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Assessment of the Prevalence of Childhood Obesity, Associated Lifestyle Factors, Metabolic Risk Factors, and Early Cardiovascular Risk Among School-Going Children

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ABSTRACT

Background: Childhood obesity has become a major public health concern due to its increasing prevalence and association with adverse metabolic and cardiovascular outcomes. Early identification of obesity and its related risk factors is essential for preventing long-term health complications.
Aim: To assess the prevalence of childhood obesity, associated lifestyle factors, metabolic risk factors, and early cardiovascular risk among school-going children.
Materials and Methods: This observational cross-sectional study was conducted in the Department of Pediatrics, ESIC Medical College and Hospital, Kalaburagi, Karnataka, from January 2025 to December 2026. A total of 58 school-going children aged 6–16 years were included using consecutive sampling. Data regarding demographic characteristics, anthropometric measurements, dietary habits, physical activity, screen time, and sleep patterns were collected using a structured questionnaire. Laboratory investigations included fasting blood glucose, HbA1c, serum insulin, lipid profile, liver and renal function tests, serum uric acid, and high-sensitivity C-reactive protein (hs-CRP). Insulin resistance was assessed using the Homeostatic Model Assessment of Insulin Resistance (HOMA-IR). Statistical analysis was performed using SPSS version 26.0, with a p-value <0.05 considered statistically significant.
Results: Among the 58 participants, 20.7% were obese and 19.0% were overweight, resulting in an overall prevalence of overweight/obesity of 39.7%. High screen time (63.8%), inadequate physical activity (58.6%), frequent sugary drink consumption (51.7%), and daily junk food intake (43.1%) were common lifestyle risk factors. Low HDL cholesterol (31.0%), hypertriglyceridemia (27.6%), elevated LDL cholesterol (24.1%), and insulin resistance (19.0%) were the most frequent metabolic abnormalities. Central obesity was observed in 34.5% of children, while 27.6% were categorized as having increased early cardiovascular risk. Junk food intake, prolonged screen time, physical inactivity, and shorter sleep duration were significantly associated with overweight and obesity ($p<0.05$). Obesity, elevated triglycerides, insulin resistance, prolonged screen time, and physical inactivity were identified as independent predictors of early cardiovascular risk.
Conclusion: Childhood overweight and obesity were common among school-going children and were significantly associated with unhealthy lifestyle behaviors, metabolic abnormalities, and early cardiovascular risk. Early screening and comprehensive lifestyle interventions are essential to reduce future cardiometabolic complications.

Keywords: *Childhood obesity, Overweight, Lifestyle factors, Metabolic risk factors, Insulin resistance, Dyslipidemia, Cardiovascular risk, School-going children.*

INTRODUCTION

Childhood obesity has emerged as one of the most significant public health challenges of the 21st century, with its prevalence increasing rapidly in both developed and developing countries. The World Health Organization (WHO) defines overweight and obesity as abnormal or excessive fat accumulation that presents a risk to health. In children, obesity is generally assessed using body mass index (BMI)-for-age percentiles based on standardized growth charts, taking into account age- and sex-specific variations. The increasing prevalence of childhood obesity has become a major concern because obesity established during childhood often persists into adolescence and adulthood, predisposing individuals to lifelong metabolic and cardiovascular complications.[1]

Globally, the prevalence of childhood overweight and obesity has increased dramatically over the past four decades. According to the WHO, more than 390 million children and adolescents aged 5–19 years were overweight in 2022, including over 160 million who were living with obesity. The burden is particularly rising in low- and middle-income countries due to rapid urbanization, nutritional transition, sedentary lifestyles, and increased consumption of calorie-dense processed foods.[1] India, once predominantly affected by childhood undernutrition, is now experiencing a dual burden of malnutrition, with childhood obesity becoming increasingly common in urban as well as semi-urban populations.[2]

Childhood obesity results from a complex interaction between genetic susceptibility, environmental influences, behavioral factors, and socioeconomic determinants. Excessive intake of energy-dense foods, increased consumption of sugar-sweetened beverages, inadequate physical activity, prolonged screen time, reduced outdoor play, and poor sleep patterns have all been recognized as important contributors to excessive weight gain among children.[3,4] Family history of obesity, parental diabetes, and unhealthy household dietary practices further increase the risk of obesity by influencing both genetic predisposition and shared lifestyle behaviors.[5]

Obesity in children is associated with numerous metabolic abnormalities that collectively increase future cardiovascular risk. These include insulin resistance, impaired fasting glucose, dyslipidemia, hypertension, central obesity, hyperuricemia, and chronic low-grade inflammation. Insulin resistance is considered the central pathophysiological mechanism linking obesity with type 2 diabetes mellitus and metabolic syndrome. The Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) has become a widely accepted method for estimating insulin resistance in pediatric populations.[6]

Adipose tissue is now recognized as an active endocrine organ that secretes adipokines and inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α), interleukin-6 (IL-6), and leptin, which contribute to chronic systemic inflammation. Elevated high-sensitivity C-reactive protein (hs-CRP), an inflammatory biomarker, has been consistently associated with obesity and early endothelial dysfunction in children. These inflammatory changes contribute to vascular injury even before clinical cardiovascular disease becomes apparent.[7]

Several studies have demonstrated that obese children exhibit unfavorable lipid profiles characterized by elevated triglycerides, increased low-density lipoprotein (LDL) cholesterol, reduced high-density lipoprotein (HDL) cholesterol, and elevated total cholesterol levels. These abnormalities significantly increase the risk of premature atherosclerosis and cardiovascular disease later in life. Waist circumference and waist-to-height ratio have also emerged as reliable indicators of central adiposity and cardiometabolic risk, often outperforming BMI in predicting metabolic complications.[8]

Hypertension is another important consequence of childhood obesity. Increased adiposity contributes to activation of the sympathetic nervous system, renin–angiotensin–aldosterone system, and endothelial dysfunction, resulting in elevated blood pressure. Multiple studies have reported a strong correlation between obesity and childhood hypertension, which significantly increases the future risk of ischemic heart disease and stroke.[9]

Lifestyle modifications remain the cornerstone for prevention and management of childhood obesity. Regular physical activity, reduced sedentary behavior, healthy dietary practices, adequate sleep, and family-based interventions have demonstrated significant benefits in improving anthropometric parameters and metabolic health among children. Early identification of high-risk children through school-based screening programs can facilitate timely intervention and reduce long-term disease burden.[10]

Despite increasing awareness, limited data are available regarding the prevalence of childhood obesity and its associated metabolic and cardiovascular risk factors among school-going children in North Karnataka. Regional variations in dietary habits, physical activity, socioeconomic status, and urbanization necessitate local epidemiological data to formulate effective preventive strategies. Therefore, the present study was undertaken to assess the prevalence of

childhood obesity, associated lifestyle factors, metabolic risk factors, and early cardiovascular risk among school-going children attending schools in Kalaburagi, Karnataka.

MATERIALS AND METHODS

Study Design and Setting

This hospital- and school-based, observational cross-sectional study was conducted in the Department of Pediatrics, ESIC Medical College and Hospital, Kalaburagi, Karnataka, India, over a period of one year from **January 2025 to December 2026**. The study was designed to assess the prevalence of childhood obesity, associated lifestyle factors, metabolic risk factors, and early cardiovascular risk among school-going children. The methodology was developed in accordance with standard epidemiological approaches used in childhood obesity research.

Study Population

The study included **58 school-going children** aged **6–16 years** who were enrolled from selected government and private schools in Kalaburagi district. Children were screened through school health visits, and eligible participants were recruited after obtaining permission from school authorities.

Sample Size

A total of **58 children** fulfilling the eligibility criteria were included during the study period using consecutive sampling.

Inclusion Criteria

Children fulfilling all of the following criteria were included:

- Age between 6 and 16 years.
- Enrolled in government or private schools.
- Parents/guardians willing to provide written informed consent.
- Children providing assent wherever appropriate.
- Availability for anthropometric examination and laboratory investigations.

Exclusion Criteria

Children with any of the following were excluded:

- Known endocrine disorders causing obesity (hypothyroidism, Cushing syndrome).
- Genetic syndromes associated with obesity.
- Chronic renal, hepatic, cardiac, or neurological disorders.
- Long-term corticosteroid therapy or medications affecting body weight.
- Acute illness at the time of examination.
- Refusal of consent.

Data Collection

A pre-designed, pretested structured case record form was used for data collection.

Demographic Characteristics

The following information was recorded:

- Age
- Gender
- School type (Government/Private)
- Socioeconomic status (Modified Kuppuswamy Scale)
- Residential area (Urban/Rural)
- Family history of obesity
- Family history of diabetes mellitus
- Family history of hypertension
- Family history of cardiovascular disease

Clinical Evaluation

Detailed clinical examination included:

- Height (cm)
- Weight (kg)
- Body Mass Index (BMI)
- BMI-for-age percentile (WHO Growth Charts)
- Waist circumference
- Hip circumference

- Waist-Hip Ratio
- Waist-to-Height Ratio
- Mid Upper Arm Circumference (MUAC)
- Blood pressure
- Pulse rate

Children were classified as:
- Underweight
- Normal weight
- Overweight
- Obese

according to **WHO BMI-for-age percentile criteria**.

Lifestyle Assessment
Lifestyle-related information was obtained using a structured questionnaire administered to both children and parents.

Dietary Habits
The following variables were recorded:
- Number of meals/day
- Breakfast consumption
- Junk food intake
- Fast food consumption/week
- Sugary beverage intake
- Fruit consumption
- Vegetable intake
- Milk consumption
- Daily calorie pattern
- Eating outside home
- Snacking frequency

Physical Activity
Information included:
- Outdoor play duration/day
- Sports participation
- Walking or cycling to school
- Sedentary time
- Television viewing hours
- Mobile phone usage
- Computer/laptop usage
- Total screen time/day

Sleep Pattern
- Sleep duration/night
- Sleep quality
- Bedtime
- Wake-up time

Laboratory Investigations
After overnight fasting (8–10 hours), venous blood samples were collected for:
- Fasting Blood Sugar (FBS)
- HbA1c
- Serum Insulin
- Lipid Profile
    - Total Cholesterol
    - Triglycerides
    - HDL Cholesterol
    - LDL Cholesterol
    - VLDL

- Liver Function Tests
- Renal Function Tests
- Serum Uric Acid
- High-Sensitivity C-Reactive Protein (hs-CRP)

Insulin resistance was assessed using the **Homeostatic Model Assessment of Insulin Resistance (HOMA-IR)**:
HOMA-IR = [Fasting Insulin (µU/mL) × Fasting Glucose (mg/dL)] / 405
Children with elevated HOMA-IR values were considered to have insulin resistance.

Assessment of Metabolic Risk Factors
Metabolic abnormalities evaluated included:

- Obesity
- Central obesity
- Elevated fasting glucose
- Prediabetes
- Dyslipidemia
- Hypertriglyceridemia
- Low HDL cholesterol
- Elevated LDL cholesterol
- Elevated blood pressure
- Insulin resistance
- Hyperuricemia
- Elevated hs-CRP

Assessment of Early Cardiovascular Risk
Early cardiovascular risk was evaluated using:

- Waist circumference
- Waist-to-height ratio
- Blood pressure
- Lipid abnormalities
- Insulin resistance
- Family history of premature cardiovascular disease
- hs-CRP level

Children with multiple cardiometabolic abnormalities were categorized as having increased early cardiovascular risk.

Outcome Measures
Primary Outcome

- Prevalence of childhood overweight and obesity among school-going children.

Secondary Outcomes

- Association between obesity and dietary habits.
- Association between obesity and physical activity.
- Association between obesity and screen time.
- Association between obesity and sleep duration.
- Prevalence of metabolic abnormalities.
- Association between obesity and insulin resistance.
- Association between obesity and dyslipidemia.
- Assessment of early cardiovascular risk factors.

Statistical Analysis
Data were entered into Microsoft Excel and analyzed using **Statistical Package for Social Sciences (SPSS) version 26.0** (IBM Corp., Armonk, NY, USA).

- Continuous variables were expressed as **mean ± standard deviation (SD)**.
- Categorical variables were expressed as **frequency and percentage**.
- Student's independent *t*-test or Mann–Whitney U test was used for comparison of continuous variables.
- Chi-square test or Fisher's exact test was used for categorical variables.
- Pearson or Spearman correlation analysis was performed to determine associations between anthropometric measurements and metabolic parameters.

- Multivariate logistic regression analysis was performed to identify independent predictors of childhood obesity and cardiometabolic risk.
- A **p-value <0.05** was considered statistically significant.

Ethical Considerations

The study protocol was approved by the **Institutional Ethics Committee (IEC), ESIC Medical College and Hospital, Kalaburagi** before commencement of the study. Written informed consent was obtained from parents or legal guardians, and assent was obtained from children whenever applicable. Confidentiality of participants was maintained throughout the study in accordance with the Declaration of Helsinki and institutional ethical guidelines.

RESULTS AND OBSERVATIONS

Table 1. Demographic Characteristics of Study Participants (n=58)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
6–8	12	20.7
9–11	18	31.0
12–14	17	29.3
15–16	11	19.0
Gender		
Male	31	53.4
Female	27	46.6
Residence		
Urban	36	62.1
Rural	22	37.9
School Type		
Government	26	44.8
Private	32	55.2

Observation: The majority of participants belonged to the 9–11-year age group (31.0%). Males constituted 53.4% of the study population. Most children were from urban areas (62.1%) and attended private schools (55.2%).

Table 2. Nutritional Status According to BMI-for-Age

BMI Category	Frequency	Percentage (%)
Underweight	5	8.6
Normal weight	30	51.7
Overweight	11	19.0
Obese	12	20.7

Observation: More than one-third (39.7%) of the children were either overweight or obese, while 51.7% had normal BMI.

Table 3. Anthropometric Measurements

Parameter	Mean ± SD
Age (years)	11.2 ± 2.8
Height (cm)	143.8 ± 14.7
Weight (kg)	45.7 ± 13.6
BMI (kg/m²)	22.3 ± 4.5
Waist Circumference (cm)	75.4 ± 11.3
Hip Circumference (cm)	86.8 ± 12.2
Waist-Height Ratio	0.53 ± 0.07
Systolic BP (mmHg)	111.8 ± 11.5
Diastolic BP (mmHg)	71.6 ± 8.2

Observation: Obese children demonstrated higher BMI, waist circumference, waist-height ratio, and blood pressure compared to children with normal BMI.

Table 4. Lifestyle Factors

Variable	Frequency	Percentage (%)
Daily Junk Food Intake	25	43.1
Sugary Drinks ≥3/week	30	51.7
Breakfast Skipping	18	31.0
Physical Activity <60 min/day	34	58.6

Screen Time >2 hours/day	37	63.8
Sleep <8 hours/day	20	34.5

Observation: High screen time (63.8%), inadequate physical activity (58.6%), and frequent sugary drink consumption (51.7%) were common among study participants.

Table 5. Family History of Metabolic Diseases

Variable	Frequency	Percentage (%)
Obesity	21	36.2
Diabetes Mellitus	24	41.4
Hypertension	20	34.5
Cardiovascular Disease	13	22.4

Observation: Diabetes mellitus (41.4%) was the most common positive family history followed by obesity (36.2%).

Table 6. Metabolic Risk Factors

Parameter	Frequency	Percentage (%)
Elevated Fasting Blood Sugar	7	12.1
Elevated HbA1c	8	13.8
Elevated Total Cholesterol	13	22.4
High Triglycerides	16	27.6
Low HDL	18	31.0
High LDL	14	24.1
Insulin Resistance (High HOMA-IR)	11	19.0

Observation: Low HDL cholesterol (31.0%) and hypertriglyceridemia (27.6%) were the most frequent metabolic abnormalities.

Table 7. Early Cardiovascular Risk Factors

Variable	Frequency	Percentage (%)
Central Obesity	20	34.5
Elevated Blood Pressure	10	17.2
Waist-Height Ratio >0.5	22	37.9
Elevated hs-CRP	9	15.5
High Cardiovascular Risk	16	27.6

Observation: Approximately one-third of children had central obesity, while 27.6% were categorized as having increased early cardiovascular risk.

Table 8. Association Between BMI Category and Lifestyle Factors

Variable	Normal BMI (n=30)	Overweight/Obese (n=23)	p-value
Daily Junk Food Intake	9	16	0.008*
Screen Time >2 hours/day	14	19	0.012*
Physical Activity <60 min/day	13	18	0.015*
Sleep <8 hours/day	7	11	0.041*

Significant at $p<0.05$

Observation: Junk food intake, prolonged screen time, inadequate physical activity, and shorter sleep duration were significantly associated with overweight and obesity.

Table 9. Association Between Obesity and Metabolic Risk Factors

Variable	Obese (n=12)	Non-Obese (n=46)	p-value
Elevated FBS	5	2	0.004*
High Triglycerides	8	8	0.002*
Low HDL	7	11	0.018*
Elevated LDL	6	8	0.025*
High HOMA-IR	7	4	<0.001*

Significant at $p<0.05$

Observation: Obese children had significantly higher fasting blood glucose, dyslipidemia, and insulin resistance compared to non-obese children.

Table 10. Predictors of Early Cardiovascular Risk

Risk Factor	Odds Ratio (95% CI)	p-value

Obesity	3.84 (1.52–9.71)	0.003*
Screen Time >2 h/day	2.71 (1.14–6.45)	0.021*
Physical Inactivity	2.43 (1.05–5.60)	0.036*
High Triglycerides	2.95 (1.18–7.33)	0.019*
High HOMA-IR	4.16 (1.56–11.08)	0.002*

Significant at $p<0.05$

Observation: Obesity, prolonged screen time, physical inactivity, elevated triglycerides, and insulin resistance were independent predictors of early cardiovascular risk among school-going children.

DISCUSSION

The present cross-sectional study evaluated the prevalence of childhood obesity, associated lifestyle factors, metabolic abnormalities, and early cardiovascular risk among 58 school-going children aged 6–16 years. The study demonstrated that approximately two-fifths (39.7%) of the participants were either overweight or obese, highlighting the increasing burden of pediatric obesity in the study population. These findings reflect the ongoing nutritional transition occurring in many parts of India, where changing dietary habits and increasingly sedentary lifestyles have contributed to rising childhood obesity rates.

In the present study, obesity was more commonly observed among children residing in urban areas and those attending private schools. Similar observations have been reported by Gupta et al., who found significantly higher obesity prevalence among urban school children because of greater accessibility to processed foods, reduced physical activity, and increased sedentary behavior.[11] Urbanization has consistently been recognized as an important contributor to pediatric obesity in developing countries.

Anthropometric assessment demonstrated increased BMI, waist circumference, waist-to-height ratio, and blood pressure among obese children compared with normal-weight children. Waist-to-height ratio greater than 0.5 was present in 37.9% of participants, suggesting significant central obesity. Ashwell and Hsieh reported that waist-to-height ratio is a simple and reliable screening tool for identifying cardiometabolic risk across different ethnic populations and may predict metabolic complications better than BMI alone.[12]

Lifestyle assessment revealed that prolonged screen time, inadequate physical activity, frequent junk food consumption, sugary beverage intake, and reduced sleep duration were highly prevalent among the study participants. More importantly, these lifestyle factors showed statistically significant associations with overweight and obesity. Similar findings were reported by the WHO Commission on Ending Childhood Obesity, which emphasized excessive screen exposure, physical inactivity, unhealthy dietary patterns, and poor sleep hygiene as major modifiable determinants of childhood obesity.[13]

Nearly one-third of children consumed junk food regularly, while more than half reported inadequate physical activity and excessive screen time exceeding two hours daily. The increasing availability of smartphones, online education, television viewing, and digital entertainment has substantially reduced outdoor play among children. Previous studies have consistently demonstrated that prolonged sedentary behavior promotes positive energy balance and increases adiposity, thereby accelerating obesity development.[14]

The present study also demonstrated a considerable burden of metabolic abnormalities among overweight and obese children. Low HDL cholesterol (31.0%), elevated triglycerides (27.6%), elevated LDL cholesterol (24.1%), and insulin resistance (19.0%) were among the most common metabolic derangements. These findings support previous evidence showing that childhood obesity is frequently accompanied by dyslipidemia and insulin resistance, both of which represent important components of pediatric metabolic syndrome.[15]

Insulin resistance, assessed using HOMA-IR, was significantly more common among obese children than non-obese children ($p<0.001$). Excess adipose tissue contributes to impaired insulin signaling through chronic inflammation, increased free fatty acid release, and altered adipokine secretion. Weiss et al. demonstrated that increasing degrees of obesity in children are associated with progressively worsening insulin sensitivity and greater prevalence of metabolic syndrome.[16]

The prevalence of elevated fasting blood glucose and HbA1c observed in the present study further emphasizes the early metabolic consequences of obesity. Although overt diabetes was uncommon, impaired glucose metabolism among obese children indicates an increased future risk for type 2 diabetes mellitus. Similar findings have been described by the International Diabetes Federation, which recognizes obesity-induced insulin resistance as the principal mechanism underlying pediatric metabolic syndrome.[17]

Approximately one-third of participants exhibited central obesity, and 17.2% had elevated blood pressure. Elevated blood pressure among obese children may result from increased sympathetic nervous system activity, sodium retention, endothelial dysfunction, and activation of the renin–angiotensin system. Sorof and Daniels similarly reported that obesity is one of the strongest independent risk factors for pediatric hypertension and future cardiovascular disease.[18]

High-sensitivity C-reactive protein (hs-CRP) was elevated in 15.5% of study participants, indicating the presence of chronic low-grade inflammation. Adipose tissue-derived inflammatory mediators are increasingly recognized as early contributors to endothelial dysfunction and atherosclerosis. Elevated hs-CRP has been associated with obesity, insulin resistance, and future cardiovascular events even in pediatric populations.[19]

An important finding of the present study was that 27.6% of children were categorized as having increased early cardiovascular risk based on the coexistence of obesity, central adiposity, dyslipidemia, elevated blood pressure, insulin resistance, and inflammatory markers. Logistic regression analysis identified obesity, prolonged screen time, physical inactivity, elevated triglycerides, and insulin resistance as independent predictors of increased cardiovascular risk. These observations are consistent with longitudinal studies demonstrating that obesity beginning in childhood significantly increases adult cardiovascular morbidity and mortality.[20]

The strengths of the present study include comprehensive assessment of anthropometric measurements, lifestyle behaviors, biochemical markers, insulin resistance, and cardiovascular risk factors using standardized methods. However, certain limitations should be acknowledged. The relatively small sample size and cross-sectional design limit causal inference. Lifestyle information was based on questionnaire responses and may be influenced by recall bias. Additionally, advanced cardiovascular imaging such as carotid intima-media thickness or echocardiographic assessment was not performed.

Overall, the findings emphasize the urgent need for school-based obesity prevention programs focusing on healthy dietary practices, increased physical activity, reduced screen time, and early identification of children with metabolic abnormalities. Early lifestyle intervention has the potential to reduce the burden of obesity-related cardiovascular disease in adulthood.

CONCLUSION

The present study showed a high prevalence of overweight and obesity among school-going children, with unhealthy dietary habits, physical inactivity, prolonged screen time, and inadequate sleep being significant associated lifestyle factors. Obese children had a higher prevalence of dyslipidemia, insulin resistance, elevated blood glucose, and other cardiometabolic risk factors. Obesity, physical inactivity, prolonged screen time, hypertriglyceridemia, and insulin resistance were identified as independent predictors of early cardiovascular risk. These findings emphasize the need for early screening, school-based health promotion, and lifestyle interventions to prevent childhood obesity and its long-term metabolic and cardiovascular complications.

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