

Association of Physical Activity, Dietary Habits, and Sedentary Behaviour with Overweight and Obesity among School-Going Children Aged 10–17 Years: A Cross-Sectional Study

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Received: 26 Jun 2026/ Revised: 19 Jul 2026/ Accepted: 23 Aug 2026

ABSTRACT

Background: Childhood overweight and obesity are growing public-health challenges associated with low physical activity, unhealthy diets, and sedentary behaviours. This study aimed to determine their prevalence among school-going children aged 10–17 years and assess their association with physical activity, dietary habits, and sedentary behaviour.

Methods: A school-based cross-sectional study was conducted among 400 children aged 10–17 years using multistage sampling. Data on sociodemographic factors, diet, physical activity, screen time, and sedentary behaviours were collected using a pretested questionnaire. Height and weight were measured, and BMI was classified using revised IAP 2015 charts. Associations were assessed using chi-square and multivariable logistic regression, with $p < 0.05$ considered significant.

Results: Among 400 participants, 56 (14.0%) were overweight and 32 (8.0%) were obese, with an overall prevalence of 22.0%. Overweight/obesity was significantly associated with low physical activity, screen time ≥ 2 hours/day, frequent fast-food intake, and sugar-sweetened beverage consumption ($p < 0.05$). Multivariable analysis identified inadequate physical activity (AOR 2.18), higher screen time (AOR 2.46), frequent fast-food intake (AOR 1.78), and sugar-sweetened beverage consumption (AOR 1.67) as independent predictors of overweight/obesity.

Conclusion: In this school-based sample, overweight and obesity were common and were associated with inadequate physical activity, prolonged recreational screen exposure, frequent fast-food consumption, and frequent sugar-sweetened beverage intake. Integrated school- and family-based strategies promoting physical activity and healthier dietary and screen-time behaviours may help address excess weight among school-going children.

Key-words: Childhood obesity; overweight; physical activity; sedentary behaviour; screen time; dietary habits; school children; BMI

INTRODUCTION

Childhood overweight and obesity constitute an increasingly important public-health problem worldwide.

The World Health Organization (WHO) recognizes obesity as a chronic, relapsing disease resulting from complex interactions among biological, behavioural, environmental, and socioeconomic factors.^[1] Globally, more than 390 million children and adolescents aged 5–19 years were overweight in 2022, of whom more than 160 million were living with obesity. The prevalence of overweight among individuals aged 5–19 years increased from approximately 8% in 1990 to 20% in 2022.^[1]

India is simultaneously experiencing undernutrition and a rapidly increasing burden of childhood overweight and obesity. Changes in socioeconomic conditions,

How to cite this article

Dhal SP, Rout V, Mishra A, Chand A. Association of Physical Activity, Dietary Habits, and Sedentary Behaviour with Overweight and Obesity among School-Going Children Aged 10–17 Years: A Cross-Sectional Study. SSR Inst Int J Life Sci., 2026; 12(5): 11011-11018.



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urbanization, transportation, food environments, digital technology use, and recreational activities have substantially modified children's lifestyles. Systematic reviews from India have documented considerable geographical and socioeconomic variation in childhood overweight and obesity^[2,3] A recent comprehensive meta-analysis of Indian school-going children estimated a pooled obesity prevalence of approximately 7%, with evidence of an increasing trend over time.^[4]

Childhood obesity is important not merely because of excessive body weight during childhood but also because of its immediate and long-term consequences. Children with obesity are more likely to remain overweight or obese during adulthood.^[5] Higher childhood BMI has also been associated with increased risks of adult diabetes and coronary heart disease.^[6] Furthermore, obesity during childhood may adversely affect psychological well-being, quality of life, school participation, and social functioning.^[1]

Physical inactivity is an important modifiable behavioural factor associated with excess adiposity. WHO recommends that children and adolescents aged 5–17 years undertake an average of at least 60 minutes per day of moderate-to-vigorous intensity, predominantly aerobic, physical activity across the week.^[7] Regular physical activity improves cardiorespiratory fitness, muscular fitness, bone health, cardiometabolic health, cognitive outcomes, and mental health and contributes to lower adiposity.^[7] Nevertheless, opportunities for active play and outdoor recreation may be displaced by television viewing, smartphone use, computers, gaming, and other sedentary pursuits.

Screen-based sedentary behaviour is particularly relevant in contemporary childhood. A systematic review and meta-analysis reported that children exposed to ≥ 2 hours/day of screen time had significantly greater odds of overweight/obesity than those exposed to < 2 hours/day.^[8] A subsequent dose-response meta-analysis among adolescents similarly demonstrated an increased risk of overweight/obesity with greater screen exposure.^[9] Indian studies have also reported associations between excessive screen time, inadequate physical activity, and increased BMI among school-going children.^[10]

Dietary transition constitutes another component of the childhood obesity epidemic. Increased accessibility of fast foods, packaged snacks, refined carbohydrates, fried

foods, and sugar-sweetened beverages, together with irregular meal patterns and inadequate consumption of fruits and vegetables, may promote positive energy balance. These dietary behaviours may coexist with inadequate physical activity and excessive sedentary time, creating an obesogenic lifestyle.

Schools provide an important setting for identifying these behaviours because children spend a substantial proportion of their waking hours within the school environment. However, data assessing the combined association of physical activity, dietary practices, and sedentary behaviour with overweight and obesity among school-going children in Jamshedpur remain limited. Therefore, the present study was undertaken to determine the prevalence of overweight and obesity and to assess the association of selected lifestyle factors with overweight/obesity among school-going children aged 10–17 years.

MATERIALS AND METHODS

Study Design, Setting and Period- A school-based cross-sectional analytical study was conducted among school-going children aged 10–17 years in Tirupati District, Andhra Pradesh, India, from June 2025 to March 2026. The study included students attending eight selected schools, comprising four government schools and four private schools, during the study period.

Study Population- Children aged 10–17 years who were enrolled in the selected schools and present during data collection constituted the study population.

Sample Size- The required sample size was calculated using the formula $n = 4pq/d^2$, assuming an anticipated prevalence of overweight/obesity of 20%, based on previously published studies among Indian school-going children, with an absolute precision of 4.5% and a 95% confidence level.

Using these assumptions, the minimum calculated sample size was approximately 316 participants. As multistage sampling was employed, a design effect of 1.0 was considered. After allowing for an anticipated 20% non-response or incomplete-data rate, the required sample size increased to approximately 380 participants. To ensure an adequate sample and improve statistical power, a total of 400 children were recruited for the study.

Sampling Technique- A multistage sampling technique was used. In the first stage, schools were selected from the official list of government and private schools in Tirupati District, Andhra Pradesh, using stratified simple random sampling, with schools stratified according to management type. The required sample was then allocated proportionately to the selected schools and subsequently to eligible classes based on student strength.

Within each selected class, students were chosen by systematic random sampling from the class attendance register. The sampling interval (k) was calculated by dividing the total number of eligible students in the class by the number of students required from that class. A random starting number between 1 and k was selected using a random-number method, and thereafter every k th student on the attendance register was recruited until the required sample for that class was achieved. If a selected student was absent or did not meet the eligibility criteria, the next eligible student on the register was considered.

Inclusion Criteria

- Children aged 10–17 years.
- Written informed consent from parents/guardians.
- Age-appropriate assent from the child.

Exclusion Criteria

- Chronic diseases significantly affecting growth or body weight.
- Long-term medications affecting body weight.
- Physical disabilities preventing anthropometric assessment or physical activity evaluation.
- Unwillingness to participate.

Data Collection- Data were collected using a pretested, structured questionnaire developed for the present study after reviewing relevant published literature and commonly used survey instruments assessing dietary practices, physical activity, sedentary behaviour, and screen exposure among school-going children and adolescents. The questionnaire was reviewed by experts in Community Medicine/Public Health and Paediatrics for content relevance, clarity, comprehensibility, and suitability for the target age group.

Questionnaire- The questionnaire was prepared in English and translated into Telugu, followed by back-translation into English by an independent bilingual investigator to ensure conceptual consistency. It was administered through face-to-face interviews by trained investigators in a designated area of the school. Before the main survey, the questionnaire was pretested among approximately 10% of the intended sample in a school not included in the final study. Questions found to be ambiguous or difficult to understand were modified following pretesting. Data obtained during the pretest were not included in the final analysis.

The questionnaire included information on sociodemographic characteristics, dietary habits, physical activity, sedentary behaviour, and recreational screen exposure.

Dietary variables included frequency of breakfast consumption, fast-food intake, fried or packaged snack consumption, sugar-sweetened beverage intake, and fruit and vegetable consumption. Participants were asked to report their usual consumption during the preceding 7 days. Frequent fast-food consumption and frequent sugar-sweetened beverage consumption were defined as intake on ≥ 3 occasions per week. Fruit and vegetable intake was categorized as < 5 servings/day or ≥ 5 servings/day. Breakfast skipping was defined as skipping breakfast on ≥ 3 days per week, whereas children consuming breakfast on most days were categorized as regular breakfast consumers.

Physical activity was assessed using a 7-day recall approach, in which participants reported the average duration per day spent in moderate-to-vigorous physical activities such as brisk walking, running, cycling, outdoor games, sports, and other activities that noticeably increased breathing or heart rate. Children reporting an average of ≥ 60 minutes of moderate-to-vigorous physical activity per day were categorized as having adequate physical activity, in accordance with World Health Organization recommendations. Children reporting < 60 minutes/day were classified as having inadequate physical activity.

Sedentary behaviour was assessed by asking participants to estimate the average amount of time spent during the preceding 7 days watching television, using smartphones or tablets, using computers, and playing video games for recreational purposes. Participants reported their usual recreational screen exposure separately for weekdays

and weekends, from which an average daily duration was estimated. Screen use undertaken specifically for school classes, homework, or other educational activities was excluded from recreational screen-time calculations. Average recreational screen exposure was categorized as <2 hours/day or ≥2 hours/day for analysis. Participants were also asked about the average daily duration of non-school sedentary activities such as sitting, reading, studying outside school hours, and other seated leisure activities.

Anthropometric Assessment- Body weight was measured to the nearest 0.1 kg using a calibrated digital weighing scale, with participants wearing light clothing and without footwear. Height was measured to the nearest 0.1 cm using a portable stadiometer, with the participant standing upright without footwear, heels together, and the head positioned in the Frankfurt horizontal plane.

Both height and weight were measured twice, and the mean of the two measurements was used for analysis. When the two measurements differed substantially, a third measurement was obtained and the two closest readings were averaged. The weighing scale was checked and calibrated each day before data collection using a standard known weight and reset to zero before each measurement. The stadiometer was checked for correct vertical positioning and zero alignment before use.

BMI was calculated as:

$$\text{BMI} = \text{Weight (kg)} / \text{Height}^2 (\text{m}^2)$$

Weight status was classified according to the revised Indian Academy of Pediatrics (IAP) 2015 BMI-for-age growth charts for Indian children and adolescents aged 5–18 years. The age- and sex-specific BMI cut-offs corresponding to an adult-equivalent BMI of 23 kg/m² and 27 kg/m² at 18 years were used to define overweight and obesity, respectively. Children with a BMI below the overweight cut-off were categorized as non-overweight

for the primary analysis, those with BMI values between the adult-equivalent cut-offs of 23 and <27 kg/m² were classified as overweight, and those with BMI values corresponding to ≥27 kg/m² were classified as obese. For regression analysis, overweight and obese participants were combined into a single overweight/obesity outcome category and compared with children who were not overweight or obese.

Statistical Analysis- Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 26.0. Categorical variables were summarized as frequencies and percentages, and continuous variables as mean ± SD or median (IQR), as appropriate. Associations were assessed using the chi-square or Fisher's exact test. Variables with p<0.20 in univariable analysis or clinical relevance were included in multivariable binary logistic regression. AORs with 95% CIs were reported. Multicollinearity was assessed using VIF and tolerance statistics, and model fit using the Hosmer–Lemeshow test. Complete-case analysis was performed for minimal missing data. A two-sided p<0.05 was considered statistically significant.

Ethical Considerations- Approval was obtained from the Institutional Ethics Committee and respective school authorities. Written informed consent from parents/guardians and age-appropriate assent from children were obtained. Participation was voluntary, confidentiality was maintained, and participants could withdraw at any stage without consequences.

RESULTS

A total of 400 school-going children were included. The mean age was 13.5 ± 2.1 years. There were 208 (52.0%) boys and 192 (48.0%) girls. Nearly two-thirds (65.0%) of participants had normal BMI, whereas 14.0% were overweight and 8.0% were obese. Overall, 22.0% had overweight or obesity (Table 1).

Table 1: Sociodemographic and Anthropometric Characteristics of Participants (N=400)

Characteristic	Number (n)	Percentage (%)
Age group		
10–12 years	142	35.5
13–15 years	174	43.5
16–17 years	84	21



Sex		
Boys	208	52
Girls	192	48
BMI category		
Underweight	52	13
Normal weight	260	65
Overweight	56	14
Obese	32	8
Overweight + obesity	88	22

Overweight/obesity was observed in 30.0% of children performing <60 minutes/day of physical activity compared with 14.0% among those achieving ≥60 minutes/day ($p<0.001$) (Table 2).

Table 2: Association between Physical Activity and Overweight/Obesity

Physical activity	Normal/underweight n (%)	Overweight/obese n (%)	Total	p-value
≥60 min/day	172 (86.0)	28 (14.0)	200	<0.001
<60 min/day	140 (70.0)	60 (30.0)	200	
Total	312 (78.0)	88 (22.0)	400	

Frequent consumption of fast foods and sugar-sweetened beverages was significantly associated with overweight/obesity. Children consuming fast food ≥3 times/week had an overweight/obesity prevalence of 31.5%, compared with 17.4% among less frequent consumers. Similarly, frequent consumption of sugar-

sweetened beverages was associated with a higher prevalence of overweight/obesity (30.0% vs. 16.7%). Low fruit and vegetable consumption and frequent breakfast skipping were also significantly associated with excess weight (Table 3).

Table 3: Association of Dietary Habits with Overweight/Obesity

Dietary factor	Category	Overweight/obese n (%)	p-value
Fast-food intake	≥3 times/week (n=130)	41 (31.5)	0.001
	<3 times/week (n=270)	47 (17.4)	
Sugar-sweetened beverages	≥3 times/week (n=160)	48 (30.0)	0.004
	<3 times/week (n=240)	40 (16.7)	
Fruit/vegetable intake	<5 servings/day (n=300)	75 (25.0)	0.015
	≥5 servings/day (n=100)	13 (13.0)	
Breakfast	Skipped ≥3 days/week (n=105)	32 (30.5)	0.017
	Regular breakfast (n=295)	56 (19.0)	

Children reporting ≥2 hours/day of recreational screen exposure had a higher prevalence of overweight/obesity than those reporting <2 hours/day (31.0% vs. 13.0%;

$p<0.001$). Longer non-school sedentary sitting time was also significantly associated with overweight/obesity ($p<0.001$) (Table 4).

Table 4: Association between Sedentary Behaviour and Overweight/Obesity

Sedentary behaviour	Normal/underweight n (%)	Overweight/obese n (%)	Total	p-value
Screen time <2 h/day	174 (87.0)	26 (13.0)	200	<0.001
Screen time ≥2 h/day	138 (69.0)	62 (31.0)	200	
Sitting/studying ≤3 h/day*	164 (84.1)	31 (15.9)	195	<0.001
Sitting/studying >3 h/day*	148 (72.2)	57 (27.8)	205	

*Outside routine school classroom hours.

After adjustment for the other variables included in the multivariable logistic regression model, recreational screen time of ≥2 hours/day was associated with more than twice the odds of overweight/obesity compared with screen time of <2 hours/day (AOR 2.46; 95% CI 1.44–4.21; $p=0.001$). Similarly, children engaging in <60 minutes/day of moderate-to-vigorous physical activity had significantly higher odds of overweight/obesity than those meeting the recommended activity level (AOR 2.18; 95% CI 1.29–3.68; $p=0.004$).

Frequent fast-food consumption was independently associated with overweight/obesity, with children consuming fast food ≥3 times/week having

approximately 78% higher adjusted odds compared with those consuming it less frequently (AOR 1.78; 95% CI 1.05–3.02; $p=0.032$). Frequent consumption of sugar-sweetened beverages was also significantly associated with overweight/obesity (AOR 1.67; 95% CI 1.01–2.78; $p=0.047$).

Low fruit and vegetable consumption (AOR 1.48; 95% CI 0.76–2.86; $p=0.247$) and breakfast skipping (AOR 1.41; 95% CI 0.82–2.43; $p=0.215$) showed higher point estimates of odds but were not statistically significant after multivariable adjustment, as their 95% confidence intervals included 1.0 and their p -values exceeded 0.05 (Table 5).

Table 5: Multivariable Logistic Regression for Factors Associated with Overweight/Obesity

Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
Physical activity <60 min/day	2.18	1.29–3.68	0.004
Screen time ≥2 h/day	2.46	1.44–4.21	0.001
Fast food ≥3 times/week	1.78	1.05–3.02	0.032
Sugary beverages ≥3 times/week	1.67	1.01–2.78	0.047
Low fruit/vegetable consumption	1.48	0.76–2.86	0.247
Breakfast skipping	1.41	0.82–2.43	0.215

Overall, the multivariable analysis identified high recreational screen exposure, inadequate physical activity, frequent fast-food consumption, and frequent sugar-sweetened beverage intake as independent correlates of overweight/obesity in the study population.

DISCUSSION

The present cross-sectional study assessed the association of physical activity, dietary habits, and sedentary behaviour with overweight and obesity among school-going children aged 10–17 years. In the analyzed dataset, 14% of children were overweight and 8% were

obese, resulting in a combined prevalence of 22%. Several modifiable behaviours, including inadequate physical activity, prolonged screen exposure, frequent fast-food consumption, and frequent intake of sugar-sweetened beverages, were associated with overweight/obesity.

The observed burden is consistent with evidence that childhood overweight and obesity are important health challenges in India. Ranjani et al. highlighted considerable heterogeneity in prevalence across Indian studies, influenced by age, socioeconomic status, geographical location, and diagnostic criteria.^[2] A more

recent systematic review also confirmed the continuing burden among Indian children and adolescents.^[3] Deepa *et al.* reported a pooled obesity prevalence of 6.97% among school-going children in India and demonstrated a rising trend over time.^[4] Differences between studies may reflect variations in study populations, urban-rural composition, socioeconomic characteristics, age distributions, and BMI classification methods.

Physical inactivity was independently associated with overweight/obesity in the present study. Children performing <60 minutes of daily physical activity had approximately twice the adjusted odds of overweight/obesity. This finding is biologically plausible because lower energy expenditure may contribute to positive energy balance. WHO recommends an average of at least 60 minutes/day of moderate-to-vigorous physical activity for children and adolescents aged 5–17 years.^[7]

Sedentary behaviour, particularly recreational screen exposure, was another important correlate. Children reporting ≥ 2 hours/day of screen time had substantially greater odds of overweight/obesity. Fang *et al.* reported increased odds of childhood overweight/obesity with screen exposure ≥ 2 hours/day.^[8] Haghjoo *et al.* similarly reported an association between higher screen time and overweight/obesity among adolescents.^[9] Indian evidence has also demonstrated relationships between screen use, physical inactivity, and excess weight among school-going children.^[10] Potential pathways include displacement of physical activity, prolonged sitting, exposure to food advertising, eating during screen use, and disturbed sleep.

Dietary behaviour was also associated with overweight/obesity. Frequent consumption of fast foods and sugar-sweetened beverages remained statistically significant in the multivariable model. These foods and beverages may contribute substantial energy while having relatively low satiety, particularly when consumed frequently. However, because of the cross-sectional design, the observed associations should not be interpreted as proof of causation.

The clustering of unhealthy behaviours is clinically relevant. Prolonged recreational screen exposure may coexist with reduced outdoor activity and consumption of energy-dense snacks or sugar-sweetened beverages. Obesity prevention should therefore address multiple behaviours rather than focusing on a single exposure.

Integrated interventions involving children, parents, schools, healthcare professionals, and the wider food and physical environment may be appropriate.

Early intervention is important because excess weight may persist beyond childhood. Singh *et al.* demonstrated tracking of childhood overweight into adulthood^[5] while Llewellyn *et al.* reported associations between higher childhood BMI and subsequent diabetes and coronary heart disease.^[6] Prevention during the school years therefore represents an opportunity to influence current and future health.

STRENGTHS

Strengths of the study include its school-based design, standardized anthropometric assessment, assessment of multiple lifestyle behaviours, and use of multivariable analysis.

LIMITATIONS

The study has several limitations. First, its cross-sectional design prevents determination of temporality and causality between lifestyle behaviours and overweight/obesity. Second, dietary intake, physical activity, and screen time may be subject to recall and reporting bias if self-reported. Third, the study was conducted in Jamshedpur, which may limit generalizability to other populations. Fourth, residual confounding may be present if potentially relevant variables such as socioeconomic status, parental BMI, sleep duration, or pubertal status were not measured or included in the model. Finally, the findings apply to school-going children and may not represent children who are not enrolled in school.

CONCLUSIONS

In this school-based sample of children aged 10–17 years, overweight and obesity were common. Inadequate physical activity, recreational screen time ≥ 2 hours/day, frequent fast-food intake, and frequent sugar-sweetened beverage consumption were associated with overweight/obesity after adjustment for the variables included in the model. School-based and family-based health programmes should promote regular moderate-to-vigorous physical activity, healthier food choices, reduced intake of energy-dense processed foods and sugar-sweetened beverages, and appropriate limits on recreational screen exposure. Periodic BMI

assessment and health education involving students, teachers, and parents may support early identification and prevention of unhealthy weight gain.

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