dairy products and without eggs, fish or meat was considered vegetarian; a diet which contained meat, fish, or other parts of animals, including eggs, was considered non-vegetarian/mixed. The frequency of junk food consumption was measured as no consumption, occasional consumer (consume less than twice a week) and frequent consumer (consume two or more times).

After the questionnaire was completed, anthropometric features were measured. Height was recorded to the nearest centimeter using a stadiometer with the child standing upright, with bare feet parallel, heels, buttocks, and shoulders touching the upright rod and head in Frankfurt plane; the headpiece of the device was gently lowered to measure height [13]. Weight was recorded using a calibrated and standardized digital weighing scale. BMI was calculated as weight in kilograms divided by the square of height in meters. Then, z-scores were calculated for each individual using the formula, z = {calculated BMI − median BMI (of the same age group as that of calculated) / standard deviation}. The median BMI used in the above formula was taken from the WHO 2007 Multi-centric Growth Reference Study (MGRS) Charts for ages 5-19 years. BMI was classified based on its distribution by gender and age according to the WHO 2007 MGRS charts into severe thinness (< −3 SD), thinness (< −2 SD), normal (−2 SD to +1 SD), overweight (> +1 SD), and obese (> +2 SD) [14].

3. Statistical analysis

Data were analyzed using SPSS for Windows, version 24 (IBM Corp, Armonk, New York, USA). Findings on socio-demographic status, dietary habits and BMI categories among participants are reported as frequencies and percentages. Independent sample t-test was used to compare the associations between gender and other continuous variables such as age, weight, height, and BMI. A Chi-square test was used to find the association between categorical variables (BMI categories and gender). To determine the relationship between BMI and other independent variables, BMI was categorized into two categories, normal BMI and elevated BMI (overweight and obese students). A Chi-square test was applied to examine the association between elevated BMI and other independent variables at the 5% level of significance. All the variables that were significant at 5% level of significance in bivariate analysis, in addition to gender (although gender was not found to be significant in bivariate analyses), were then entered into a multivariate logistic regression analysis to generate the adjusted odds ratio

Table 1. Characteristics of study participants (N=1185)

Variable	Number	Percentage (%)
Types of school		
Government	331	27.9
Aided	431	36.4
Unaided/private	423	35.7
Gender		
Male	590	49.8
Female	595	50.2
Religion		
Hindu	780	65.8
Muslim	138	11.6
Christian	267	22.5
Education of father		
Illiterate	126	10.6
Primary	361	30.5
Secondary	407	34.3
Higher secondary and above	291	24.6
Education of mother		
Illiterate	106	8.9
Primary	399	33.7
Secondary	398	33.6
Higher secondary and above	282	23.8
Occupation of father		
Professional	107	9.0
Skilled	295	24.9
Unskilled	484	40.8
Business	209	17.6
Unemployed	90	7.6
Occupation of mother		
Professional	73	6.2
Skilled	26	2.2
Unskilled	282	23.8
Business	8	0.7
Housewife	796	67.2
Dietary habits		
Vegetarian	101	8.5
Non-vegetarian/mixed	1,084	91.5
Frequency of junk food consumption		
No consumption	83	7
Occasionally	917	77.4
Frequently	185	15.6

Values are presented as number and percentage (%).

(AOR). Then adjusted odds ratio with corresponding 95% confidence interval (CI) were presented. P-values less than 0.05 were considered statistically significant. Before performing multiple regression analysis, independent variables were tested for multicollinearity among them. Based on previous literature, tolerance and variance inflation factors (VIF) were used to check for multicollinearity [15]. This test result indicated that no serious multicollinearity issues existed among the independent variables. The Hosmer and Lemeshow test was applied to determine the goodness-of-fit of the model.

4. Ethical approval

Ethical approval for the study from which this data was extracted was obtained from the Institutional Ethical Committee, Kasturba Hospital, Manipal University (IEC 198/2012). Informed consent was obtained from parents/guardians and the school administration prior to study enrollment. The anonymity of the students was maintained in this study.

RESULTS

1. General characteristics of study participants

Table 1 shows the distribution of characteristics of study participants. Out of 1185 participants, 36.4% were from unaided/private schools, followed by 35.7% from aided schools, and 27.9% from government schools. There was an almost equal distribution among males and females, 49.8% and 50.2%, respectively. Approximately two-thirds (65.8%) of the participants were Hindu by religion, and only 11.6% were Muslims. Most of the parents had attained primary and secondary education (father, 64.8%; mother, 67.3%). Regarding the occupation of parents, 40.8% of the fathers had unskilled work and more than two-thirds (67.2%) of the mothers were housewives. Most participants (91.5%) were non-vegetarian/mixed in their dietary habits. More than three-fourths (77.4%) of the participants consumed junk food occasionally and 15.6% consumed junk food frequently.

2. Anthropometric measurements and BMI categories

Anthropometric outcomes and the distribution of BMI categories of study participants by gender are summarized in Table 2. The participant age range was 12-16 years (mean ± SD, 13.71, 0.99). The mean age in years (13.79 ± 0.99 vs. 13.62 ± 1), weight in kg (42.59 ± 11.39 vs. 41.32 ± 8.87), and height in cm (155.98 ± 10.63 vs. 152.56 ± 6.98) were found to be higher in males than in females. The mean BMI in kg/m^2 (17.25 ± 3.10 vs. 17.64 ± 3.00) were higher in females than in males. Anthropometric measures such as age, weight, height, and BMI showed a significant difference among gender ($p < 0.05$). The prevalence of overweight and obese status was found to be 11.0% and 7.1% among males and 10.6% and 5.4% among females, respectively. The overall prevalence of overweight and obese children was found to be 10.8% and 6.2%, respectively.

Table 2. Anthropometric measurements and BMI categories by gender

Outcome measure	Males [n = 590 (49.8%)]		Females [n = 595 (50.2%)]		Total [N = 1185)]		p-value
	Mean	±SD	Mean	±SD	Mean	±SD	
Age (years)	13.79	0.99	13.62	1.00	13.71	0.99	0.004*
Weight (kg)	42.59	11.39	41.32	8.87	41.95	10.22	0.033*
Height (cm)	155.98	10.63	152.56	6.98	154.26	9.14	<0.001*
BMI (kg/m^2)	17.25	3.10	17.64	3.00	17.45	3.05	0.032*
BMI Categories	N	%	N	%	N	%	
Normal	483	81.9	500	84.0	983	83	0.437
Overweight	65	11.0	63	10.6	128	10.8	
Obese	42	7.1	32	5.4	74	6.2	

Student's t-test and Chi-square (X^2) test was used for statistical analyses.
*Statistically significant ($p < 0.05$).

3. Bivariate analysis

Table 3 shows bivariate analyses of independent variables with elevated BMI. The prevalence of elevated BMI varied significantly among students in different types of schools (6.9%, 10.9% and 31.2% in government, aided, and unaided/private schools, respectively; $p < 0.001$). Religion, education of both the father and mother, occupation of both the father and mother and frequency of junk food consumption were significantly associated with elevated BMI

Table 3. Bivariate analysis of independent variables with elevated BMI

Variables (N = 1185)	Normal BMI		Elevated BMI		p-value
	N	%	N	%	
Type of school					
Government	308	93.1	23	6.9	<0.001*
Aided	384	89.1	47	10.9	
Unaided/private	291	68.8	132	31.2	
Gender					
Male	483	81.9	107	18.1	0.321
Female	500	84	95	16	
Religion					
Hindu	683	87.6	97	12.4	<0.001*
Muslim	101	73.2	37	26.8	
Christian	199	74.5	68	25.5	
Education of father					
Illiterate	109	86.5	17	13.5	<0.001*
Primary	327	90.6	34	9.4	
Secondary	337	82.8	70	17.2	
Higher and above	210	722	81	27.8	
Education of mother					
Illiterate	92	86.8	14	13.2	<0.001*
Primary	360	90.2	39	9.8	
Secondary	322	80.9	76	19.1	
Higher and above	209	74.1	73	25.9	
Occupation of father					
Professional	73	68.2	34	31.8	<0.001*
Skilled	241	81.7	54	18.3	
Unskilled	440	90.9	44	9.1	
Business	147	70.3	62	29.7	
Unemployed	82	91.1	8	8.9	
Occupation of mother					
Professional	53	72.6	20	27.4	<0.001*
Skilled	21	80.8	5	19.2	
Unskilled	265	94	17	6.0	
Business	6	75	2	25	
Housewife	638	80.2	158	19.8	
Diet					
Vegetarian	80	79.2	21	20.8	0.295
Non-vegetarian/mixed	903	83.3	181	16.7	
Frequency of junk food consumption					
No consumption	73	88	10	12	0.032*
Occasionally	768	83.8	149	16.2	
Frequently	142	76.8	43	23.2	

Values are presented as number and percentage (%).
Chi-square (X^2) test was used for bivariate statistical analyses.
*Statistically significant ($p < 0.05$).

($p < 0.05$). However, dietary habits were not significantly associated with elevated BMI, thus were not included in the multivariate analysis. Although gender had no statistical association with elevated BMI, it was included in logistic regression analysis.

4. Multivariate analysis

Table 4 shows the multivariate logistic regression analysis results examining the associations of elevated BMI adjusted for variables such as types of schools, gender, religion, education of father, education of mother, occupation of father, occupation of mother and frequency of consumption of junk foods. Adjusted odds ratio (AOR) and corresponding 95% confidence intervals (CI) were presented. Students in private schools were more likely to have elevated BMI relative to students in government schools (AOR 2.87; CI 1.55-5.31, p = 0.001). Muslim and Christian students were at greater risk of having elevated BMI relative to Hindu students (for Muslim, AOR 2.26; CI 1.39-3.67, p = 0.001, for Christian, AOR 1.60; CI 1.07-2.38, p = 0.02). Fathers with 'professional' and 'businessman' occupations increased the risk of elevated BMI relative to unemployed fathers (for professional, AOR 2.50; CI 1.00-6.29, p = 0.05, for businessman, AOR 2.43; CI 1.05-5.62, p = 0.03). Education of father and mother, occupation of mother, and frequency of junk food consumption did not show significant relationships in the logistic regression analysis.

DISCUSSION

Various studies have been conducted in India to assess the prevalence of overweight/obese school-going children. But the burden of the problems associated with being overweight or obese is unclear, as different studies have used different methods/cut-offs points to define childhood overweight and obese status [3].

Our study found that mean age, weight, height, and BMI differed significantly between males and females. A study conducted in Peru also found similar significant differences among males and females, although not for age and BMI [16]. Our study revealed that the overall prevalence of overweight and obese status was 10.8% and 6.2% respectively, and the prevalence of overweight and obese status was higher among males compared to females, which is similar to other studies [17-19]. A study done in Hyderabad [20] and Ethiopia [21] showed a higher prevalence of overweight status but a lower prevalence of obesity among girls compared to boys. Other studies have found higher rates of

Table 4. Multivariate logistic regression analysis assessing the relationship between different independent variables and elevated BMI

Variables (N = 1185)	Adjusted OR (95% CI)	p-value
Type of school		
Government	1	
Aided	1.17 (0.66-2.07)	0.57
Unaided/private	2.87 (1.55-5.31)	0.001*
Gender		
Male	1	
Female	0.84 (0.60-1.17)	0.32
Religion		
Hindu	1	
Muslim	2.26 (1.39-3.67)	0.001*
Christian	1.60 (1.07-2.38)	0.02*
Education of father		
Illiterate	1	
Primary	0.78 (0.34-1.76)	0.55
Secondary	0.77 (0.34-1.71)	0.52
Higher and above	0.83 (0.36-1.90)	0.67
Education of mother		
Illiterate	1	
Primary	0.91 (0.38-2.19)	0.84
Secondary	1.12 (0.48-2.63)	0.78
Higher and above	0.94 (0.39-2.28)	0.90
Occupation of father		
Professional	2.50 (1.00-6.29)	0.05*
Skilled	1.35 (0.59-3.10)	0.46
Unskilled	1.33 (0.58-3.00)	0.49
Business	2.43 (1.05-5.62)	0.03*
Unemployed	1	
Occupation of mother		
Professional	1.01 (0.54-1.87)	0.97
Skilled	0.87 (0.30-2.50)	0.80
Unskilled	0.62 (0.34-1.14)	0.13
Business	1.77 (0.31-9.91)	0.51
Housewife	1	
Frequency of junk food consumption		
No consumption	1	
Occasionally	1.20 (0.58-2.47)	0.61
Frequently	1.34 (0.60-2.96)	0.46
Hosmer and lemeshow test		0.483

Multiple Logistic Regression was used for multivariate statistical analyses.
OR: Odds Ratio, CI: Confidence Interval, 1: Reference Category.
*Statistically significant ($p < 0.05$).

obesity among females compared to males [22-24]. In the current study, none of the students were found to be underweight. The effective implementation of a mid-day meal program may be associated with such nutritional outcomes among school children in Karnataka [25].

In our study, we re-categorized BMI into normal and elevated BMI (which included overweight/obese categories) to identify the factors associated with elevated BMI using univariate analysis and multivariate logistic regression. Another study also re-categorized BMI category into normal and overweight/obese to determine the factors associated with elevated BMI [16]. Our study found the prevalence of elevated BMI to be higher in aided and private schools compared to government schools. Students in private schools were more than two times as likely to be overweight/obese compared to students in government schools, which is consistent with results from other studies [20,21,26-28]. This finding can be attributed to the fact that children of a higher socioeconomic status tend to study in private schools and are more likely to be overweight/obese due to lifestyle patterns leading to inappropriate dietary habits and decreased physical activity.

Hindu students were less likely to be overweight/obese relative to other religions. The Hindu dietary lifestyle, with a primary focus on vegetables rather than on meat, may be one of the contributing factors to this difference. Nevertheless, other factors also may come into play.

Although, in the current study, more males than females were overweight/obese, this difference was not statistically significant, similar to the findings of other studies [27,29-32]. The occurrence of obesity is primarily related to one's behavior and lifestyle. However, adequate nutritional status is associated with hormonal changes and central initiation of puberty by which children develop secondary sexual characteristics resulting in fat accumulation and redistribution [33].

In our study, the level of parent education did not have any significant relationships with elevated BMI among the students. This finding was consistent to other studies [27,34]. We observed that a father's occupation of 'professional' or 'business' was significantly related to children being obese or overweight. In another study, parental occupation in 'service' or 'business' was significantly associated with overweight and obese schoolchildren [27,35]. It can be inferred from these findings that family characteristics play an important role in the development of elevated BMI. These occupations can be related to family affluence and sedentary lifestyles, thus supporting the occurrence of overweight and obese children. However, a study done in Trinidad and Tobago did not find any significant relationships between parental occupation and obesity among children [34].

Regarding dietary patterns, our results showed no significant differences between vegetarians and mixed/non-vegetarians in terms of risk of being overweight/obese. This is similar to associations observed in other studies [27,32,36,37]. Diet alone is not a precursor of obesity. The duration and intensity of physical activity along with diet plays a major role in the occurrence of obesity. Even after controlling genetic liability and childhood environment, decreased rate of weight gain was associated with persistent physical activity [38]. The association between the consumption of junk food and obesity was not statistically significant in our study. However, the association between frequent consumption of junk/fast foods and the risk of being overweight was found to have a significant positive correlation in other studies [29,32,39,40]. In many areas, especially urban areas, there is a tendency to consume high-calorie snacks and junk food.

Like other studies, this study also has its limitations. Firstly, since this study is cross-sectional in nature, the cause-and-effect relationship cannot be established. Secondly, the application of international reference standards to categorize BMI in an Indian setting may pose one of the limitations of the study. Also, in this study, we did not take into consideration, the sexual maturation among adolescents and physical activity level was not measured.

CONCLUSION

The results of this study indicate that the prevalence of overweight and obese school-going children is relatively high. Students in private schools are at a greater risk of being overweight/obese relative to students in government schools. There were no differences among males and females regarding the burden of being overweight/obese. As

adult obesity has its onset in childhood, we need to focus on preventive strategies to reduce and curb the occurrence of childhood obesity and the priority populations should be children and adolescents. Prevention programs should be incorporated into school curricula, school environments and school activities [16]. Thus, reinforcing both healthy lifestyles and healthy dietary habit needs to be the norm of the schools.

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