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DETERMINANTS OF OVERWEIGHT AND OBESITY AMONG SCHOOL-GOING ADOLESCENTS IN BAREILLY, UTTAR PRADESH: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Adolescent obesity has emerged as a major public health challenge in India. Bareilly, a rapidly urbanizing tier-2 city in Uttar Pradesh, lacks comprehensive data on the prevalence and determinants of adolescent obesity. This study was conducted to address this critical evidence gap.

Objectives: To estimate the prevalence of overweight and obesity among school-going adolescents (14–19 years) in Bareilly district and to identify associated sociodemographic, behavioral, and lifestyle determinants.

Methods: A cross-sectional study was conducted among 600 school-going adolescents selected through two-stage cluster sampling from government and private schools of Bareilly block. Standardized anthropometric measurements (height, weight, waist and hip circumference) were performed and BMI classified using WHO growth reference for age and sex. Sociodemographic, dietary, and lifestyle data were collected using a pre-tested structured questionnaire. Chi-square tests and binary logistic regression were used for statistical analysis.

Results: Among 600 adolescents (54.8% male, 45.0% female; mean age 15.8 years), the overall prevalence of overweight was 8.17% and obesity was 3.00%, with a combined overweight/obesity prevalence of 11.17%. Prevalence was significantly higher among males (13.98%) compared to females (7.78%), and in private school students (14.13%) compared to government school students (8.79%). On multivariable logistic regression, male sex (AOR: 1.99; 95% CI: 1.12–3.63; p=0.02), high screen time (>4 hrs/day: AOR: 3.82; 95% CI: 1.40–11.81; p=0.01), positive family history of obesity (AOR: 3.57; 95% CI: 2.02–6.35; p<0.001), and low physical activity were identified as independent predictors of overweight/obesity. The logistic regression model showed good discriminatory ability (AUC=0.78).

Conclusion: The combined overweight/obesity prevalence of 11.17% among Bareilly adolescents is concerning and consistent with escalating trends in northern India. Male sex, family history of obesity, excessive screen time, and physical inactivity are key modifiable and non-modifiable risk factors. School-based multi-component interventions targeting physical activity promotion, screen time reduction, and dietary counseling are urgently needed.

Keywords: *Adolescent obesity, BMI, overweight, school-going, Bareilly, Uttar Pradesh, physical activity, screen time, family history*

INTRODUCTION

Obesity represents one of the most pressing public health challenges of the 21st century, affecting populations across all age groups and socioeconomic strata. The World Health Organization (WHO) has declared obesity a global epidemic, recognizing its profound implications for population health, healthcare infrastructure, and economic productivity. Childhood and adolescent obesity is particularly alarming as it establishes metabolic and behavioral patterns that persist throughout life, substantially increasing lifetime risk for non-communicable diseases (NCDs) including cardiovascular disorders, type 2 diabetes mellitus, certain cancers, and premature mortality.

Global obesity trends reveal a dramatic escalation. A landmark pooled analysis of 3,663 population-representative studies encompassing 222 million participants across 190 countries documented that the prevalence of obesity among children and adolescents aged 5–19 years rose more than fivefold — from 1.7% in 1990 to 8.5% in 2022. The absolute number of affected children and adolescents increased from 31 million to 159 million during this period. When combined with 879 million obese adults in 2022, the total global burden of obesity surpassed one billion individuals for the first time in history.[1]

India presents a unique epidemiological scenario characterized by the concurrent burden of undernutrition and rising overweight/obesity — the 'double burden of malnutrition.' India harbors approximately 253 million adolescents aged 10–19 years, constituting the world's largest adolescent population and accounting for approximately one-fifth of the global adolescent pool. The NCD Risk Factor Collaboration analysis revealed that in 2022, 12.5 million Indian children aged 5–19 years were classified as obese, marking a dramatic increase from 0.4 million in 1990.[1][4] A scoping review of 93 studies on Indian adolescents documented overweight prevalence ranging from 1.25% to 35.8% and obesity from 0.3% to 24.6%, with consistently higher rates in urban areas, higher socioeconomic strata, and private school students.[5]

Uttar Pradesh, India's most populous state with a population exceeding 200 million, contributes substantially to the national burden of adolescent obesity. Yet district-level epidemiological data within the state remain sparse. Bareilly district, situated in the Rohilkhand region of western Uttar Pradesh, is undergoing rapid urbanization featuring increased access to processed and energy-dense foods, reduced physical activity, and escalating screen exposure associated with smartphone and internet penetration. Despite these emerging risk factors, comprehensive prevalence data and systematic assessment of determinants among adolescents in Bareilly are entirely lacking, representing a critical gap in regional epidemiological evidence.

This study was therefore conducted to estimate the prevalence of overweight and obesity among school-going adolescents aged 14–19 years in Bareilly district and to identify the key sociodemographic, behavioral, dietary, and psychosocial determinants associated with these conditions, with the aim of providing locally relevant evidence to inform evidence-based prevention strategies.

MATERIALS AND METHODS

Study Design and Setting

This was a cross-sectional descriptive study conducted among school-going adolescents aged 14–19 years in selected government and private schools of Bareilly block, Bareilly district, Uttar Pradesh,

India. The study was conducted over a period of 12 months after obtaining ethical approval from the Institutional Ethics Committee of Rajshree Medical Research Institute, Bareilly.

Sample Size and Sampling Procedure

The sample size was calculated using the formula $n = [DEFF \times Z^2 \times p \times q] / e^2$, where prevalence (p) = 18% based on previous studies, Z = 1.96 (95% confidence level), margin of error (e) = 4%, and design effect (DEFF) = 1.5 for cluster sampling. The calculated sample size was 532; adding 10% for non-response yielded a target of 585 students. The final sample collected was 600 students.

A two-stage cluster sampling methodology was employed. In Stage 1, ten schools were randomly selected from Bareilly block after stratification by school type (government/private) and area (urban/semi-urban/rural) using a lottery method. In Stage 2, two classes containing students aged 14–19 years were randomly selected from each school, and all students present in one section of each selected class were enrolled.

Inclusion and Exclusion Criteria

Students aged 14–19 years enrolled in selected schools who provided written assent and whose parents provided informed consent were included. Students absent on the day of data collection, those outside the 14–19 years age range, and those with known medical conditions affecting weight or height (e.g., endocrine disorders, genetic syndromes) or on medications affecting body weight were excluded.

Data Collection and Study Tools

Data were collected using a pre-designed, pre-tested, bilingual (English and Hindi) structured questionnaire containing sections on socio-demographic characteristics, dietary patterns (meal frequency, breakfast habits, outside food consumption, fast food and soft drink intake, fruit and vegetable intake), physical activity, screen time, sleep duration and quality, family history, and psychosocial factors (stress level, body image perception, emotional eating, self-esteem).

Anthropometric measurements were performed using standardized techniques: height using a stadiometer (accuracy ±0.1 cm) with the participant standing erect without footwear, head in the Frankfurt plane; weight using a digital weighing scale (accuracy ±0.1 kg) with minimal clothing; waist circumference using a non-stretchable tape at the midpoint between the lower rib margin and iliac crest at end of normal expiration; and hip circumference at the maximum circumference over the buttocks. BMI was calculated as weight (kg) divided by height squared (m^2). Students were classified using WHO BMI-for-age Z-score reference standards: severe thinness (<−3 SD), thinness (−3 SD to <−2 SD), normal (−2 SD to +1 SD), overweight (>+1 SD to +2 SD), and obese (>+2 SD).

Statistical Analysis

Data were entered in MS Excel and analyzed using R version 4.0. Continuous variables were expressed as mean ± standard deviation. Categorical variables were expressed as frequencies and percentages. Chi-square test (or Fisher's exact test where appropriate) was used to assess associations between categorical variables and overweight/obesity status. Independent t-test or Mann-Whitney U test was used for continuous variables. Odds ratios with 95% confidence intervals were computed. Binary logistic regression was performed to identify independent predictors of overweight/obesity, with results expressed as adjusted odds ratios (AOR). Pearson's correlation coefficient was used to examine relationships between continuous variables. The discriminatory ability of the logistic regression model was assessed using the area under the receiver operating characteristic (ROC) curve (AUC). A p-value <0.05 was considered statistically significant.

RESULTS

Sociodemographic Characteristics

A total of 600 students (599 with complete data) were enrolled in the study. The sample comprised 329 males (54.8%) and 270 females (45.0%). The predominant age group was 16–17 years (46.2%),

followed by 14–15 years (39.3%) and 18–19 years (14.3%). Government school students constituted 55.0% of the sample. In terms of school location, 40.1% were from urban, 39.9% from semi-urban, and 20.0% from rural areas. The majority belonged to the upper (Class I: 43.9%) and upper-middle (Class II: 37.2%) socioeconomic strata by Modified Kuppuswamy classification. Nuclear, joint, and extended family types were nearly equally distributed. The sociodemographic profile is summarized in Table 1.

Table 1: Sociodemographic Profile of Study Participants (n=600)

Variable	Category	n	Percentage (%)
Age Group	14–15 years	236	39.33
	16–17 years	277	46.17
	18–19 years	86	14.33
Sex	Male	329	54.83
	Female	270	45.00
School Type	Government	330	55.00
	Private	269	44.83
School Area	Urban	240	40.00
	Semi-urban	239	39.83
	Rural	120	20.00
Socioeconomic Status (Modified Kuppuswamy)	Class I (Upper)	263	43.83
	Class II (Upper Middle)	223	37.17
	Class III (Lower Middle)	73	12.17
	Class IV (Upper Lower)	28	4.67
	Class V (Lower)	12	2.00
Family Type	Nuclear	191	31.83
	Joint	207	34.50
	Extended	201	33.50
Total		**599**	**100.00**

BMI Distribution and Prevalence of Overweight/Obesity

The mean BMI of the study population was 21.31 kg/m². On WHO BMI-for-age Z-score classification, the majority of students (84.47%) were in the normal category. Underweight/severe thinness/thinness was observed in 4.34% of students. Overweight was present in 8.18% (n=49) and obesity in 3.01% (n=18) of students, yielding a combined overweight/obesity prevalence of 11.19%. The BMI distribution is detailed in Table 2 and illustrated in Figures 1 and 9.

Table 2: BMI Category Distribution among Adolescents (n=600)

BMI Category	n	Percentage (%)
Underweight/Severe Thinness/Thinness	26	4.34
Normal	506	84.47
Overweight	49	8.18
Obese	18	3.01
Total (Overweight + Obese)	**67**	**11.19**

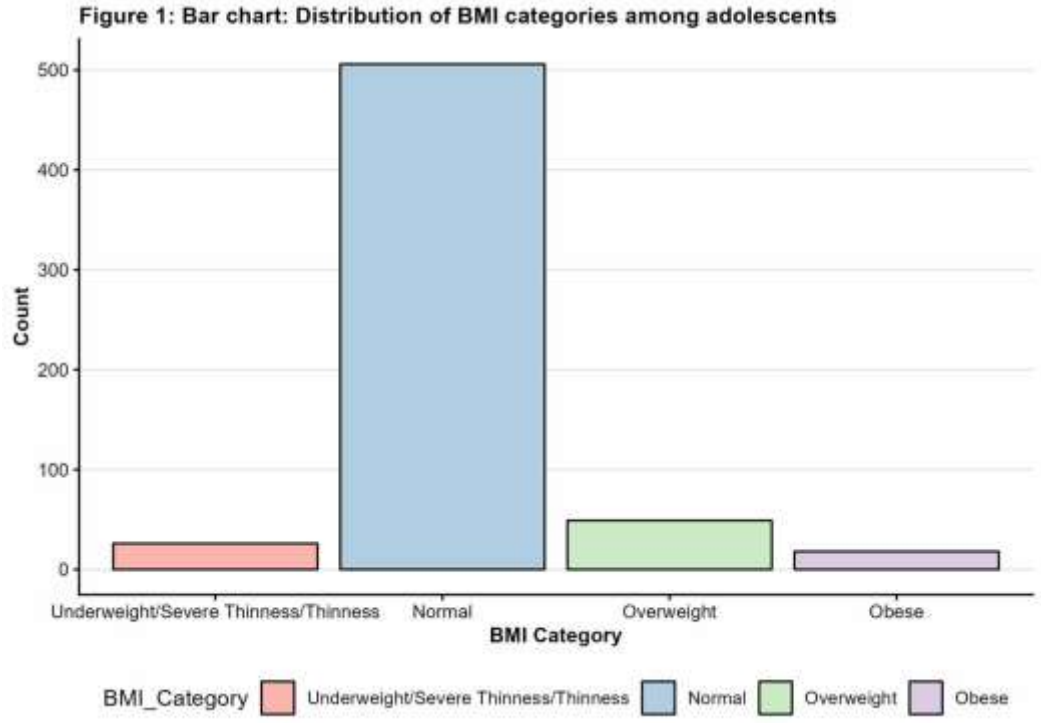


Figure 1: Bar chart showing distribution of BMI categories among study adolescents

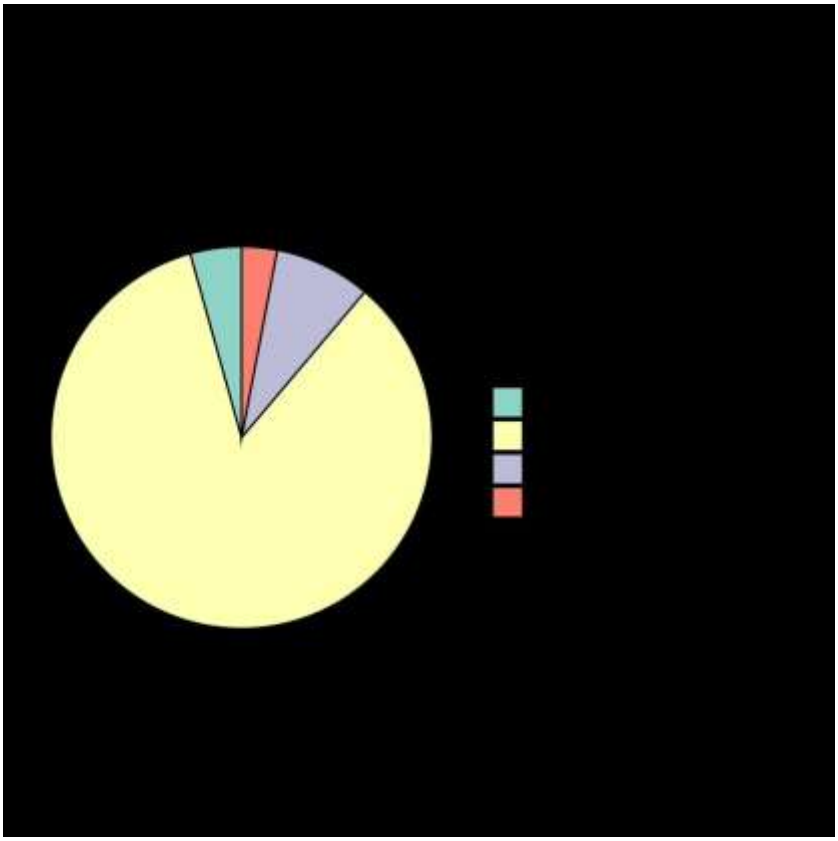


Figure 9: Pie chart depicting proportional distribution of BMI categories

Association of Overweight/Obesity with Sex

The prevalence of overweight/obesity was significantly higher among males (13.98%; 46/329) compared to females (7.78%; 21/270). This sex-based difference was statistically significant ($p<0.05$), as shown in Table 3 and Figure 2.

Table 3: Association of Overweight/Obesity with Sex

Sex	Normal/Underweight/Thinness	Overweight/Obese	Total	Prevalence (%)
Female	249	21	270	7.78
Male	283	46	329	13.98

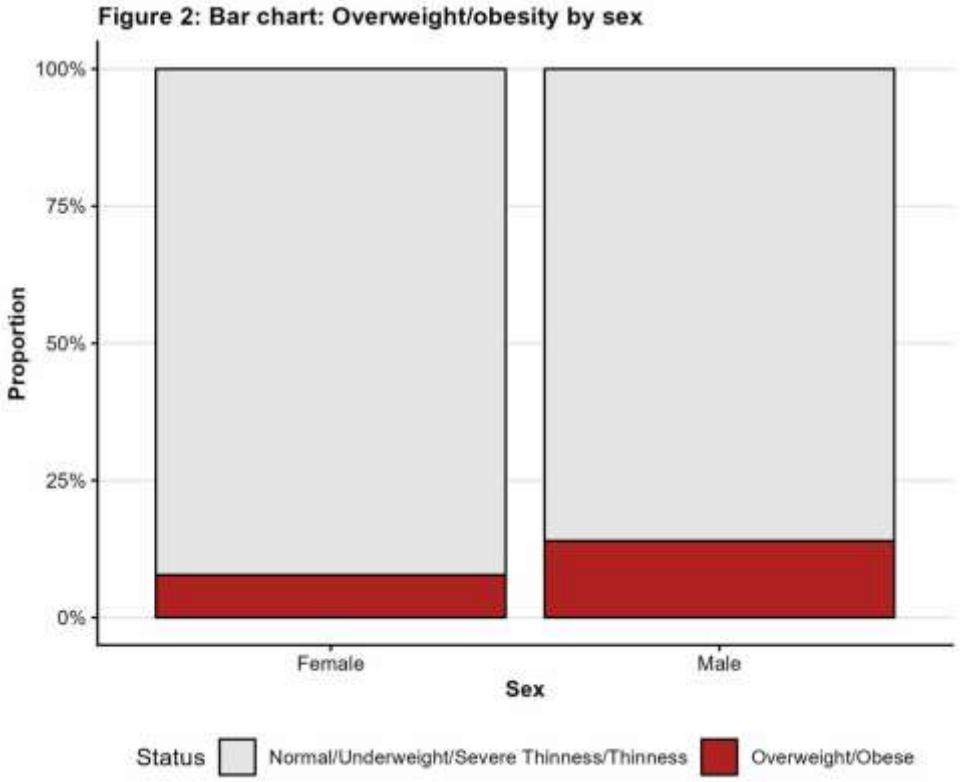


Figure 2: Bar chart depicting overweight/obesity prevalence by sex

Association with Age Group

Overweight/obesity prevalence was highest in the 14–15 years age group (13.98%), followed by 16–17 years (11.19%), with the lowest prevalence in the 18–19 years group (3.49%). The trend across age groups demonstrated a decreasing pattern with advancing age, as visualized in Figures 3 and 13. Table 4 summarizes the age-wise distribution.

Table 4: Association of Overweight/Obesity with Age Group

Age Group	Normal/Underweight/Thinness	Overweight/Obese	Total	Prevalence (%)
14–15 years	203	33	236	13.98
16–17 years	246	31	277	11.19
18–19 years	83	3	86	3.49

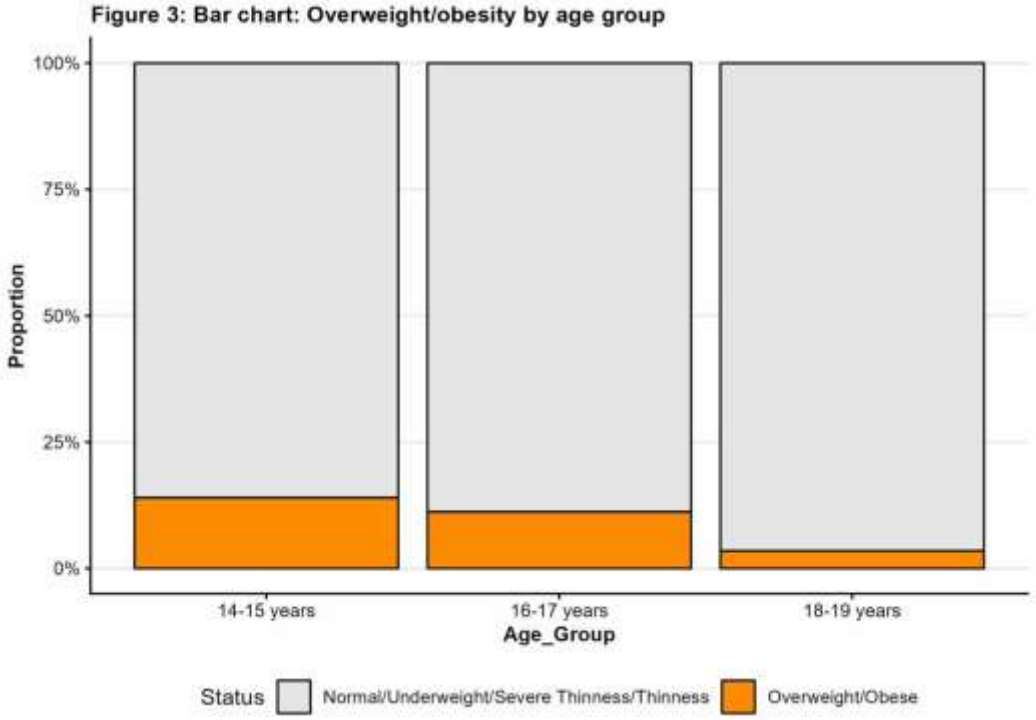


Figure 3: Bar chart showing overweight/obesity prevalence by age group

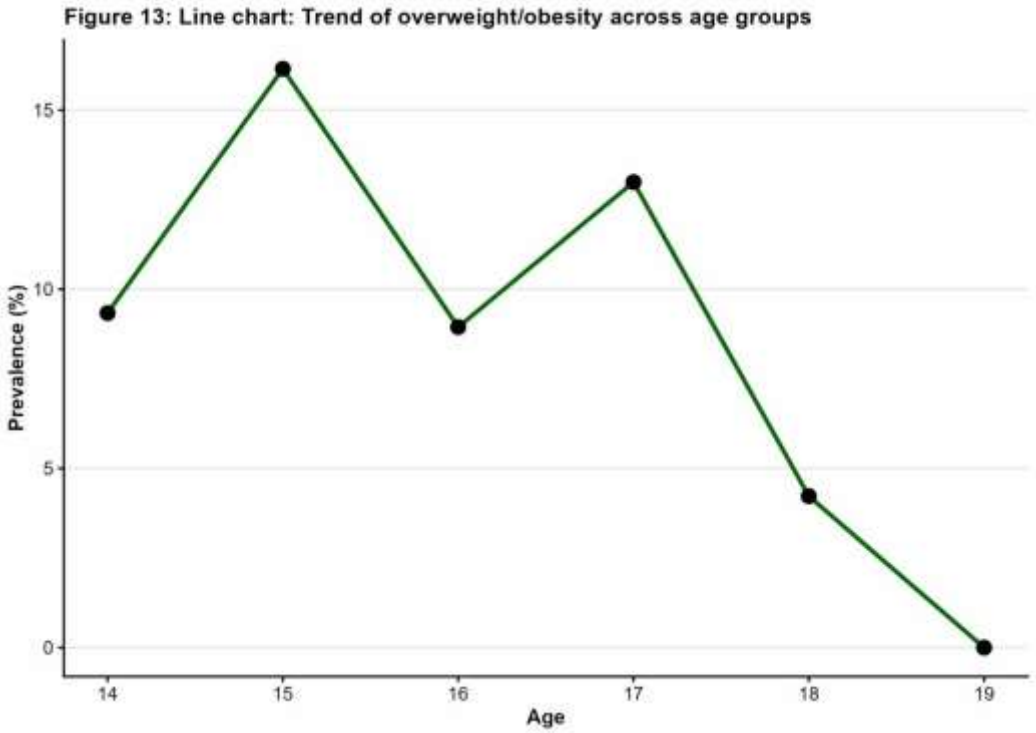


Figure 13: Line chart depicting trend of overweight/obesity across individual age groups

Association with School Type

Private school students exhibited a higher prevalence of overweight/obesity (14.13%; 38/269) compared to government school students (8.79%; 29/330), with this difference approaching statistical significance. Table 5 and Figure 4 present the school type-wise distribution.

Table 5: Association of Overweight/Obesity with School Type

School Type	Normal/Underweight/Thinness	Overweight/Obese	Total	Prevalence (%)
Government	301	29	330	8.79
Private	231	38	269	14.13

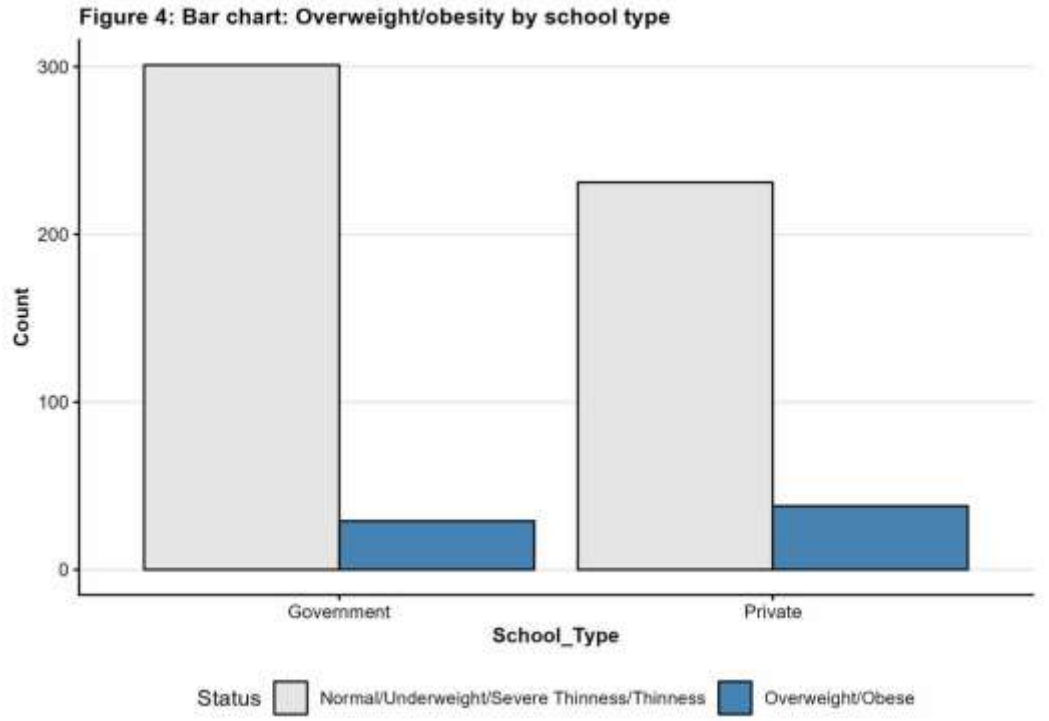


Figure 4: Bar chart showing overweight/obesity by school type

Association with Socioeconomic Status

A gradient pattern was observed in overweight/obesity prevalence across socioeconomic classes. Class I (upper) and Class II (upper-middle) had the highest prevalence at 12.93% and 11.66%, respectively, with lower prevalence in Class III (6.85%) and Class IV (3.57%). Table 6 and Figure 5 summarize the SES-wise distribution.

Table 6: Association of Overweight/Obesity with Socioeconomic Status

SES (Kuppuswamy)	Normal/Underweight/Thinness	Overweight/Obese	Total	Prevalence (%)
Class I	229	34	263	12.93
Class II	197	26	223	11.66
Class III	68	5	73	6.85
Class IV	27	1	28	3.57
Class V	11	1	12	8.33

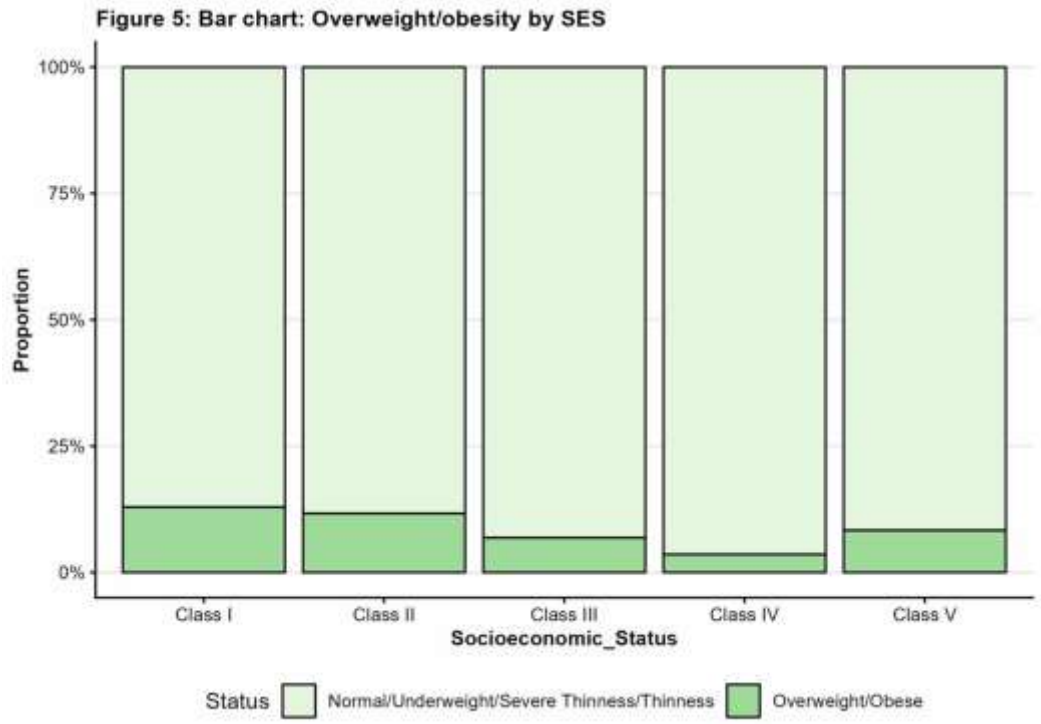


Figure 5: Bar chart showing overweight/obesity prevalence across socioeconomic classes

Association with Physical Activity

A clear inverse relationship was observed between physical activity level and overweight/obesity prevalence. Students with low physical activity had the highest prevalence (24.36%; 19/78), which declined progressively with moderate (10.38%; 27/260) and high physical activity levels (8.05%; 21/261). This dose-response relationship was statistically significant. Table 7 and Figures 6 and 10 illustrate this association.

Table 7: Association of Overweight/Obesity with Physical Activity Level

Physical Activity Level	Normal/Underweight/Thinness	Overweight/Obese	Total	Prevalence (%)
Low	59	19	78	24.36
Moderate	233	27	260	10.38
High	240	21	261	8.05

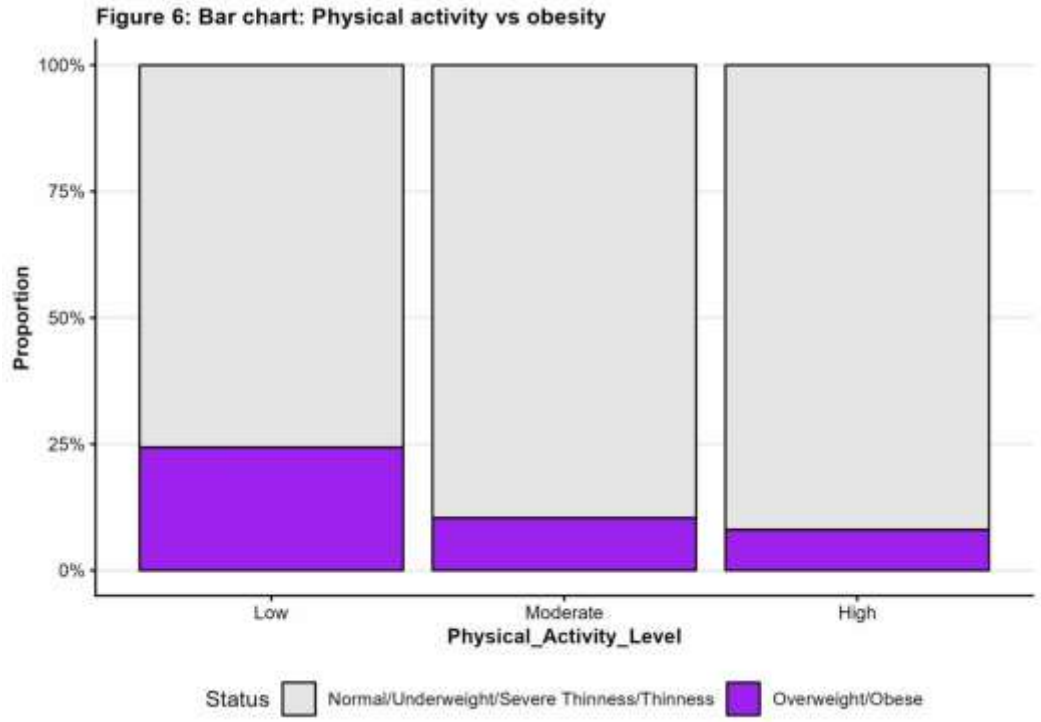


Figure 6: Bar chart showing overweight/obesity prevalence by physical activity level

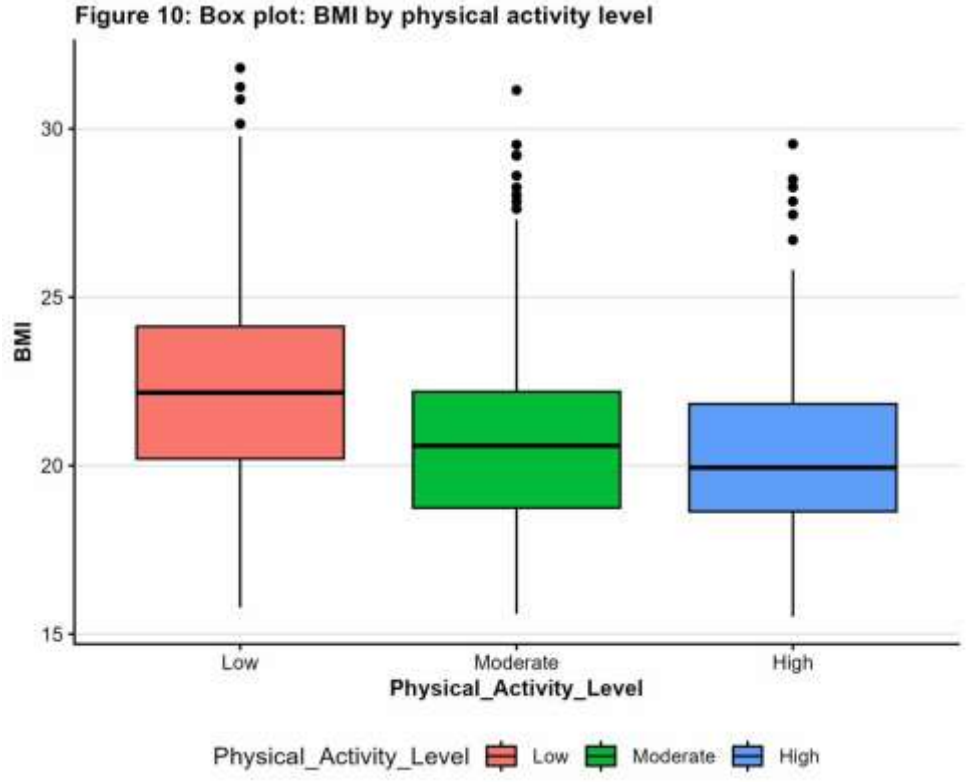


Figure 10: Box plot illustrating BMI distribution by physical activity level

Association with Screen Time

Screen time demonstrated a dose-response relationship with overweight/obesity prevalence. Students spending <2 hours/day on screens had a prevalence of 7.23%, which rose to 10.57% for 2–4 hours/day and further to 15.62% for >4 hours/day. This association was statistically significant. Table 8 and Figures 7 and 11 present the screen time analysis.

Table 8: Association of Overweight/Obesity with Screen Time

Screen Time Group	Normal/Underweight/Thinness	Overweight/Obese	Total	Prevalence (%)
< 2 hours/day	77	6	83	7.23
2–4 hours/day	347	41	388	10.57
> 4 hours/day	108	20	128	15.62

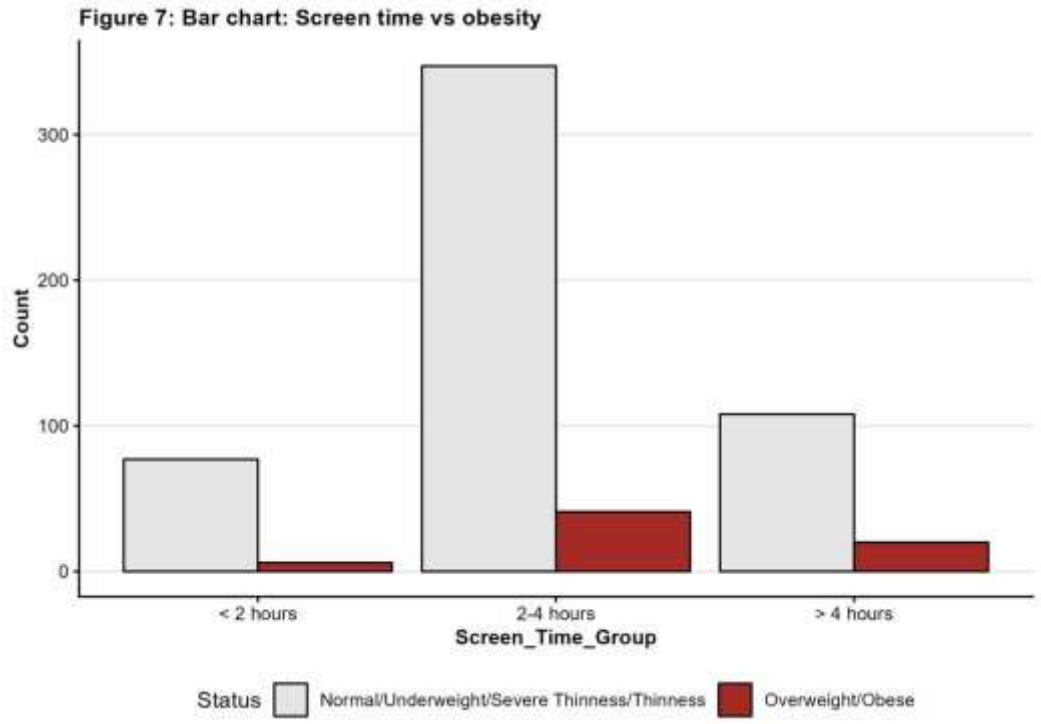


Figure 7: Bar chart showing overweight/obesity prevalence by screen time category

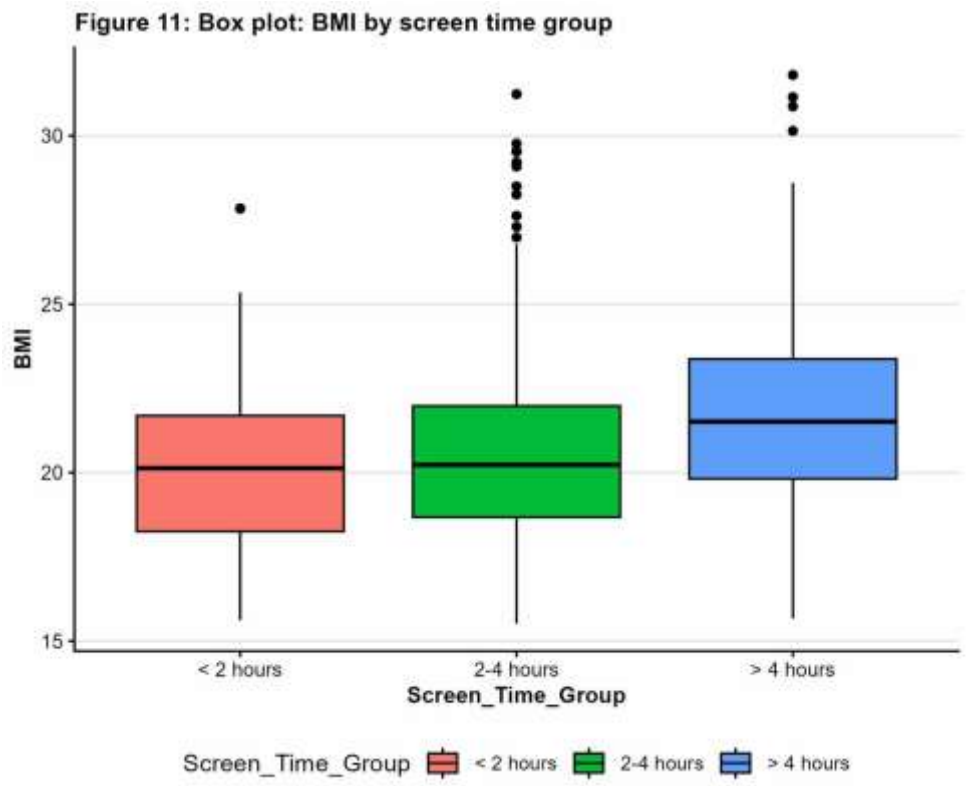


Figure 11: Box plot showing BMI distribution by screen time group

Association with Sleep Duration

Sleep duration showed an inverse relationship with overweight/obesity prevalence. Students sleeping 6 hours/day had the highest prevalence (15.69%), followed by 5 hours (13.38%), 7 hours (9.22%), and 8 hours (6.08%). Longer sleep duration appeared to be protective against overweight/obesity. Table 9 and Figure 8 detail this association.

Table 9: Association of Overweight/Obesity with Sleep Duration

Sleep Duration	Normal/Underweight/Thinness	Overweight/Obese	Total	Prevalence (%)
5 hours	136	21	157	13.38
6 hours	129	24	153	15.69
7 hours	128	13	141	9.22
8 hours	139	9	148	6.08

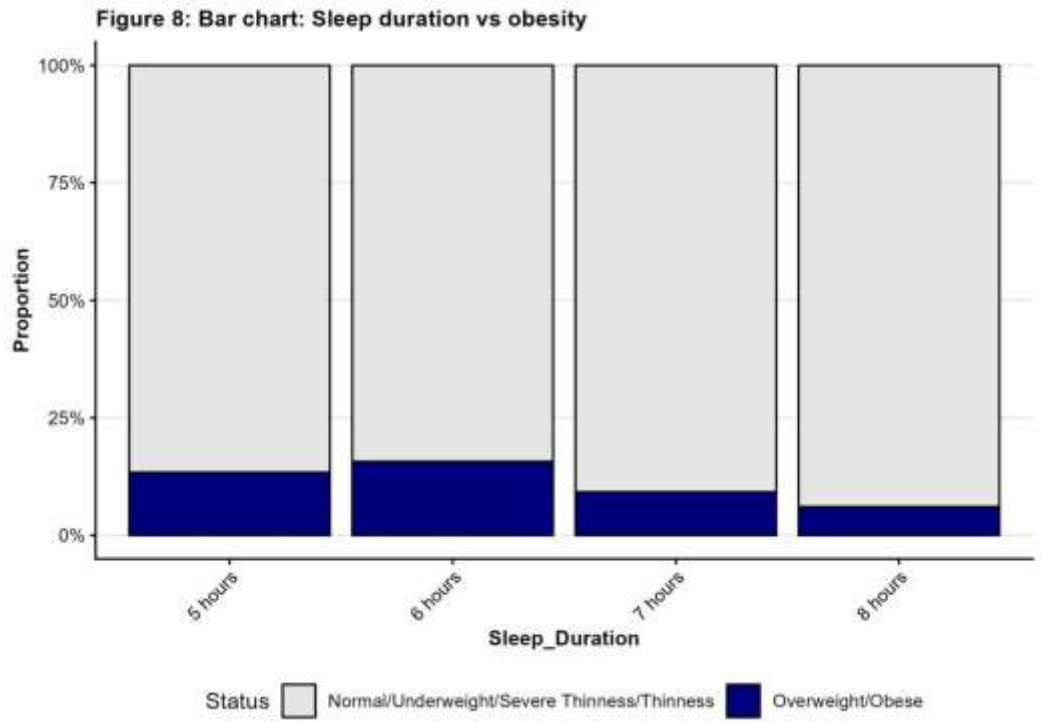


Figure 8: Bar chart depicting overweight/obesity prevalence by sleep duration

Association with Dietary Pattern, Family History, and Psychosocial Factors

Dietary pattern (vegetarian vs. non-vegetarian) did not show a significant difference in overweight/obesity prevalence (11.60% vs. 10.31%, respectively). However, family history of obesity emerged as one of the strongest determinants — students with a positive family history had a prevalence of 22.41% (39/174) compared to 6.59% (28/425) among those without, a difference that was highly statistically significant ($p<0.001$). Stress levels showed a moderate association, with the highest prevalence in the moderate stress group (13.86%), followed by high (10.05%) and low stress (9.57%).

Table 10: Association of Overweight/Obesity with Family History of Obesity

Family History	Normal/Underweight/Thinness	Overweight/Obese	Total	Prevalence (%)
No	397	28	425	6.59
Yes	135	39	174	22.41

Mean BMI by Sex and Age Group

Mean BMI increased progressively with age in both sexes. Among females, mean BMI increased from 19.60 ± 2.45 kg/m² in the 14–15 years group to 21.37 ± 2.99 kg/m² in the 18–19 years group. Among males, mean BMI increased from 20.57 ± 2.88 to 21.40 ± 2.84 kg/m². Males had higher mean BMI than females in the younger age groups, with the gap narrowing with advancing age. Table 11 presents the mean BMI by sex and age group.

Table 11: Mean BMI by Sex and Age Group

Sex	Age Group	Mean BMI (kg/m²)	SD
Female	14–15 years	19.60	2.45

	16–17 years	20.83	3.11
	18–19 years	21.37	2.99
Male	14–15 years	20.57	2.88
	16–17 years	20.95	2.77
	18–19 years	21.40	2.84

Correlation Analysis

Pearson's correlation analysis revealed a very strong positive correlation between BMI and waist circumference ($r=0.954$, $p<0.001$) and between BMI and hip circumference ($r=0.921$, $p<0.001$). Similarly, waist and hip circumference were strongly correlated with each other ($r=0.934$, $p<0.001$). Screen time showed a weak but statistically significant positive correlation with BMI ($r=0.165$, $p<0.001$). The scatter plot of BMI versus waist circumference is shown in Figure 12 and the correlation matrix is summarized in Table 12.

Table 12: Pearson's Correlation Matrix (n=600)

Variable	BMI	Waist Circumference (cm)	Hip Circumference (cm)
BMI	1.00	0.954*	0.921*
Waist Circumference (cm)	0.954*	1.00	0.934*
Hip Circumference (cm)	0.921*	0.934*	1.00
Screen Time (hrs)	0.165*	0.155*	0.137*

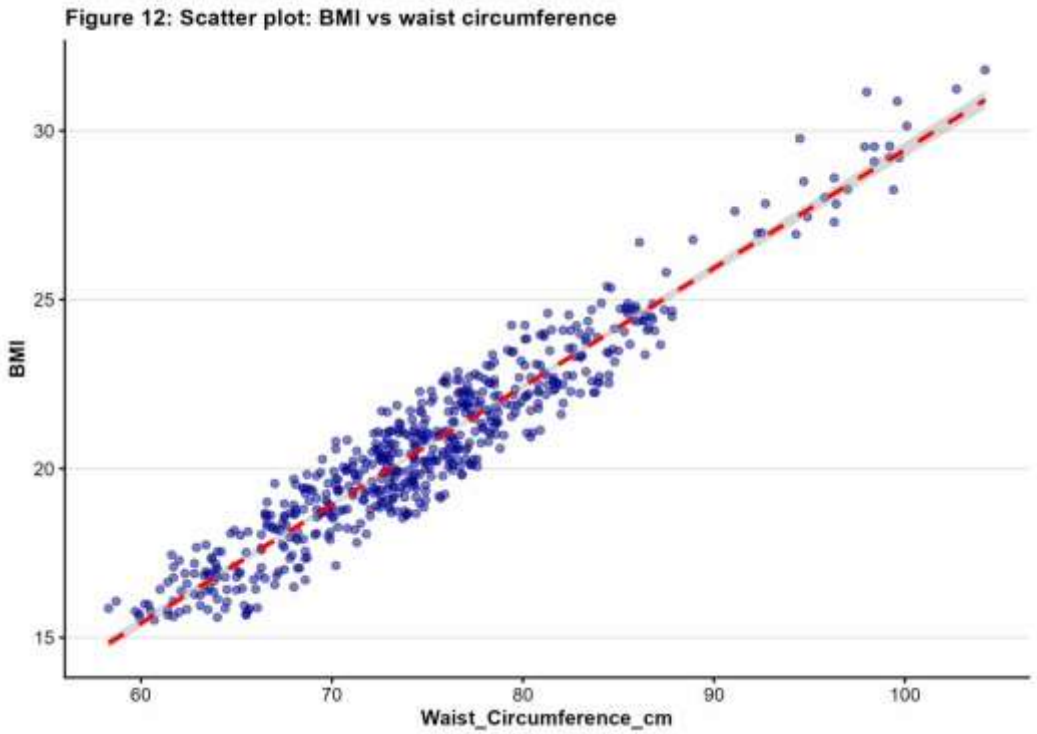


Figure 12: Scatter plot showing strong positive correlation between BMI and waist circumference

Multivariable Logistic Regression Analysis

Binary logistic regression was performed with overweight/obesity as the dependent variable. After adjustment for all covariates, four factors emerged as statistically significant independent predictors of overweight/obesity:

1. Male sex (AOR: 1.99; 95% CI: 1.12–3.63; p=0.020): Males had approximately twice the odds of being overweight/obese compared to females.
2. Screen time >4 hours/day (AOR: 3.82; 95% CI: 1.40–11.81; p=0.010): Students with high screen time had nearly four times the odds of overweight/obesity compared to those with <2 hours/day.
3. Positive family history of obesity (AOR: 3.57; 95% CI: 2.02–6.35; p<0.001): Family history was the strongest predictor, with affected students having 3.57 times higher odds of overweight/obesity.
4. Moderate physical activity (AOR: 0.45; 95% CI: 0.22–0.95; p=0.030) and high physical activity (AOR: 0.34; 95% CI: 0.16–0.73; p=0.010) were protective, with higher activity levels conferring greater protection compared to low activity.

The logistic regression model demonstrated good discriminatory ability with an AUC of 0.78 on the ROC curve. Table 13 presents the complete regression results, the Forest Plot of adjusted odds ratios is shown in Figure 14, and the ROC curve in Figure 15.

Table 13: Binary Logistic Regression Analysis — Predictors of Overweight/Obesity

Variable	Adjusted OR	95% CI	p-value
Male sex (ref: Female)	1.99	1.12–3.63	0.020*
Private school (ref: Govt)	1.65	0.94–2.92	0.080
Age 16–17 yrs (ref: 14–15)	0.64	0.35–1.15	0.140
Age 18–19 yrs (ref: 14–15)	0.11	0.02–0.34	<0.001*
Moderate PA (ref: Low)	0.45	0.22–0.95	0.030*
High PA (ref: Low)	0.34	0.16–0.73	0.010*
Screen 2–4 hrs (ref: <2)	1.90	0.79–5.35	0.180
Screen >4 hrs (ref: <2)	3.82	1.40–11.81	0.010*
Family History: Yes (ref: No)	3.57	2.02–6.35	<0.001*
SES Class II (ref: Class I)	0.90	0.49–1.62	0.720
SES Class III (ref: Class I)	0.59	0.19–1.52	0.310
SES Class IV (ref: Class I)	0.34	0.02–1.83	0.310
SES Class V (ref: Class I)	0.57	0.03–3.80	0.620

** Statistically significant (p<0.05); AOR = Adjusted Odds Ratio; CI = Confidence Interval; PA = Physical Activity; Ref = Reference category*

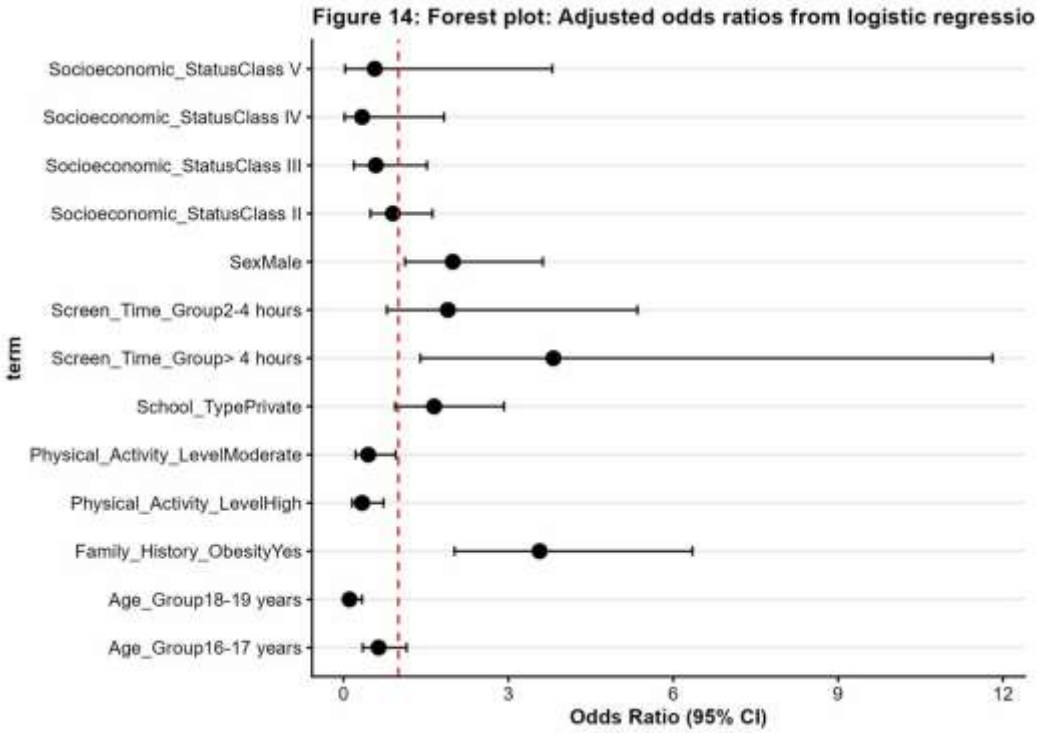


Figure 14: Forest plot displaying adjusted odds ratios from binary logistic regression analysis

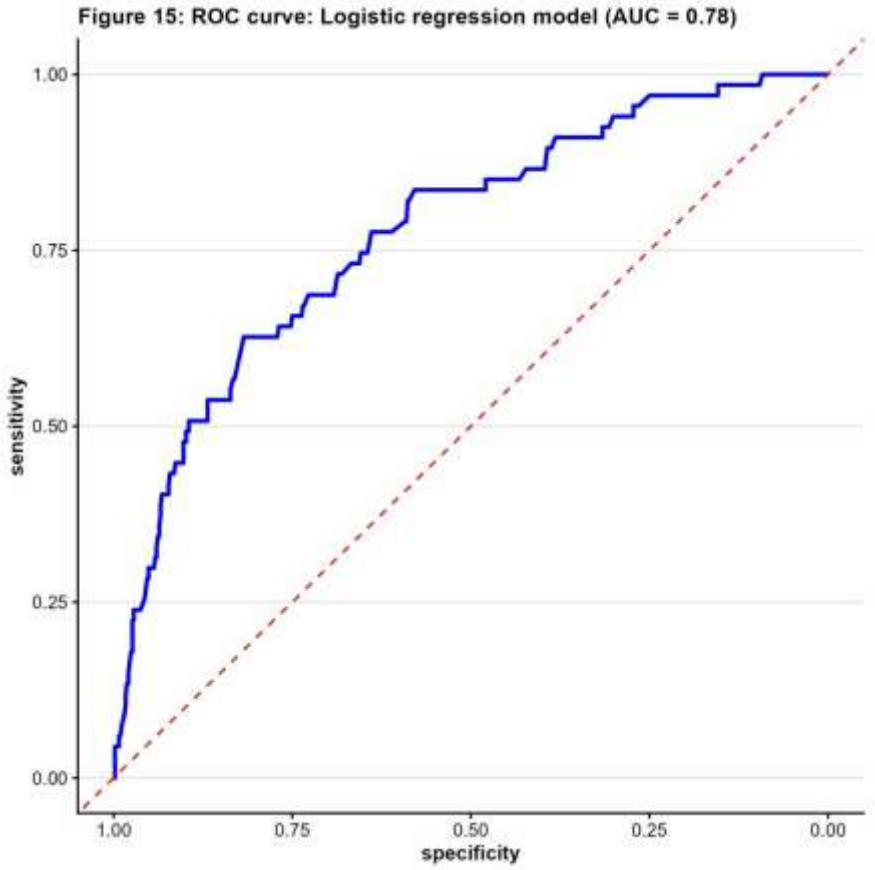


Figure 15: ROC curve of the logistic regression model (AUC = 0.78)

DISCUSSION

This cross-sectional study, involving 600 school-going adolescents aged 14–19 years from Bareilly district, Uttar Pradesh, documents a combined overweight/obesity prevalence of 11.19% — with

overweight at 8.17% and obesity at 3.00%. This represents the first comprehensive district-level prevalence estimate from Bareilly, providing critical baseline data for this rapidly urbanizing tier-2 city.

The overall prevalence observed in the present study is broadly consistent with estimates from comparable Indian settings. A meta-analysis of 21 studies spanning 186,901 Indian children by Sahoo et al. (2023) reported pooled obesity prevalence of 8.4% and overweight prevalence of 12.4%, indicating that approximately one in five Indian children were either overweight or obese.[6] The scoping review by Panda et al. (2025) encompassing 93 studies documented wide variation ranging from 1.25% to 35.8% for overweight and 0.3% to 24.6% for obesity, with higher rates consistently observed in urban areas and higher SES groups.[5] A cross-sectional study from neighboring Meerut, Uttar Pradesh by Jain et al. (2023) among 872 adolescents reported a combined overweight/obesity prevalence of 21.3%, somewhat higher than our finding, possibly reflecting Meerut's greater degree of urbanization.[7]

The significant sex-based difference in overweight/obesity prevalence — 13.98% in males versus 7.78% in females — is consistent with the broader Indian literature. Sahoo et al. (2023) reported significantly higher odds of obesity among males (OR: 1.33; 95% CI: 1.12–1.58), and our multivariable analysis confirmed this, with males having an AOR of 1.99 (95% CI: 1.12–3.63; p=0.020).[6] Gender-differentiated feeding practices with preferential provision of energy-dense foods to male children, along with social constraints limiting outdoor physical activity among girls, may contribute to these observed disparities. At the global level, the NCD Risk Factor Collaboration (2024) documented higher obesity prevalence among boys (9.3%) compared to girls (6.9%) in 2022.[1]

Private school attendance was associated with a higher overweight/obesity prevalence (14.13% vs. 8.79% in government schools), consistent with the established literature. Sahoo et al. (2023) documented nearly threefold higher odds of obesity among private school students (OR: 2.87; 95% CI: 1.94–4.25).[6] Private school attendance serves as a proxy for higher SES in India, reflecting greater access to processed foods, private transportation reducing active commuting, and enhanced availability of sedentary recreational options. However, in our multivariable analysis, school type did not reach statistical significance (AOR: 1.65; 95% CI: 0.94–2.92; p=0.08), suggesting that the school type effect may be mediated through associated lifestyle factors captured elsewhere in the model.

A higher SES gradient — with Class I (12.93%) and Class II (11.66%) showing higher prevalence than Class III (6.85%) and IV (3.57%) — aligns with the epidemiological transition in India, where economic development has enabled greater affordability of processed foods and adoption of sedentary lifestyles in higher socioeconomic groups. This contrasts with patterns seen in high-income countries, where obesity is more prevalent in lower SES groups.[25,26]

Physical activity demonstrated a strong inverse dose-response relationship with overweight/obesity: prevalence was 24.36% in the low activity group, declining to 10.38% with moderate and 8.05% with high activity. After adjustment, both moderate (AOR: 0.45; p=0.03) and high physical activity (AOR: 0.34; p=0.01) were significantly protective. These findings are congruent with global evidence. Panda et al. (2025) reported that physical inactivity was identified as a risk factor in 36.5% of included studies, with sedentary adolescents having 1.5–3 times higher odds of obesity.[5] The WHO recommends a minimum of 60 minutes of moderate-to-vigorous physical activity daily for adolescents, a target that the majority of our study population failed to meet.

Screen time showed a significant positive dose-response relationship with overweight/obesity (7.23% for <2 hrs, 10.57% for 2–4 hrs, and 15.62% for >4 hrs/day). In multivariable analysis, screen time >4 hours/day was independently associated with overweight/obesity (AOR: 3.82; 95% CI: 1.40–11.81; p=0.01). This is consistent with findings from a systematic review and dose-response meta-analysis by Haghjoo et al. (2022), which documented a 27% increase in obesity odds per additional hour of daily screen time, with a linear dose-response relationship.[37] Screen-based activities promote obesity through multiple pathways including displacement of physical activity, exposure to food advertising, mindless eating, and disruption of sleep through blue light exposure.

Family history of obesity emerged as the single strongest predictor of overweight/obesity in our study, with an AOR of 3.57 (95% CI: 2.02–6.35; p<0.001), corresponding to a prevalence of 22.41% versus 6.59% in those without family history. This powerful association reflects the combined influence of shared genetic susceptibility (estimated heritability of BMI: 40–75%) and shared family-level environmental and behavioral factors.[10] Sahoo et al. (2023) similarly documented family history as an important factor (OR: 2.46; 95% CI: 1.68–3.61).[6]

The overweight/obesity prevalence showed a declining trend with advancing age: from 13.98% in 14–15 years to 11.19% in 16–17 years and 3.49% in 18–19 years. This pattern may reflect selection bias (older students may have dropped out) or genuine lifestyle changes with increasing age, including greater engagement in physical activity among older male students. The age-specific line chart (Figure 13) revealed a bimodal pattern at individual age levels, with peaks at age 15 and 17, warranting further investigation.

Adequate sleep appeared protective against overweight/obesity, with students sleeping 8 hours showing the lowest prevalence (6.08%) compared to those sleeping 5–6 hours (13.38–15.69%). This aligns with established evidence: Miller et al. (2018) documented a 1.57-fold greater risk of obesity among adolescents with short sleep duration (<8–9 hours/night).[41] Short sleep promotes obesity through hormonal dysregulation, increasing ghrelin and reducing leptin secretion, resulting in increased appetite.

The logistic regression model achieved an AUC of 0.78, indicating good discriminatory ability. The anthropometric correlation analysis demonstrated very strong correlations between BMI and waist circumference (r=0.954) and BMI and hip circumference (r=0.921), validating BMI as an accurate measure of adiposity in this population. Screen time showed a weak but significant positive correlation with BMI (r=0.165), consistent with the modest effect size seen in screen time interventions.

Strengths and Limitations

This study has several strengths: it is the first comprehensive district-level study from Bareilly, it employed a robust two-stage cluster sampling design, included both government and private schools from urban, semi-urban, and rural areas, used standardized anthropometric measurements, and assessed a comprehensive range of determinants. However, the cross-sectional design precludes establishment of causality, and self-reported dietary and activity data may be subject to recall and social desirability biases. The study was restricted to school-going adolescents, potentially excluding those not enrolled in formal education. The generalizability to non-school settings and other districts requires caution.

CONCLUSION

This study documents a combined overweight/obesity prevalence of 11.19% among school-going adolescents in Bareilly district, Uttar Pradesh — consistent with the escalating trend in northern India and representing a significant public health concern. Male sex, positive family history of obesity, excessive screen time (>4 hours/day), and low physical activity were identified as independent predictors of overweight/obesity, while adequate physical activity was significantly protective.

These findings provide the first locally-relevant baseline data for Bareilly district, with important implications for targeted prevention. School-based multi-component interventions combining structured physical activity programs, screen time reduction initiatives, nutritional education, and family-level counseling are urgently needed. Healthcare providers should incorporate routine anthropometric screening and family history assessment in adolescent health services. Policy efforts should target the built environment to create opportunities for physical activity and restrict the availability of unhealthy food options in and around schools. The findings also highlight the need for longitudinal studies and regular surveillance mechanisms to track trends in adolescent obesity in this underserved northern Indian setting.

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