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Original Research Article

EXOGENOUS OBESITY IN CHILDREN AGED 5-12YEARS ATTENDING A TERTIARY CARE PEDIATRIC OPD: ASSESSMENT USING IAP 2015 BMI CHARTS WITH EVALUATION OF RISK FACTORS, METABOLIC COMPLICATIONS AND CORRELATION WITH WAIST CIRCUMFERENCE

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ABSTRACT

Background: Childhood obesity is escalating globally and in India, precipitating early-onset metabolic abnormalities. This study evaluated metabolic complications and risk factors in children with exogenous obesity using IAP 2015 charts. The aim is to determine risk factors and metabolic complications of paediatric obesity and correlate BMI with waist circumference (WC).

Materials and Methods: This cross-sectional analytical study enrolled 52 children (aged 5–12 years, BMI ≥95th percentile for age and sex) at a tertiary hospital from June 2024 to May 2025. Anthropometrics, lifestyle behaviours, biochemical profiles, and abdominal ultrasonography were evaluated. Data were analysed via SPSS using Pearson's correlation.

Results: The cohort comprised 53.8% boys; 42.3% were aged 8–10 years. Mean BMI was 23.5 ± 2.1kg/m² and mean WC was 75.3 ±7.2cms. Major risk factors included screen-time greater than 2 hours/day (84.6%) and family history of obesity (65.4%). Dyslipidemia (48.1%), elevated liver enzymes (25.0%), and impaired fasting glucose (11.5%) were highly prevalent. A strong positive correlation was found between BMI and WC ($r = 0.81$, $p < 0.001$). Metabolic syndrome was diagnosed in 28.8% of subjects.

Conclusion: Pediatric obesity drives early metabolic derangements and modifiable sedentary behaviors. Waist circumference strongly predicts metabolic risk and should routinely complement BMI screening.

Keywords: Childhood obesity, Body Mass Index, Waist circumference, Dyslipidemia, Metabolic syndrome.

INTRODUCTION

Childhood obesity has emerged as a major 21st-century public health challenge, with rising prevalence across developed and developing nations. The World Health Organization (WHO) recognizes obesity as a complex, multifactorial, preventable disease driven by genetic, behavioral, and environmental factors.[1] It represents excess adiposity from an imbalance between calorie intake and energy expenditure. Recently, India has witnessed an epidemiological transition, with changing diets, sedentary habits, urbanization, and socioeconomic shifts driving a pediatric obesity surge.[2,3]

The implications extend far beyond cosmetic concerns. Obese children face elevated risks for early metabolic derangements, including insulin resistance, dyslipidemia, non-alcoholic fatty liver disease, and hypertension.[4] The underlying pathophysiology involves a chronic low-grade inflammatory state marked by adipokine

dysregulation and endothelial dysfunction, creating a pro-atherogenic milieu early in life.[5] This predisposes children to long-term cardiovascular morbidity, with longitudinal data confirming that childhood obesity tracks strongly into adulthood, increasing persistent metabolic syndrome risks.[6,7]

The scale of this issue in India is underscored by regional and national data. Khadilkar et al. reported an obesity prevalence of 18.4% in boys and 12.8% in girls aged 2–17 years.[8] Similarly, Chhatwal et al. found a prevalence of 12.4% in males and 9.9% in females among school children aged 9–15 years.[9] A meta-analysis of 21 Indian studies encompassing 1,86,901 children estimated a pooled prevalence of 8.4% for obesity and 12.4% for overweight.[10] Determinants like parental obesity, maternal employment, and private schooling significantly associate with higher risk.[10]

International data corroborate this alarming trend. The Global Burden of Disease Study demonstrated that between 1980 and 2013, the worldwide prevalence of pediatric overweight and obesity rose by nearly 50%.[11] In Asia, rapid urbanization has accelerated this epidemic, with sedentary behaviors and energy-dense diets acting as primary drivers.[12] A 4-year cohort study in Hong Kong revealed that obesity persisted in 60% of children transitioning into adolescence, highlighting its chronic nature.[13]

These complications are increasingly recognized in clinical practice. Asma Deeb et al. reported that 63.9% of obese children exhibited acanthosis nigricans, while over half had dyslipidemia or elevated liver enzymes, indicating early-onset metabolic syndrome.[14] Similarly, Elham Al Amiri et al. documented that 5.4% of obese children had prediabetes and nearly 1% had overt type 2 diabetes.[15] Waist circumference, an index of central adiposity, correlates strongly with insulin resistance and cardiometabolic risk, serving as a critical screening parameter alongside BMI.[16]

Consequently, early pediatric screening is vital to mitigate long-term sequelae. The Indian Academy of Pediatrics (IAP) 2015 charts offer ethnicity-specific reference parameters for Indian children aged 5–18 years.[17] However, regional data regarding exogenous obesity and its metabolic risks remain scarce in Eastern India. This study, therefore, aims to evaluate metabolic complications among obese children aged 5–12 years attending a tertiary outpatient department, and analyze correlations between BMI, waist circumference, and familial risk factors to guide early lifestyle and therapeutic interventions.

MATERIALS AND METHODS

Study Design: The present study was a cross-sectional analytical observational study conducted to identify exogenous obesity among children aged 5 to 12 years attending the pediatric outpatient department (OPD) and to evaluate its associated metabolic complications and risk factors. The study design was selected as it allowed correlation of obesity indices with biochemical and familial parameters without any intervention.

Study Setting: The study was carried out in the Department of Paediatrics, Silchar Medical College and Hospital (SMCH), a tertiary care teaching institution catering to a mixed urban and semi-urban population. The pediatric OPD of SMCH receives an average of 150–200 patients daily, providing a diverse representation of children from various socioeconomic backgrounds. The hospital is equipped with advanced diagnostic laboratories and imaging facilities, ensuring reliable biochemical and anthropometric evaluations. All investigations including anthropometry, blood sampling, and ultrasonography were performed within the hospital premises.

Study Duration: The study was conducted over a 12-month period, from June 2024 to May 2025, allowing adequate time for recruitment, screening, data collection, and laboratory analyses. This duration ensured representation across all seasons to minimize any seasonal variation in weight, diet, or physical activity among children.

Participants: Children presenting to the pediatric outpatient department who met the inclusion criteria and had written parental informed consent (along with child assent where applicable) were enrolled.

Inclusion Criteria

- Age 5–12 years.
- Obese by IAP 2015 growth charts (BMI ≥95th percentile for age and sex).
- Exogenous obesity without syndromic or underlying pathological causes.

Exclusion Criteria

- Chronic systemic, metabolic, or endocrine disorders (e.g., hypothyroidism, Cushing's syndrome, renal failure).
- Concomitant use of long-term corticosteroids, anticonvulsants, or medications altering growth and metabolism.

Study Sampling: A consecutive sampling technique was adopted. All children aged 5–12 years attending the pediatric OPD during the study period were screened sequentially. Those who met the inclusion criteria were enrolled. This non-probability sampling method ensured feasibility and reduced selection bias, as all eligible participants presenting during the defined period were considered.

Study Sample Size: Based on previous regional data from Assam reporting a childhood obesity prevalence of 2.8%, the sample size was calculated using the formula: $n=4pq/d^2$,

where $p = 0.028$, $q = (1-p)$, and $d = 0.05$ (5% absolute precision).

The calculated sample size was approximately 44. Employing a consecutive sampling technique, all eligible individuals who met the inclusion criteria during study period were included in the study. Due to the fixed one year recruitment window, the final sample size yielded 52 participants.

Study Groups: In this cross-sectional analytical study, participants were categorized using the IAP 2015 growth charts, with obesity defined as BMI ≥95th percentile for age and sex. Rather than utilizing a separate, concurrent control group, clinical and metabolic deviations were evaluated by comparing cohort data against standard reference laboratory intervals and normative age-and-sex-specific BMI percentiles.

Study Parameters

The study evaluated the following parameters:

Anthropometric Parameters:

- Height (cm) measured using a stadiometer.
- Weight (kg) measured using a calibrated digital weighing scale.
- Body Mass Index (BMI) calculated as weight (kg)/height² (m^2).
- Waist circumference (cm) measured midway between the lowest rib and iliac crest using a non-stretchable tape.

Biochemical Parameters:

- Fasting Blood Sugar (FBS) and Post-Prandial Blood Sugar (PPBS).
- Lipid Profile: Total cholesterol, triglycerides, HDL, LDL, and VLDL.
- Liver Function Tests (LFT): AST, ALT, and alkaline phosphatase.
- Thyroid Function: Thyroid Stimulating Hormone (TSH).

Radiological Parameter:

- Ultrasound abdomen for assessment of fatty liver.

Risk Factor Assessment:

- Dietary pattern (frequency of junk food and sugary beverages).
- Physical activity and screen time.
- Sleep duration.
- Family history of obesity, diabetes, or hypertension.

Study Procedure: Children attending the outpatient department were screened using IAP 2015 BMI charts. Eligible participants underwent detailed clinical and anthropometric evaluations, including waist circumference measurements for central adiposity. Following an 8–10 hour overnight fast, venous blood samples were collected under aseptic precautions. Fasting glucose, lipid profiles, liver function tests, and TSH levels were processed using an automated analyzer (VITROS 5600 Integrated System). Abdominal ultrasonography was performed to evaluate hepatic steatosis. Familial, dietary, and physical activity risk factors were gathered via a structured caregiver questionnaire. All data were documented in a standardized proforma.

Study Data Collection: Data collection was performed prospectively during OPD visits. Anthropometric and biochemical data were entered immediately into a Microsoft Excel master sheet by the investigator. The same observer carried out all measurements to minimize inter-observer variation. Laboratory investigations were recorded from hospital reports, and imaging findings were verified by a consultant radiologist. The questionnaire data were coded for statistical entry.

Data Analysis: Data were analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY). Continuous variables (anthropometric and biochemical parameters) were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Pearson's correlation coefficient (r) was utilized to evaluate linear relationships between BMI and parameters including waist circumference and biochemical markers. Statistical significance was defined as $p < 0.05$.

Ethical Considerations: The study was approved by the Institutional Ethics Committee of Silchar Medical College and Hospital, Silchar (Approval No: SMC/ETHICS/M1/2024/33) and adhered to the Declaration of Helsinki. Written parental informed consent and child assent (wherever necessary) were obtained prior to enrollment. Participation was voluntary, data confidentiality was maintained, and participants with metabolic abnormalities were referred for appropriate clinical management.

RESULTS

A total of 52 obese children aged 5–12 years were enrolled. The majority of the participants belonged to the middle childhood age group of 8 to 10 years (42.3%), a trend that remained consistent when stratified across both genders. Conversely, the youngest age group (5 to 7 years) comprised the smallest proportion of the cohort (25%). The detailed baseline age and gender distribution are summarized in [Table 1].

Table 1: Baseline Demographics of the Study Cohort (n = 52)

Age Group (years)	Boys (n = 28)	Girls (n = 24)	Total n (%)
5 – 7	7 (25.0%)	6 (25.0%)	13 (25.0%)
8 – 10	12 (42.9%)	10 (41.7%)	22 (42.3%)
11 – 12	9 (32.1%)	8 (33.3%)	17 (32.7%)
Total	28 (53.8%)	24 (46.2%)	52 (100%)

The mean anthropometric measurements of the cohort reflected elevated metabolic risk profiles [Table 2]. Notably, the mean body mass index (BMI) was 23.5±2.1 kg/m^2, placing the study population at or above the 95th percentile according to the IAP 2015 standards. Furthermore, the mean waist-to-height ratio was 0.58±0.05, exceeding the established cardiovascular risk threshold of 0.5.

Table 2: Baseline Anthropometric Characteristics of the Study Population

Parameter	Mean ± SD	Range	Reference (Standard)
Height (cm)	130.4 ± 8.7	116 – 148	—
Weight (kg)	40.2 ± 6.8	30 – 56	—
BMI (kg/m²)	23.5 ± 2.1	20.1 – 28.2	≥95th percentile (IAP 2015)
Waist Circumference (cm)	75.3 ± 7.2	63 – 88	—
Waist-to-Height Ratio	0.58 ± 0.05	0.50 – 0.69	Risk if > 0.5

Sedentary lifestyles and dietary habits were highly prevalent across the cohort. The most pervasive risk factors identified were excessive screen time greater than 2 hours per day (84.6%), insufficient physical activity less than 1 hour per day (80.8%), and frequent junk food consumption (75.0%). Additionally, a family history of obesity was present in the majority of the participants (65.4%). These behavioral and familial risk factors are detailed in [Table 3] and illustrated in [Figure 1].

Table 3: Prevalence of Behavioral and Familial Risk Factors in the Study Population

Risk Factor	Present n (%)	Absent n (%)
Family history of obesity	34 (65.4%)	18 (34.6%)
Family history of T2DM or HTN	28 (53.8%)	24 (46.2%)
Junk-food consumption > 3×/week	39 (75.0%)	13 (25.0%)
Physical activity < 1 h/day	42 (80.8%)	10 (19.2%)
Screen time > 2 h/day	44 (84.6%)	8 (15.4%)
Sleep < 8 h/night	31 (59.6%)	21 (40.4%)
Maternal Employment	24 (46%)	28 (54%)

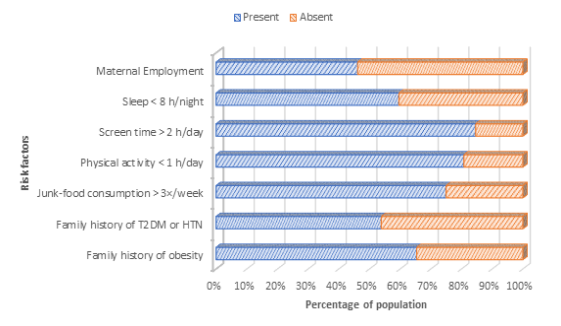

Figure 1: Bar diagram showing Distribution of key behavioral and familial risk factors among the study participants.

Socioeconomic evaluation revealed that more than half of the study participants belonged to the middle class (53.8%) according to the Modified Kuppuswamy scale. Additionally, a clear majority of the children were enrolled in private educational institutions (69.2%), as detailed in [Table 4].

Clinical assessment revealed a high prevalence of metabolic and physical markers of obesity within the cohort. Acanthosis nigricans was the most frequent clinical sign, present in over half of the participants (57.7%). Additionally, ultrasonographic hepatomegaly (23.1%) and hypertension (17.3%) were the leading systemic complications identified. These clinical comorbidities are detailed in [Table 5] and illustrated in [Figure 2].

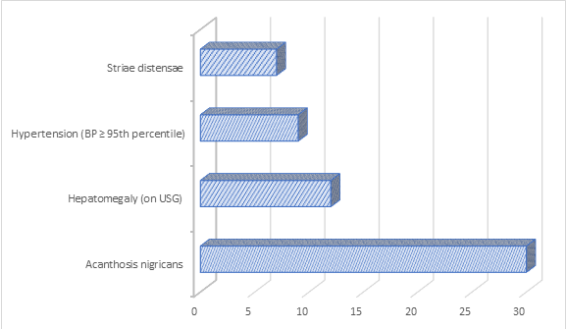

Figure 2: Bar diagram showing Prevalence of clinical signs and systemic comorbidities among the study participants.

Table 4: Socioeconomic Status and Educational Profile of the Study Cohort

Variable	Category	n (%)
Socio-economic class (Modified Kuppuswamy)	Upper	14 (26.9%)
	Middle	28 (53.8%)
	Lower	10 (19.3%)
Type of school	Private	36 (69.2%)
	Government	16 (30.8%)

Table 5: Clinical Manifestations and Comorbidities among the Study Participants

Parameter	n (%) Positive
Acanthosis nigricans	30 (57.7%)
Hepatomegaly (on USG)	12 (23.1%)
Hypertension (BP ≥ 95th percentile)	9 (17.3%)
Striae distensae	7 (13.5%)

Biochemical analysis revealed significant dyslipidemia and subclinical metabolic derangements across the cohort [Table 6]. The most prominent metabolic abnormality was low high-

density lipoprotein (HDL) cholesterol, affecting nearly half of the participants (48.1%). Elevated total cholesterol (38.5%), triglycerides (34.6%), and low-density lipoprotein (LDL) cholesterol (36.5%) were also highly prevalent. Liver enzymes were mildly elevated in ≈ 25%, consistent with early non-alcoholic fatty liver disease (NAFLD).

Table 6: Biochemical and Metabolic Profiles of the Study Cohort

Parameter	Mean ± SD	Abnormal n (%)	Reference Range
FBS (mg/dL)	92.6 ± 9.8	6 (11.5%) > 110	70 – 110
PPBS (mg/dL)	122.3 ± 17.5	8 (15.4%) > 140	< 140
Total Cholesterol (mg/dL)	184.2 ± 33.1	20 (38.5%) > 170	< 170
Triglycerides (mg/dL)	143.7 ± 35.6	18 (34.6%) > 130	< 130
HDL (mg/dL)	38.6 ± 6.2	25 (48.1%) < 40	> 40
LDL (mg/dL)	116.4 ± 25.9	19 (36.5%) > 110	< 110
AST (U/L)	41.3 ± 8.9	11 (21.2%) > 40	10 – 40
ALT (U/L)	44.6 ± 10.2	13 (25.0%) > 45	10 – 45
TSH (µIU/mL)	3.14 ± 1.22	4 (7.7%) > 4.5	0.4 – 4.5

Correlation analysis demonstrated significant associations between body mass index (BMI) and key metabolic parameters. A very strong, positive correlation was observed between BMI and waist circumference ($r = 0.81$, $p < 0.001$). Furthermore, BMI showed moderate, statistically significant positive correlations with triglycerides ($r = 0.49$) and ALT levels ($r = 0.42$), alongside a significant inverse correlation with HDL cholesterol ($r = -0.45$). The correlation with fasting blood sugar (FBS) was weak though statistically significant ($r = 0.33$, $p = 0.015$). These correlation parameters are detailed in [Table 7], and the linear relationship between BMI and central adiposity is illustrated in [Figure 3].

Table 7: Pearson Correlation Matrix of BMI with Anthropometric and Biochemical Parameters

Parameter	Pearson r	p-value
BMI vs Waist Circumference	0.81	< 0.001
BMI vs Triglycerides	0.49	0.001
BMI vs HDL	–0.45	0.002
BMI vs ALT	0.42	0.004
BMI vs FBS	0.33	0.015

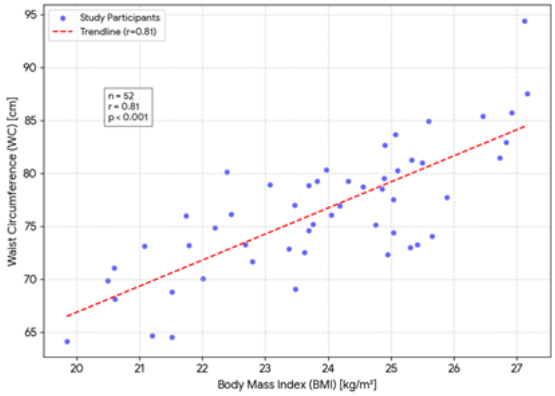

Figure 3: Scatter plot illustrating the correlation between Body Mass Index (BMI) and Waist Circumference in obese children (n=52). The Pearson correlation coefficient (r=0.81, p<0.001) indicates a strong positive relationship.

The overall prevalence of metabolic syndrome and its individual component criteria was evaluated across the study population. Central obesity was the most common component, identified in over three-quarters of the cohort (78.8%), followed by low HDL cholesterol (48.1%). Ultimately, more than a quarter of the children (28.8%) met the clinical threshold for metabolic syndrome by exhibiting three or more concurrent criteria. These diagnostic components are detailed in Table 8 and visually summarized in [Figure 4].

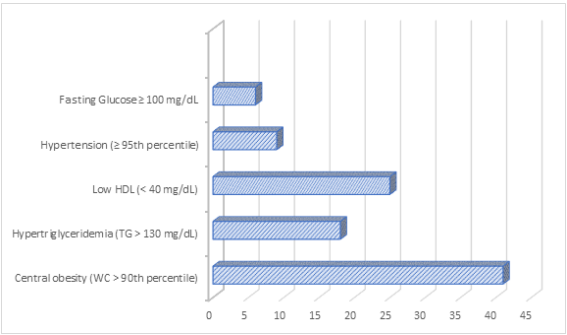

Figure 4: Bar diagram showing Prevalence of individual clinical components of metabolic syndrome within the cohort.

Table 8: Prevalence of Metabolic Syndrome Components and Overall Diagnosis in the Study Population

Component	Criterion Applied
Central obesity (WC > 90th percentile)	41 (78.8%)
Hypertriglyceridemia (TG > 130 mg/dL)	18 (34.6%)
Low HDL (< 40 mg/dL)	25 (48.1%)
Hypertension (≥ 95th percentile)	9 (17.3%)
Fasting Glucose ≥ 100 mg/dL	6 (11.5%)
≥ 3 components present → Metabolic Syndrome	15 (28.8%)

DISCUSSION

The present study assessed the risk factors, and metabolic complications of exogenous obesity in children aged 5–12 years attending a tertiary-care pediatric OPD. Using IAP 2015 BMI charts, 52 children were identified as obese and evaluated for anthropometric, biochemical, and familial correlations. The findings highlight the emerging burden of lifestyle-related obesity and early metabolic derangements in school-age Indian children.

Childhood obesity is now recognized as a major non-communicable disease of the 21st century. The World Health Organization has reported a steady global rise in pediatric obesity due to nutritional transition and declining physical activity.[1] The mean BMI of 23.5 kg/m² observed in this cohort was well above the 95th percentile of the IAP 2015 growth charts,[17] confirming the reliability of these ethnic-specific standards. The male preponderance and peak occurrence in the 8–10 year group parallel earlier Indian findings by Khadilkar et al. (2011) and Chhatwal et al. (2004), who reported higher rates among boys and pre-adolescents.[8,9]

Socioeconomic factors played a decisive role. More than two-thirds of the children were from middle- or upper-class families and attended private schools. Similar trends were demonstrated in the recent meta-analysis by Singh et al. (2023), which estimated an 8.4 % pooled obesity prevalence among Indian children, with significantly higher risk in urban and private-school settings.[10] Rapid urbanization, improved purchasing power, and screen-based leisure activities have all contributed to this pattern.[2,12] In the present study, 84 % had screen time exceeding two hours daily and 80 % engaged in less than one hour of physical activity, reinforcing the behavioral basis of the epidemic.

Family history of obesity or cardiometabolic disease was present in nearly two-thirds of participants, consistent with earlier observations that parental obesity and shared household habits are strong predictors of childhood obesity.[8,2] Prentice (2006) emphasized that gene–environment interaction in transitional economies amplifies the obesity risk.[2] Thus, family-centered preventive counselling is essential.

Anthropometric analysis showed strong correlation between BMI and waist circumference ($r = 0.81$, $p < 0.001$), confirming that central adiposity accompanies generalized obesity. Waist-to-height ratio > 0.5 in 77 % of participants indicates significant visceral fat accumulation. Tung et al. (2021) similarly reported that central obesity persisted in 60 % of Chinese students through adolescence, predicting future metabolic disease.[13]

Clinical evaluation revealed acanthosis nigricans in 58 % and fatty-liver changes in 23 %, both markers of insulin resistance. Comparable frequencies were reported by Deeb et al. (2020), who found acanthosis in 63.9 % and dyslipidemia in 55.3 % of obese children, and by Al Amiri et al. (2019), who noted prediabetes in 5.4 % and diabetes in 0.87 %.[14,15] In our study, biochemical testing showed low HDL in 48 %, hypertriglyceridemia in 35 %, and elevated liver enzymes in 25 %. These results mirror the global pattern of early-onset dyslipidemia and non-alcoholic fatty-liver disease among obese youth.[4,5]

The clustering of metabolic abnormalities was notable, with 29 % meeting ≥ 3 criteria for metabolic syndrome. This prevalence corresponds with worldwide estimates of 20–30 % in obese pediatric populations.[5,11] Styne et al. (2017) in the Endocrine Society guideline emphasized early screening for dyslipidemia and hepatic steatosis in all obese children.[5] The observed positive correlation of BMI with triglycerides and ALT, and negative correlation with HDL, underscores the metabolic vulnerability of Indian children even before adolescence.

When compared with national data, the metabolic abnormalities in this cohort were somewhat higher, possibly due to rapid lifestyle changes post-pandemic and urban dietary exposure. Yet, the mean biochemical values remained lower than those reported in Western populations, suggesting potential ethnic or dietary protective influences. Nevertheless, as Simmonds et al. (2016) demonstrated, obese children are about five times more likely to remain obese into adulthood and develop chronic metabolic disease.[6] Early detection and intervention thus remain paramount.

Overall, the findings reaffirm that childhood obesity in India is driven primarily by modifiable behaviors—high caloric intake, sedentary lifestyle, and insufficient sleep—within a permissive family and urban environment. The IAP 2015 BMI charts,[17] together with waist-circumference assessment proved effective for identifying children at risk of metabolic complications. Preventive programs should focus on school-based health education, reduction of screen exposure, and promotion of daily physical activity.

Limitations: Our study has certain limitations that warrant consideration. First, the cross-sectional design prevents the establishment of a direct causal relationship between the identified lifestyle risk factors and metabolic outcomes. Second, the study was conducted at a single tertiary care center with a relatively small sample size (n = 52), which may limit the generalizability of our findings to the broader Indian pediatric population. Additionally, advanced biomarkers of metabolic syndrome, such as fasting insulin levels, homeostatic model assessment of insulin resistance (HOMA-IR), or gold-standard imaging for hepatic steatosis, were not assessed due to resource and financial constraints. Future large-scale, multicenter longitudinal studies are required to validate these findings across diverse socio-economic strata.

CONCLUSION

In conclusion, the present study reaffirms that childhood obesity among Indian children aged 5–12 years is accompanied by significant metabolic complications and is driven largely by modifiable lifestyle factors. Integration of IAP BMI charts with waist-circumference assessment and family-based behavioral interventions is essential for effective screening and prevention. The findings correspond closely with international evidence, reinforcing the universal nature of the pediatric obesity epidemic and the urgent need for early, multidimensional public-health action.

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