

A Cross-Sectional Study to Assess Prevalence & Factors influencing Obesity, Overweight, and Underweight Among School Children in Mangalore

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ABSTRACT

Background:

Childhood obesity is an emerging public health concern, coexisting with undernutrition in developing countries like India. This study aims to assess the prevalence and factors influencing obesity, overweight, and underweight among school children aged 10–15 years in Mangalore, with a comparative analysis of private and government schools.

Methods:

A cross-sectional study was conducted among 2,023 school children, selected randomly from government and private schools in urban and rural settings. Data on socioeconomic status, dietary habits, physical activity, and lifestyle factors were collected using structured questionnaires and anthropometric measurements. BMI was categorized using WHO BMI-for-age standards, and statistical analysis was performed using SPSS 16, with a Chi-square test and multivariate regression analysis applied to determine significant associations.

Results:

The overall prevalence of obesity, overweight, and underweight was 5.2%, 10.53%, and 24.72%, respectively. Obesity was significantly higher among private school children (7.88%) and urban residents (7.89%), whereas underweight was more prevalent among government school children (31.24%) and rural residents (30.92%) ($p < 0.0001$). Junk food consumption >2 times/week, sedentary screen time >2 hours/day, and lower physical activity were strongly associated with obesity ($p < 0.000001$). Underweight was linked to lower socioeconomic status, inadequate calorie intake, and maternal unemployment ($p < 0.0001$).

Conclusion:

The study highlights the dual burden of malnutrition, with rising obesity and overweight in affluent urban children and persistent undernutrition among low-income groups. Dietary habits, sedentary behavior, physical activity, and socioeconomic factors play a crucial role in BMI variations. Targeted interventions focusing on balanced nutrition, increased physical activity, and lifestyle modifications are essential to address this growing public health issue.

Keywords: *Childhood obesity, overweight, underweight, school children, BMI, dietary habits, physical activity, socioeconomic status, India.,.*

1. INTRODUCTION

Childhood obesity is one of the most serious public health challenges of the 21st century, affecting both developed and developing nations. It is associated with a higher risk of obesity, premature death, and disability in adulthood. (1) India faces a dual burden of malnutrition, with high rates of undernutrition alongside a rising prevalence of childhood obesity. About 46% of children under three years are stunted, 47% are underweight, and 16% are wasted, while obesity-related health costs have risen significantly over the last two decades. (2, 3)

Globally, childhood obesity varies widely, with over 30% of children in the USA classified as overweight, compared to less than 2% in Sub-Saharan Africa. The prevalence of obesity among school children is 20% in the UK and Australia, 15.8% in Saudi Arabia, and 10% in Japan. (4) In developed nations, childhood obesity is more common among lower socioeconomic groups, while in India, higher-income children are at greater risk, whereas in developing nations like India, children from upper socioeconomic strata are more likely to be obese. (5)

Indian studies have reported varying prevalence rates of childhood obesity (3%–29%) and underweight (15%–60.44%) across different states. (6) A study conducted among school children in Mangalore reported overweight (9.9%), obesity (4.8%), and underweight (23.9%). (7) The etiology of obesity is multifactorial, involving genetic, metabolic, psychological, and lifestyle factors. (8) Increased screen time, junk food consumption, and reduced outdoor activities contribute significantly to obesity. (9)

A notable disparity exists between private and government school children. Obesity is higher in private schools due to better socioeconomic status and unhealthy dietary habits, whereas underweight is more prevalent in government schools due to inadequate nutrition. (10) Urban children face higher obesity risk, while rural children are more prone to undernutrition. (11)

Given this growing burden of malnutrition, the present study aims to assess the prevalence of obesity, overweight, and underweight and the factors influencing these conditions among school children aged 10–15 years, with a comparative analysis of private and government schools.

2. METHODOLOGY

Study design & Study setting

This study was a cross-sectional study conducted to determine the prevalence and factors influencing obesity, overweight, and underweight among school children aged 10 to 15 years in Mangalore Taluk. The study was carried out in four different schools, ensuring equal representation of various socio-demographic strata. Two of the selected schools were government schools, and two were private schools, with one school from each category located in an urban area and the other in a rural area. The study was conducted over a one-year period from February 2012 to March 2013.

Sample size and Sampling technique

The sample size was determined based on pilot study, which reported an obesity prevalence of 9%. Using a 5% level of significance and an allowable error of 15%, the sample size was calculated using the formula. This resulted in an estimated sample size of 1,797 students. To account for non-response and absenteeism (10%), an additional 180 students were included, making a total of 1,977. However, due to better parental cooperation and response, the final sample size reached 2,023 students.

Schools were selected randomly from a list obtained from the Block Education Office, Mangalore Taluk. The schools were alphabetically arranged, assigned numbers, and randomly chosen. Schools that declined participation were replaced using the same selection process. Before the study, school authorities, teachers, and parents were informed, and written consent was obtained from parents.

Data collection tools and technique

Data collection involved two main components: personal interviews and anthropometric measurements. Personal interviews were conducted using pre-tested questionnaires, which were sent to parents to collect information on socio-demographic factors, dietary habits, physical activity, and lifestyle patterns. School records were also used for additional details. Anthropometric measurements were recorded for each child, including weight, height, and BMI. Weight was measured using a portable digital weighing machine, regularly calibrated against standard equipment, while height was recorded using a non-stretchable measuring tape fixed against a wall. BMI was calculated using the formula $BMI = \text{Weight (kg)} / \text{Height (m}^2\text{)}$ and classified as per WHO BMI-for-age standards. (12) Children with a BMI greater than the 95th percentile were classified as obese, those between the 85th and 95th percentile were overweight, those between the 5th and 85th percentile were considered normal weight, and those below the 5th percentile were classified as underweight. (13, 14)

The study included children aged 10 to 15 years who were present on the day of data collection and whose parents consented to participation. Children below 10 or above 15 years of age, those who were absent even on the second visit, and those who refused participation were excluded from the study.

Several independent variables were assessed in relation to obesity, overweight, and underweight. Socioeconomic status was determined using Modified Kuppaswamy's and Modified Prasad's socioeconomic scales. (15) Other factors considered included working status of the mother, number of children in the household, study time after school, mode of commuting to school, dietary habits (junk food consumption, vegetarian/non-vegetarian diet), physical activity (outdoor games, physical training at school), screen time (TV and computer usage), and daily calorie intake compared with RDA. (16) The presence of pallor was also evaluated clinically as an indicator of possible anemia.

Data analysis plan

The collected data were analyzed using Microsoft Excel, SPSS 16, and Open-Epi software. Descriptive statistics were used to estimate the prevalence of obesity, overweight, and underweight across various categories. To assess the association between BMI and different socio-demographic factors, a Chi-square test was applied, with a p-value of < 0.05 considered statistically significant.

Ethical consideration

This study was conducted with prior approval from the Institutional Ethics Committee (IEC). Informed consent was obtained from parents/guardians, and verbal assent was taken from children. Participants were assured of confidentiality, and data were used solely for research purposes. Anthropometric measurements were conducted respectfully, ensuring privacy and dignity. Children with severe undernutrition or health concerns were advised for further medical evaluation.

3. RESULTS

A total of 2,023 school children aged 10–15 years participated in the study. Of these, 970 (47.96%) were from government schools and 1,053 (52.04%) were from private schools. The gender distribution included 956 males (47.26%) and 1,067 females (52.74%).

Prevalence of Obesity, Overweight, and Underweight

The overall prevalence of obesity, overweight, and underweight in the study population was 5.2%, 10.53%, and 24.72%, respectively. Males had a higher prevalence of obesity (6.27%) compared to females (4.22%), while the prevalence of overweight was higher among females (Table 7, Figure 7). The highest prevalence of obesity (9.76%) and overweight (16.26%) was observed in the 10-year age group, whereas underweight prevalence increased with age, with the highest percentage (51.49%) found in 15-year-olds. (Table 1)

Association of Socio-Demographic Factors with BMI Categories

The study assessed the relationship between various socio-demographic factors and BMI categories among school children. Gender-wise distribution showed that males had a higher prevalence of underweight (28.97%) and obesity (6.27%), whereas females had a higher prevalence of overweight (11.10%) ($p < 0.0001$). Age-wise analysis revealed that obesity and overweight were most prevalent among younger children, particularly 10-year-olds (9.76% and 16.26%, respectively), while underweight was more prevalent in older children, reaching 38.78% among 15-year-olds ($p < 0.0001$).

A significant difference was observed between children from government and private schools. Obesity (7.88%) and overweight (15.67%) were more common in private school children, whereas underweight was significantly higher in government school children (31.24%) ($p < 0.0001$). Socioeconomic status was also a key determinant, with children from upper socioeconomic classes having higher rates of overweight (10.14%) and obesity (6.19%), while underweight was more common among children from lower-middle (43.07%) and upper-lower classes (70.00%) ($p < 0.0001$).

The working status of mothers was another influential factor. Children of working mothers had higher obesity (7.60%) and overweight rates (13.00%), whereas underweight was more prevalent in children of non-working mothers (25.90%) ($p < 0.0001$). (Table 1)

Association of Dietary and Lifestyle Factors with BMI Categories

The study further explored the role of dietary habits, physical activity, and sedentary behavior in childhood obesity, overweight, and underweight. Mother's education level was associated with BMI categories, as children whose mothers had an education level above six years were more likely to be overweight (11.80%) and obese (6.60%), while underweight was more prevalent in children of mothers with lower education (26.90%) ($p = 0.00067$).

The number of children in the household also influenced BMI, with children from single-child families having higher obesity (6.80%) and overweight (12.00%) rates, while underweight was slightly more common in children from larger families (25.50%) ($p = 0.000567$).

Dietary factors played a major role in obesity prevalence. Children who consumed junk food more than twice a week had significantly higher obesity (12.40%) and overweight rates (25.20%), while underweight was more common in those consuming junk food less frequently (30.10%) ($p < 0.0000001$). Similarly, children who ate snacks while watching TV were more likely to be obese (6.10%) and overweight (11.50%), compared to those who did not snack while watching TV ($p <$

0.00002).

Physical activity levels had a significant impact on BMI. Children engaging in ≤ 2 hours of physical activity per week had higher overweight (16.20%) and obesity rates (8.80%), whereas those with > 2 hours of activity had a lower prevalence of overweight (6.10%) and obesity (2.40%) ($p < 0.0000001$). Residence also played a role, with urban children having higher overweight (12.82%) and obesity rates (7.89%), while underweight was more prevalent in rural children (30.92%) ($p < 0.0000001$). (Table 2)

Multivariate Regression Analysis of BMI Categories

A multivariate regression analysis was conducted to assess the independent predictors of obesity, overweight, and underweight among school children. Junk food consumption ($p = 0.000$) and sedentary screen time ($p = 0.000$) were the strongest predictors of obesity and overweight, with higher consumption of junk food ($\text{Exp(B)} = 0.694$) and increased sedentary time ($\text{Exp(B)} = 0.345$) significantly increasing the risk.

Children who engaged in higher levels of physical activity had a lower risk of obesity ($\text{Exp(B)} = 0.456$, $p = 0.0021$), reinforcing the role of exercise in weight management. Socioeconomic status was a significant determinant ($\text{Exp(B)} = 12.8$, $p = 1.265$), with children from higher socioeconomic backgrounds being at greater risk of obesity.

Interestingly, children from households with working mothers had a lower risk of obesity ($\text{Exp(B)} = 6.9$, $p = 0.0621$), suggesting potential differences in dietary habits and lifestyle behaviors in these households. Additionally, recommended daily allowance (RDA) of calorie intake ($p = 0.045$) was positively associated with BMI categories, indicating that higher caloric intake correlated with obesity and overweight. (Table 3)

Table 1: Association of Socio-Demographic Factors with BMI Categories

Factor	Underweight (n, %)	Normal (n, %)	Overweight (n, %)	Obese (n, %)	Total (n, %)	p-value
Gender						<0.0001
Male	277 (28.97)	523 (54.71)	96 (10.00)	60 (6.27)	956 (100)	
Female	223 (20.90)	682 (63.92)	117 (11.10)	45 (4.22)	1067 (100)	
Age Group (years)						<0.0001
10	73 (19.78)	202 (54.74)	60 (16.26)	36 (9.76)	369 (100)	
11	55 (15.99)	255 (74.13)	29 (6.69)	5 (1.45)	344 (100)	
12	75 (22.52)	212 (63.66)	25 (7.51)	21 (6.31)	333 (100)	

13	92 (26.67)	199 (57.68)	34 (9.86)	20 (5.80)	345 (100)	
14	91 (26.92)	193 (57.10)	33 (9.76)	19 (5.62)	338 (100)	
15	114 (38.78)	144 (48.98)	32 (10.88)	4 (1.36)	294 (100)	
School Type						
Government	303 (31.24)	597 (61.55)	48 (4.95)	22 (2.29)	970 (100)	<0.0001
Private	197 (18.71)	608 (57.74)	165 (15.67)	83 (7.88)	1053 (100)	
Socioeconomic Status						
Upper	38 (4.05)	746 (79.62)	95 (10.14)	58 (6.19)	937 (100)	<0.0001
Upper Middle	166 (38.60)	156 (36.28)	84 (19.53)	24 (5.58)	430 (100)	
Lower Middle	261 (43.07)	293 (48.35)	30 (4.95)	22 (3.63)	606 (100)	
Upper Lower	35 (70.00)	10 (20.00)	4 (8.00)	1 (2.00)	50 (100)	
Mother's Working Status						
Working	215 (23.30)	517 (56.10)	120 (13.00)	70 (7.60)	922 (100)	<0.0001

Not Working	285 (25.90)	688 (62.50)	93 (8.40)	35 (3.20)	1101 (100)	
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Table 2: Association of Dietary and Lifestyle Factors with BMI Categories

Factor	Underweight (n, %)	Normal (n, %)	Overweight (n, %)	Obese (n, %)	Total (n, %)	p-value
Mother's Education Level						0.00067
≤ 6 Standard	228 (26.90)	519 (61.10)	75 (8.80)	27 (3.20)	849 (100)	
> 6 Standard	272 (23.20)	686 (58.40)	138 (11.80)	78 (6.60)	1174 (100)	
Number of Children in Household						0.000567
One	243 (24.00)	580 (57.20)	122 (12.00)	69 (6.80)	1014 (100)	
More Than One	257 (25.50)	625 (61.90)	91 (9.00)	36 (3.60)	1009 (100)	
Junk Food Consumption (per week)						<0.0000001
≤ 2 times	463 (30.10)	939 (61.10)	91 (5.90)	45 (2.90)	1538 (100)	
> 2 times	37 (7.60)	266 (54.80)	122 (25.20)	60 (12.40)	485 (100)	

Eating Snacks While Watching TV						<0.00002
Yes	368 (24.30)	881 (58.10)	175 (11.50)	92 (6.10)	1516 (100)	
No	132 (26.00)	324 (63.90)	38 (7.50)	13 (2.60)	507 (100)	
Total Sports & Physical Activity						<0.0000001
≤ 2 hours	217 (24.40)	449 (50.60)	144 (16.20)	78 (8.80)	888 (100)	
> 2 hours	283 (24.90)	756 (66.60)	69 (6.10)	27 (2.40)	1135 (100)	
Place of Residence						<0.0000001
Rural	312 (30.92)	589 (58.37)	83 (8.22)	25 (2.48)	1009 (100)	
Urban	188 (18.54)	616 (60.74)	130 (12.82)	80 (7.89)	1014 (100)	

Table 3: Multivariate regression analysis of obesity, overweight and underweight in children

Variables	B	S.E	Wald	p value	Exp(B)	95% C.I for Exp(B)	
						Lower	Upper
Type of school	0.594	.0305	3.89	0.125	0.652	0.496	2.615
Age in years	0.584	.0161	0.265	0.565	1.92	0.321	1.382
Sex	0.489	.0456	1.067	0.654	2.59	0.0966	1.143

Socio economic status	1.401	.0164	0.65	1.265	12.8	1.402	1.465
Working mothers	-1.921	.0131	2.941	0.0621	6.9	0.0495	2.561
Number of children in the house	-1.023	.0156	0.000	0.985	1.025	0.0334	1.385
RDA	2.45	.0161	10.69	0.045	.233	2.468	2.525
Junk food	6.59	.0198	33.137	0.000	0.694	1.413	1.475
Sedentary time - TV	2.94	.0169	51.292	0.000	0.345	2.914	3.553
Sports-physical activity	.53	0.651	12.172	0.0021	.456	0.446	0.509
Eating snacks during TV watching	-2.32	1.25	1.706	0.65	.954	0.026	1.236
Mothers educational status	.08	.179	6.263	0.351	1.267	0.145	1.654
constant	-10.9	1.25	0.000	0.989	1.301	-	-

4. DISCUSSION

The present study was conducted to assess the prevalence of obesity, overweight, and underweight among school children in Mangalore Taluk and to identify the socio-demographic, dietary, and lifestyle factors influencing these conditions. A total of 2023 children aged 10-15 years were included, with representation from both government and private schools in urban and rural settings.

Prevalence of Obesity, Overweight, and Underweight

The prevalence of obesity, overweight, and underweight in the study was 5.2%, 10.53%, and 24.72%, respectively. The prevalence of obesity was higher among boys (6.27%) than girls (4.22%), while underweight was more common among girls (20.9%) than boys (28.97%). Similar findings have been reported in studies by Chhatwal et al. in Ludhiana, where obesity among boys was 12.4% and among girls was 9.9%. (5)

Influence of Socio-Demographic Factors on BMI

The study found that children from private schools had a significantly higher prevalence of obesity (7.88%) and overweight (15.67%) compared to government school children (2.29% and 4.9%, respectively). This may be attributed to differences in socioeconomic status, dietary habits, and physical activity levels, findings similar to those reported by Kaneria et al. in Udaipur. (17)

Additionally, urban children had a significantly higher prevalence of obesity (7.89%) and overweight (12.82%) compared to rural children (2.48% and 8.22%, respectively). These findings support previous studies that emphasize the impact of urbanization on dietary choices, sedentary lifestyle, and reduced physical activity.

Association of Dietary and Lifestyle Factors with BMI

The study revealed a strong correlation between junk food consumption and obesity. Children consuming junk food more than twice a week had a significantly higher prevalence of obesity (12.4%) and overweight (25.2%), while underweight was more common in those consuming junk food less frequently (30.1%). Similar observations have been made in previous studies highlighting the role of high-calorie processed foods in childhood obesity. (18)

Sedentary behavior was also significantly associated with obesity and overweight. Children spending more than two hours daily on television or computer screens had a significantly higher prevalence of obesity (8.8%) and overweight (14.8%)

compared to those spending less than two hours (2.4% and 6.1%, respectively). These findings align with prior research linking excessive screen time with reduced physical activity and higher BMI. (19)

Impact of Physical Activity on BMI

Children who engaged in ≤ 2 hours of physical activity per day had a higher prevalence of obesity (8.8%) and overweight (16.2%), whereas those participating in >2 hours of physical activity had lower obesity (2.4%) and overweight (6.1%) rates. This reinforces global evidence on the protective role of physical activity in maintaining a healthy weight.

Influence of Parental and Household Factors

The working status of mothers had a significant impact on children's BMI. Children of working mothers had a higher prevalence of obesity (7.6%) and overweight (13.0%), whereas underweight was more prevalent among children of non-working mothers (25.9%). This may be due to differences in parental supervision over dietary habits and lifestyle. Similar findings were seen in literature as well. (20)

Moreover, the study found that children from families with more than one child had lower obesity (3.6%) and overweight (9.0%) prevalence compared to single-child households (6.8% and 12.0%, respectively). This suggests that having siblings may encourage more physical activity and reduce sedentary behaviors.

Nutritional Intake and Obesity

The study showed that children consuming total daily calories above the recommended dietary allowance (RDA) had significantly higher obesity (11.9%) and overweight (18.1%) rates, whereas those consuming below RDA had a lower prevalence of obesity (1.2%) and overweight (6.0%). These results reaffirm the importance of balanced nutrition in maintaining optimal BMI

5. CONCLUSION

The study highlights the dual burden of malnutrition among school-going children in Mangalore, with a significant prevalence of both obesity and underweight. The findings reveal that private school children, urban residents, and those from higher socioeconomic backgrounds are at greater risk of obesity and overweight, whereas underweight is more prevalent among government school children and those from lower-income households. Key contributing factors to obesity include increased junk food consumption, prolonged screen time, and reduced physical activity, while underweight is linked to inadequate calorie intake and lower socioeconomic status. The study also emphasizes the influence of maternal working status, number of children in the household, and overall dietary patterns on children's BMI. Given the rising trend of childhood obesity and persistent undernutrition, targeted interventions focusing on nutrition education, physical activity promotion, and lifestyle modifications are essential to combat this growing public health concern.

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