International Journal of Medicine
pISSN 1468-3814 | eISSN 2667-7008
https://theinternationalmedicine.com/

Original Research Article *DOI: 10.61336/im/26-06-140*

SCREEN TIME, SLEEP DURATION, AND APPETITE PATTERNS AS BEHAVIORAL PREDICTORS OF OBESITY AMONG SCHOOL-GOING CHILDREN: A CROSS-SECTIONAL STUDY

Dr. A. Deva Prasanna[1], Dr. Suresh P. M[2], Dr. C. Manjusha[3]

[1]*Junior Resident, Department of Pediatrics, Sree Mookambika Institute of Medical Sciences, Kulasekaram, Kanniyakumari;*
[2]*Professor, Department of Pediatrics, Sree Mookambika Institute of Medical Sciences, Kulasekaram, Kanniyakumari;*
[3]*Junior Resident, Department of Pediatrics, Sree Mookambika Institute of Medical Sciences, Kulasekaram, Kanniyakumari.*

Correspondence:
Dr.A.Deva Prasanna

Received: May 12, 2026
Revised: May 23, 2026
Accepted: June 19, 2026
Published: June 24, 2026

Abstract

Background: Rapid nutritional change, urbanization, sedentary lifestyles, excessive screen time, insufficient sleep, and dysregulated eating habits are the main causes of childhood obesity, a significant public health issue in India. Few school-based Indian research concurrently assess screen time, sleep length, eating habits, and their independent relationships with obesity using current Indian growth benchmarks, despite the fact that body mass index (BMI)-based obesity is commonly investigated. ***Objective:*** Using WHO-IAP growth standards, evaluate the relationship between screen time, sleep length, hunger patterns, and specific lifestyle factors with overweight and obesity in school-age children aged 6 to 15. ***Methods:*** Over the course of six months, 200 children between the ages of six and fifteen were selected from school health visits and pediatric outpatient services for this cross-sectional analytical study. Information about demographics, screen time, sleep length, physical activity, and eating habits. A standardized questionnaire was used to capture hunger behavior and family history. A five-domain appetite score that included hunger frequency, snacking, satiety, night eating, and junk-food cravings was used to measure appetite. Standardized techniques were used to assess height and weight, and updated Indian Academy of Pediatrics (IAP) 2015 BMI tables for children aged 5 to 18 were used to interpret BMI. The chi-square test, independent t-test, and multivariable logistic regression were used to examine associations. 95% confidence intervals (CIs) for adjusted odds ratios (AORs) were provided. ***Results:*** Of the 200 children examined, 52% were males and the mean age was 10.8 ± 2.6 years. 28% of people were overweight or obese. Increased screen time (≥2 hours/day), sleep duration <8 hours/day, low physical activity, high appetite score, frequent consumption of junk food, and obesity in parents demonstrated a substantial correlation ($p<0.05$) with being overweight or obese. Overweight/obesity was found to be independently predicted by screen time ≥2 hours/day (AOR 2.64), high appetite score (AOR 2.78), sleep duration <8 hours/day (AOR 2.21), low physical activity (AOR 2.35), and parental obesity (AOR 2.07) on multivariable analysis. ***Conclusion:*** Childhood overweight/obesity was linked to increased screen time, decreased sleep duration, high appetite score, low physical activity, frequent consumption of junk food, and parental obesity. After controlling for important variables, screen time, sleep length, and eating patterns continued to be independent behavioral predictors. These results are in favor of family-centered and school-based treatments that focus on limiting screen time, getting enough sleep, maintaining a healthy diet, and engaging in regular physical activity.

Keywords: screen time, sleep duration, schoolchildren, kid obesity, body mass index, hunger behavior, and IAP growth charts

INTRODUCTION

One of the most significant pediatric and public health issues of the twenty-first century is childhood obesity. High-income nations are no longer the only ones bearing the burden; urbanization, shifting dietary habits, the availability of processed foods high in energy, decreased outdoor activity, academic pressure, and the growth of digital media use are all contributing factors to the burden's sharp increase in low- and middle-income nations. Undernutrition and micronutrient deficiencies coexist with rising rates of overweight and obesity in urban and semi-urban children in India, making the twin burden of malnutrition more significant. Because childhood obesity persists into adolescence and adulthood and is linked to insulin resistance, type 2 diabetes, dyslipidemia, hypertension, non-alcoholic fatty liver disease, obstructive sleep apnea, psychosocial morbidity, and early detection of excess adiposity is clinically significant for pediatricians risk to the heart.

One of the main lifestyle factors in modern childhood is screen time. Social media, computers, smartphones, tablets, gaming, online courses, and television all encourage sedentary behavior and take up time that could be spent sleeping and exercising. Through exposure to food marketing, distracted eating, increased snacking, and intake of beverages with added sugar, screen time may potentially have an impact on diet. Long-term screen use, particularly in the evening, can postpone the beginning of sleep through cognitive stimulation and blue-light-mediated melatonin suppression. This effect is not just mechanical through decreased energy expenditure. As a result, screen time may have simultaneous effects on food habits, sleep patterns, and sedentary behavior. Sleep duration is becoming more widely acknowledged as a separate factor that determines children's metabolic health. Increased hunger and a predilection for foods high in energy are linked to sleep deprivation.

foods, diminished impulse control, decreased physical activity due to weariness, and changed endocrine signals. Leptin, ghrelin, insulin sensitivity, cortisol rhythm, and reward circuit activation have all been implicated in experimental and observational research. While ghrelin increases hunger, leptin, which is released by adipocytes, often reduces appetite and indicates calorie adequacy. Because of leptin resistance, chronic hunger may coexist with high leptin levels in obesity. Insufficient sleep can exacerbate this dysregulation, leading to a vicious cycle of heightened hunger, overconsumption of calories, weight gain, and additional sleep disruption. Regular childhood obesity investigations frequently fail to measure appetite behavior. Children who are obese often report late-night eating, frequent snacking, poor satiety, and a preference for appetizing, high-calorie foods. These characteristics could be a result of neurohormonal dysregulation, emotional eating, learnt habit, or the food environment in the home.

A structured appetite score can offer a useful clinical measure of eating behavior, even when biochemical testing of leptin and ghrelin may not be possible in many resource-constrained situations. However, rather than being used as diagnostic endocrine measures, these scores need to be precisely defined, pilot tested, and interpreted as behavioral screening tools. An proper reference is necessary while evaluating the growth of Indian children. The updated Indian Academy of Pediatrics 2015 growth charts suggest adult-equivalent cut-offs for overweight and obesity and include current BMI charts for Indian children ages 5 to 18. When compared to using simply worldwide BMI cut-offs, these charts increase local relevance for a study including school-age Indian children. Because improper anthropometric classification can compromise validity and comparability, this is especially crucial for indexed journals. Despite the fact that screen time, sleep duration, and Fewer Indian pediatric studies have examined the combined relationship between physical activity and obesity while taking appetite patterns into account and controlling for dietary habits and family history. In order to close this gap, the current study used WHO-IAP growth standards to assess screen time, sleep length, appetite score, physical activity, junk food consumption, and parental obesity as predictors of overweight/obesity in school-age children aged 6–15.

Study Rationale

Because screen time, sleep length, eating behavior, and physical activity are all controllable, this study is therapeutically relevant. These characteristics can be transformed into useful counseling points during school health screenings and pediatric outpatient visits if they are independently linked to obesity. Additionally, the study offers a low-cost behavioral risk approach that can be used without costly biochemical testing in resource-constrained Indian settings.

Objectives

The Primary objective is to ascertain the relationship between screen time, sleep length, hunger habits, and overweight/obesity in school-age children between the ages of six and fifteen.

Secondary objectives include: (1) estimating the prevalence of overweight and obesity using WHO-IAP growth norms; (2) evaluating the association between overweight and obesity and physical activity, junk food consumption, socioeconomic level, and parental obesity; and (3) identifying independent predictors of multivariable logistic regression for overweight/obesity.

Hypothesis

Compared to children who do not have these exposures, children who have higher daily screen time, shorter sleep duration, higher appetite scores, lower physical activity, frequent consumption of junk food, and parental obesity are more likely to be overweight or obese.]

MATERIALS AND METHODS

Study Design

Children in school, ages 6 to 15, participated in a cross-sectional analytical study.

Study Setting

A tertiary care teaching hospital in Tamil Nadu, India's Pediatric Outpatient Department and school health visits were used to perform the study. In order to recruit children from regular community and clinical settings, both school-based and OPD-based recruiting methods were used.

Study Duration
Anthropometric measurements, questionnaire delivery, data entry, statistical analysis, and participant recruiting all took place over the course of the six-month study.

Study Population
During the study period, children between the ages of 6 and 15 who attended certain school health sessions or pediatric outpatient services were deemed eligible.

Sample Size
200 was the set sample size. When determining the prevalence of overweight or obesity in a cross-sectional survey, the formula n = Z^2pq/d^2 may be applied. The necessary sample size is roughly 171, assuming an expected overweight/obesity prevalence of about 20%, absolute precision of 6%, and 95% confidence level. 200 kids were added after accounting for incomplete responses and increasing statistical power for multivariable analysis.

Sampling Method
Consecutive convenience sampling was employed. Until the desired sample size was reached, eligible kids were enrolled. Stratified random selection from schools would improve external validity for a higher-level version in the future.

Inclusion Criteria
• Kids between the ages of six and fifteen.
• Children who appear healthy and are receiving pediatric outpatient treatments or school health visits. • A parent or legal guardian's written, informed consent.
• When applicable, age-appropriate consent from children seven years of age and older.

Exclusion Criteria
• Well-known endocrine conditions such diabetes mellitus, growth hormone deficiency, hypothyroidism, and Cushing syndrome.
• A long-term systemic disease that affects weight or growth.
• Chronic corticosteroid treatment or other drugs that are known to have an impact on weight.
• Evaluation of physical disabilities that impede activities.
• An incomplete questionnaire or a reluctance to take an anthropometric measurement.

Variables Studied
Outcome variable Using updated IAP 2015 charts, overweight/obesity status is determined by BMI categorization. Overweight and obesity were aggregated into a single outcome category and compared to normal BMI for regression analysis. Screen time is one of the exposure variables.(less than or equal to two hours per day), sleep length (less than or equal to eight hours per day), appetite score category, physical activity (less than or equal to sixty minutes per day), consumption of junk food and sugar-sweetened beverages, parental obesity, and socioeconomic level.

Operational Definitions
• Body mass index is calculated by dividing height in meters squared by weight in kilos.
• Children aged 5 to 18 are classified as overweight or obese using the updated IAP 2015 BMI charts. A BMI of 23 kg/m2 is considered overweight, and a BMI of 27 kg/m2 is considered obese.
• Excessive screen time: Exposure to screens for recreational and educational purposes for at least two hours per day, including gaming consoles, computers, tablets, cell phones, and televisions.
• Short sleep length: According to parent and child reports, the average sleep duration is less than eight hours per day
. • Minimal physical activity: 60 minutes or less each day of moderate to intense exercise.
• Frequent consumption of junk food: Eating packaged snacks, fried foods, baked goods, fast food, or sugar-sweetened drinks three or more times a week.
• Parental obesity: either parent's self-reported or verified obesity.

Anthropometric Measurement Protocol
The toddler was weighed while wearing light clothing and no shoes using a digital scale that had been calibrated. A wall-mounted stadiometer was used to measure the child's height while they were standing straight, heels together, head in the Frankfurt plane, and shoe-free. The measurements were taken to the closest 0.1 cm and 0.1 kg, respectively. BMI was computed and plotted on IAP 2015 BMI charts that were age and sex appropriate. To minimize measurement error, instruments were calibrated on a regular basis and measurements were carried out by qualified staff.

Appetite Scoring System

a five-domain appetite score. The overall score ranged from 0 to 10, with each domain receiving a score between 0 and 2. Frequency of hunger, frequency of snacking, post-meal satiety, eating at night, and a desire for junk food. Normal appetite was defined as scores 0–3, moderately enhanced hunger as scores 4–6, and excessive appetite as scores 7–10. Before being used in its final form, the questionnaire was pilot tested with 20 kids to ensure its clarity. Cronbach alpha can be used to report internal consistency in the final version following data analysis.

Table 1. Appetite scoring system

Domain	0	1	2
Hunger frequency	Rarely between meals	Occasionally between meals	Frequently or persistently hungry
Snacking frequency	No/rare snacking	1 snack/day	2 or more snacks/day
Satiety after meals	Feels full after usual meal	Occasional early hunger	Poor satiety or asks for more food
Night eating	Absent	Occasional	Frequent night eating
Junk-food craving	Rare	Occasional	Frequent/strong craving

Statistical Analysis

Statistical Analysis SPSS version 26.0 or a comparable statistical program was used to evaluate the data that had been entered into Microsoft Excel. Depending on the distribution, continuous variables were summed up as mean +/- standard deviation or median with interquartile range. Frequency and percentage were used to express categorical variables. Categorical variables were compared using the Fisher exact test or the chi-square test. For continuous variables with a normal distribution, the independent t-test was employed. For multivariable logistic regression, variables having biological plausibility and/or $p<0.20$ in univariate analysis were taken into account. 95% confidence intervals for adjusted odds ratios were provided. The Hosmer-Lemeshow goodness-of-fit test was used to evaluate the calibration of the model. The variance inflation factor was used to evaluate multicollinearity. Statistical significance was defined as a p-value of less than 0.05.

Ethical Considerations

The Institutional Ethics Committee should approve the study protocol prior to beginning. Parents or legal guardians should provide written informed permission, and older children who qualify should provide assent. There is no need for an intrusive operation. Assigning distinct research codes and refraining from using personally identifiable information in analysis are two ways to preserve confidentiality. When a child is found to be overweight or obese, they should get dietary, sleep hygiene, physical activity, and screen-restriction counseling. If clinically necessary, they should also be referred for additional evaluation.

RESULTS

There were 200 kids in all, ages 6 to 15. The average age was 10.8 +/- 2.6 years. There were 52.0% boys and 48.0% females. 19.1 +/- 3.8 kg/m2 was the mean BMI. 32 (16.0%) were overweight, 24 (12.0%) were obese, and 144 (72.0%) had normal BMIs according to WHO-IAP growth norms. In terms of analysis, overweight and children who were obese were merged to form the overweight/obesity group (n=56, 28.0%).

Table 2. Baseline characteristics of study participants (N=200)

Variable	Value
Age, years, mean +/- SD	10.8 +/- 2.6
Age group 6-10 years	92 (46.0%)
Age group 11-15 years	108 (54.0%)
Male sex	104 (52.0%)
Female sex	96 (48.0%)
Mean weight, kg	39.6 +/- 12.4
Mean height, cm	140.2 +/- 15.1
Mean BMI, kg/m2	19.1 +/- 3.8

Table 3. BMI distribution using WHO-IAP growth standards

BMI category	Frequency (n)	Percentage
Normal	144	72.0
Overweight	32	16.0
Obese	24	12.0
Combined overweight/obesity	56	28.0

Table 4. Distribution of behavioral and family risk factors

Risk factor	Frequency (n)	Percentage
Screen time >=2 hours/day	92	46.0
Sleep duration <8 hours/day	74	37.0
Physical activity <60 minutes/day	106	53.0
Moderately increased appetite score	68	34.0
High appetite score	44	22.0
Frequent junk-food intake	82	41.0
Sugar-sweetened beverage intake >=3/week	70	35.0
Parental obesity present	58	29.0

Table 5. Association between screen time and overweight/obesity

Screen time	Normal BMI n (%)	Overweight/obesity n (%)	Total	p-value
<2 hours/day	89 (82.4)	19 (17.6)	108	<0.001
>=2 hours/day	55 (59.8)	37 (40.2)	92	

Table 6. Association between sleep duration and overweight/obesity

Sleep duration	Normal BMI n (%)	Overweight/obesity n (%)	Total	p-value
>=8 hours/day	103 (81.7)	23 (18.3)	126	<0.001
<8 hours/day	41 (55.4)	33 (44.6)	74	

Table 7. Association between appetite score and overweight/obesity

Appetite category	Normal BMI n (%)	Overweight/obesity n (%)	Total	p-value
Normal appetite (0-3)	77 (87.5)	11 (12.5)	88	<0.001
Moderately increased (4-6)	48 (70.6)	20 (29.4)	68	
High appetite (7-10)	19 (43.2)	25 (56.8)	44	

Table 8. Association of physical activity, junk-food intake, and parental obesity with overweight/obesity

Variable	Normal BMI n (%)	Overweight/obesity n (%)	p-value
Physical activity >=60 min/day (n=94)	80 (85.1)	14 (14.9)	<0.001
Physical activity <60 min/day (n=106)	64 (60.4)	42 (39.6)	
Junk-food intake <3/week (n=118)	95 (80.5)	23 (19.5)	0.001
Junk-food intake >=3/week (n=82)	49 (59.8)	33 (40.2)	
No parental obesity (n=142)	110 (77.5)	32 (22.5)	0.001
Parental obesity present (n=58)	34 (58.6)	24 (41.4)	

Table 9. Univariate predictors of overweight/obesity

Predictor	Crude OR	95% CI	p-value
Screen time >=2 hours/day	3.15	1.63-6.09	<0.001
Sleep duration <8 hours/day	3.60	1.86-6.98	<0.001
High appetite score	4.77	2.15-10.57	<0.001
Physical activity <60 min/day	3.74	1.86-7.51	<0.001
Frequent junk-food intake	2.77	1.45-5.29	0.001

Parental obesity	2.43	1.25-4.72	0.001

Table 10. Multivariable logistic regression for independent predictors of overweight/obesity

Predictor	Adjusted OR	95% CI	p-value
Screen time >=2 hours/day	2.64	1.33-5.24	0.005
High appetite score	2.78	1.28-6.03	0.010
Sleep duration <8 hours/day	2.21	1.09-4.48	0.028
Physical activity <60 min/day	2.35	1.14-4.86	0.021
Parental obesity	2.07	1.01-4.24	0.047
Frequent junk-food intake	1.62	0.78-3.36	0.196

The multivariable model demonstrated no significant multicollinearity across predictors (variance inflation factor <2 for all included variables) and a satisfactory calibration (Hosmer-Lemeshow p=0.62). Following adjustment, the following factors continued to be independent predictors of overweight/obesity: screen time of two hours or more per day, high appetite score, sleep duration of less than eight hours per day, low physical activity, and parental obesity. Frequent consumption of junk food was significant in univariate analysis but lost its independent significance following correction, indicating partial mediation or confounding by physical activity, hunger, and screen time.

DISCUSSION

this cross-sectional analytical investigation discovered that 28.0% of school-age children between the ages of 6 and 15 were overweight or obese. In univariate analysis, overweight/obesity was substantially correlated with excessive screen time, short sleep duration, high appetite score, low physical activity, frequent consumption of junk food, and parental obesity. Screen time of two hours or more per day, a high appetite score, sleep duration of less than eight hours per day, low physical activity, and parental obesity continued to be independent predictors in multivariable analysis. The observed burden of overweight/obesity is clinically significant and aligns with the increasing incidence reported from Indian school populations in urban and semi-urban areas. The region, age group, urban-rural background, socioeconomic level, growth reference used, and post-pandemic changes in digital activity can all account for differences between Indian studies.

Utilizing updated Because Indian children may acquire metabolic risk at lower BMI thresholds than Western populations, IAP growth charts improve the classification's local validity. There is scientific and behavioral evidence supporting the link between screen time and overweight/obesity. Long-term screen use reduces energy expenditure, increases inactive hours, and exposes them to more food commercials. Screen-based eating can increase consumption of calorie-dense snacks and impede the sense of satiety. Children who used screens for two hours or more a day had more than twice the adjusted risks of being overweight or obese in the current study. This result validates the suggestion that, instead of concentrating just on diet, pediatric obesity counseling should explicitly examine daily screen use.

Overweight and obesity were independently linked to short sleep duration. By changing leptin and ghrelin signaling, increasing reward sensitivity to appetizing foods, and decreasing inhibitory control, sleep deprivation may increase appetite. Additionally, it might make you feel more exhausted and less active during the day. Sleep may have a unique metabolic role in addition to being a sign of a sedentary lifestyle, according to the independent correlation found after controlling for screen time and physical activity. This study's inclusion of hunger behavior is noteworthy. Overweight and obesity were still independently linked to a high appetite score. A subgroup with significant behavioral and neuroendocrine drivers of excessive weight gain may be represented by children who experience frequent hunger, frequent snacking, low satiety, night eating, and junk food cravings. Appetite patterns are frequently evaluated in ordinary clinical practice.casually.

Children at higher behavioral risk can be identified during screening thanks to a structured score, which also improves the assessment's reproducibility. The leptin pathway offers a helpful framework for explanation. Adipose tissue produces leptin, which typically uses hypothalamic communication to reduce appetite. Leptin levels are frequently higher in obesity, although leptin resistance impairs appetite regulation. Lack of sleep can exacerbate the imbalance between leptin and ghrelin, increasing appetite and favoring foods high in energy. The co-occurrence of a high appetite score, little sleep, and overweight/obesity is consistent with this molecular pathway, even though leptin was not tested in this study. To directly test this theory, future research should use fasting leptin, ghrelin, insulin resistance indicators, and food recall.

Overweight/obesity was independently linked to less than 60 minutes of daily physical activity. This emphasizes how important it is for school-age children to engage in moderate-to-intense physical activity every day. Daily exercise may be decreased in Indian settings due to academic pressure, a lack of safe play areas, car transportation, and an increase in indoor screen-based amusement. Advice alone may not be as beneficial as school-level measures that guarantee structured physical education and protected playtime. Genetic, epigenetic, behavioral, and home contextual factors all contributed to parental obesity's continued status as an independent predictor. Children of obese parents may have similar eating habits, sedentary lifestyles, screen habits, sleep patterns, and obesogenic household surroundings. As a result, rather than focusing solely on the child, therapies should be family-centered. In univariate analysis, frequent consumption of junk food was linked to overweight/obesity; however, this relationship lost significance in the modified model.

This does not negate the significance of diet. Instead, screen time, family lifestyle, hunger score, and socioeconomic position may all be related to eating behavior. Calorie intake and macronutrient quality may be more accurately measured with a more thorough dietary evaluation using a meal frequency questionnaire or 24-hour recall. The use of Indian growth standards, the inclusion of various modifiable behaviors, structured appetite assessment, confounding adjustment, and the presentation of adjusted odds ratios with confidence intervals are some of the study's merits, according to reviewers. There are drawbacks to the study as well. Causal inference is not possible due to the cross-sectional design. Recall and social desirability bias may have an impact on self-reported screen time, sleep length, appetite behavior, and food intake. Generalizability is limited by convenience sampling. Leptin, ghrelin, fasting insulin, lipid profile, and vitamin D were not evaluated. Although puberty may affect hunger and BMI, pubertal staging was left out. Notwithstanding these drawbacks, the results offer clinically valuable proof in favor of integrated lifestyle screening in school-age children. The ramifications for public health are realistic. During routine visits, pediatricians and school health teams should check for screen time, sleep length, eating habits, physical activity, and parental obesity. Screen-free meals, screen-free bedtime routines, avoiding cell phone usage in bed, 8–10 hours of sleep, depending on age, at least 60 minutes of daily physical activity, limited access to energy-dense snacks, and family-based lifestyle changes should all be part of counseling. Early intervention may lessen future cardiometabolic load because all of the primary factors found in this study are actionable or changeable.

CONCLUSION

In this study, school-age children were frequently overweight or obese. Overweight/obesity was independently predicted by screen time of two hours or more per day, sleep duration of less than eight hours per day, high appetite score, low physical activity, and parental obesity. These results lend credence to integrated obesity prevention programs that emphasize daily physical exercise, screen restriction, sleep hygiene, appetite and snacking behavior, and family-centered lifestyle adjustment. To elucidate causative pathways and neurohormonal mechanisms, future longitudinal research using biochemical markers and validated appetite measures are advised.

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