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Lifestyle Influences on Total Body Composition in Overweight Children from South India

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KEYWORDS

Case report, esthetics, coronally advanced flap, gingival recession, porcine matrix.

ABSTRACT:

Background:

India is witnessing a dual burden of malnutrition, with rising childhood obesity coexisting with undernutrition. Conventional measures like BMI are limited in accurately assessing adiposity, especially in growing children. Dual-energy X-ray absorptiometry (DEXA) offers a more precise evaluation of fat distribution and body composition. This study assessed DEXA-derived adiposity metrics and their associations with behavioral factors in overweight South Indian children aged 5–12 years.

Methods:

A prospective cross-sectional study was conducted at a tertiary care center in South India over 12 months. Forty-three overweight children were recruited based on Indian Academy of Paediatrics BMI percentiles. DEXA scans measured Total Body Fat Percentage (TBFP), Fat-Free Mass Index (FFMI), and Android:Gynoid (A:G) fat ratio. Behavioral data on screen time, physical activity, and processed food intake were collected using structured questionnaires. Statistical analyses included chi-square tests and Pearson's correlations.

Results:

Mean TBFP was 23.3% (SD = 3.6), with a mean A:G ratio of 1.06, indicating central adiposity. Screen time and processed food intake were significantly associated with higher TBFP ($p = 0.006$ and $p = 0.007$, respectively), while physical activity showed no significant association. Moderate positive correlation was found between processed food frequency and TBFP ($r = 0.339$, $p = 0.050$).

Conclusion:

DEXA-based evaluation revealed elevated central adiposity in overweight children, which may be underestimated by BMI. Dietary behaviors and screen time were stronger predictors of adiposity than physical activity. These findings underscore the need for targeted behavioral interventions and the integration of advanced body composition assessments in pediatric obesity screening.

INTRODUCTION

Nutritional status plays a pivotal role in how children respond to illness, with adequate nutrition being essential for normal growth and development. A comprehensive nutritional assessment includes dietary and medical history, anthropometry, and biochemical parameters (1).

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Despite the recognition of nutrition as a basic human right, systemic inequities contribute to widespread malnutrition, with undernutrition prevalent in poorer regions and obesity increasing in wealthier populations. Factors like age, gender, education, and socioeconomic status influence these disparities (2). Recent findings also highlight the bidirectional relationship between malnutrition and infection, where poor nutrition weakens immunity and infection further impairs nutritional status, creating a vicious cycle (3). Additionally, early-life nutritional deficits have been linked to long-term cognitive and metabolic consequences, underscoring the need for timely interventions during critical growth periods (4).

Anthropometry, a widely used non-invasive tool, helps assess nutritional status and growth in children. Standard parameters include height, weight, BMI, and head and body circumferences. Regular measurements can detect underlying nutritional or medical issues early (5). However, BMI has significant limitations—it does not differentiate between fat and lean mass or indicate visceral fat, limiting its accuracy for body composition analysis (6,7). Though commonly used in children, BMI may not accurately reflect fat distribution or differentiate between muscle and fat mass, especially during growth and puberty (8). To overcome the shortcomings of BMI, alternative anthropometric measures like skinfold thickness and waist-to-height ratio have been investigated, as they may offer more accurate estimates of body fat in children (9). Additionally, dual-energy X-ray absorptiometry (DEXA) has gained recognition as a gold-standard technique for evaluating body composition and is frequently used to validate other anthropometric methods (10).

DEXA offers a more accurate evaluation by distinguishing bone mineral content (BMC), fat mass (FM), and lean mass (LM) using differential X-ray attenuation (11,12). Compared to BMI, DEXA provides precise measurements of FM, fat-free mass, and bone density, although its usage is limited due to cost and accessibility. Nevertheless, it is invaluable in clinical research, especially for evaluating body composition in both underweight and overweight children (12,13). Recent studies have also demonstrated DEXA's utility in tracking longitudinal changes in body composition during growth and treatment interventions (14). Furthermore, DEXA's ability to regionalize fat distribution offers important insights into metabolic risk factors beyond total body fat assessment (15).

Lifestyle factors such as physical inactivity, poor dietary habits, stress, and parental obesity play a significant role in childhood overweight and obesity. Studies have shown that children with inadequate physical activity, passive leisure patterns, and unhealthy eating behaviors are at higher risk of excess adiposity (16,17). Furthermore, recent studies indicate a high prevalence of screen-based sedentary behavior and consumption of obesogenic diets among children and adolescents, with dietary patterns showing a stronger and more consistent association with overweight and obesity than screen time alone (18). These behaviors contribute to energy imbalance and reduced physical fitness, increasing the likelihood of excess adiposity in children. Early interventions promoting active lifestyles and limiting screen time are essential in preventing childhood obesity (19).

Given these concerns, there is a pressing need to assess adiposity more precisely in children, particularly in those already identified as overweight by conventional methods. This study utilizes DEXA to evaluate body composition and investigates the influence of lifestyle factors—specifically screen time, dietary habits, and physical activity—on adiposity patterns in overweight South Indian children aged 5–12 years.

METHODOLOGY

Study Design and Setting

This was a prospective cross-sectional study conducted over a 12-month period (June 2023 to June 2024) at the Department of Pediatrics, Chettinad Hospital and Research Institute, a tertiary referral center in South India. The study aimed to assess body composition and behavioral predictors of adiposity specifically in overweight children using Dual-Energy X-ray Absorptiometry (DEXA).

Ethical Approval

Ethical clearance was obtained from the Institutional Ethics Committee (IEC Approval No: IHEC -I/1996/23). Written informed consent was secured from all parents or legal guardians. Assent was obtained from children when appropriate.

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Participants and Sampling

A total of 43 overweight children aged 5–12 years were included in this analysis. Participants were identified using Indian Academy of Paediatrics BMI percentiles, with overweight defined as a BMI above the 85th percentile for age and sex. Children were enrolled through consecutive sampling from outpatient clinics.

Inclusion Criteria

- Children aged 5–12 years categorized as overweight according to Indian BMI percentiles
- Attendance at the pediatric outpatient clinic for minor illness or routine evaluation
- Informed consent (and assent where appropriate) provided

Exclusion Criteria

- Children with chronic medical conditions (e.g., diabetes, hypothyroidism)
- Those on medications known to affect body composition
- Any DEXA scan performed within the preceding 6 months

Study Objectives

Primary Objective

To assess body composition parameters—Total Body Fat Percentage (TBFP), Fat-Free Mass Index (FFMI), and Android: Gynoid (A:G) fat ratio—using DEXA in overweight children aged 5–12 years.

Secondary Objectives

- To examine the associations between behavioral factors (screen time, physical activity, and processed food consumption) and body fat percentage in overweight children.
- To explore the relationship between BMI and DEXA-derived adiposity measures (TBFP, FFMI, A:G ratio) in the overweight pediatric population.

Anthropometric and Body Composition Assessment

Height and weight were measured using a calibrated stadiometer and electronic weighing scale. BMI was calculated and interpreted using Indian Academy of Paediatrics percentile charts.

DEXA scans were performed using a Hologic Discovery Wi scanner (Hologic Inc., Bedford, MA, USA) following standard positioning protocols to ensure precision. Parameters recorded included TBFP, FFMI), A:G, lean mass, and bone mineral content (BMC).

Behavioral Assessment

Behavioral data were collected through structured parent-reported questionnaires, including:

- Daily screen time (categorized as <1 hour, 2–3 hours, or >3 hours)
- Daily physical activity duration
- Weekly processed food consumption frequency

Statistical Analysis

All data were analyzed using IBM SPSS Statistics version 20.0. Continuous variables were reported as mean ± standard deviation (SD) or median and interquartile range (IQR), based on distribution normality (assessed using the Shapiro-Wilk test).

Associations between behavioral categories and TBFP were evaluated using the chi-square test. Correlations between behavioral factors and TBFP were analyzed using Pearson's correlation coefficient. A p-value <0.05 was considered statistically meaningful.

RESULTS

Demography

Among the 43 overweight children analyzed, the mean age was 8.8 years (SD = 2.4), with 18 males (41.9%) and 25 females (58.1%) (Table 1). Age and sex distributions support potential subgroup analysis by sex or pubertal stage.

Table 1. Demographic Characteristics

Characteristic	Value
Age (years)	Mean ± SD: 8.77 ± 2.40
Sex	Male: 18 (41.9%) Female: 25 (58.1%)

Presentation

DEXA measurements revealed a mean Total Body Fat Percentage (TBFP) of 23.3% (SD = 3.6) and a mean BMI of 20.7 kg/m² (SD = 2.6). The Fat-Free Mass Index (FFMI) averaged 15.8 (SD = 1.8), and the Android:Gynoid (A:G) fat distribution ratio was 1.06 (SD = 0.13). These findings indicate elevated overall and

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centrally distributed adiposity among overweight children (Table 2).

Table 2. Body Composition

Parameter	Mean ± SD	Median	Range
TBFP (%)	23.28 ± 3.60	22.51	18.63
FFMI	15.77 ± 1.85	15.51	10.48
A:G Ratio	1.06 ± 0.13	1.04	0.58
BMI (kg/m²)	20.71 ± 2.57	20.40	12.10
Waist-Hip Ratio	0.95 ± 0.07	0.97	0.25

Behaviourally, 24 (55.8%) of these children reported 2–3 hours of daily screen time, 20 (46.5%) consumed processed foods more than three times per week, and 15 (34.9%) engaged in more than 3 hours of physical activity per day (Table 3).

Table 3. Behavioral Patterns

Behaviour	Category	Frequency (n)	Percentage (%)
Physical Activity	<1 hour/day	10	23.3
	2–3 hours/day	18	41.9
	>3 hours/day	15	34.9
Screen Time	<1 hour/day	11	25.6
	2–3 hours/day	24	55.8
	>3 hours/day	8	18.6
Processed Food Intake	≤1 time/week	8	18.6
	2–3 times/week	15	34.9
	>3 times/week	20	46.5

Outcome

Primary Outcomes

DEXA-derived TBFP, FFMI, and A:G ratios were notably higher in overweight children compared to normative reference values. These results validate the limitations of BMI alone in identifying true adiposity and fat distribution patterns.

Secondary Outcomes

Among behavioral variables, processed food consumption and screen time were associated with higher TBFP ($\chi^2 = 5.070$, $p = 0.007$ and $\chi^2 = 10.093$, $p = 0.006$, respectively), while physical activity showed no such association ($\chi^2 = 2.279$, $p = 0.320$) (Table 4).

Table 4. Association Between Behavioral Factors and TBFP - Overweight Children

Variable	χ^2 (df)	*p*-value
Physical Activity	2.279 (2)	0.320
Screen Time	10.093 (2)	0.006
Processed Food Intake	5.070 (2)	0.007

Correlation analysis showed a moderate linear association between processed food intake and TBFP ($r = 0.339$, $p = 0.050$). No meaningful associations were observed for physical activity or screen time (Table 5) (Figure 1-3). These findings highlight dietary behaviour as a stronger predictor of adiposity in overweight children than physical activity levels alone.

Table 5. Correlation Between Behavioral Variables and TBFP - Overweight Children

Variable	*r*	*p*-value
Physical Activity	–0.094	0.595
Screen Time	0.108	0.543
Processed Food Intake	0.339	0.050

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Figure 1:

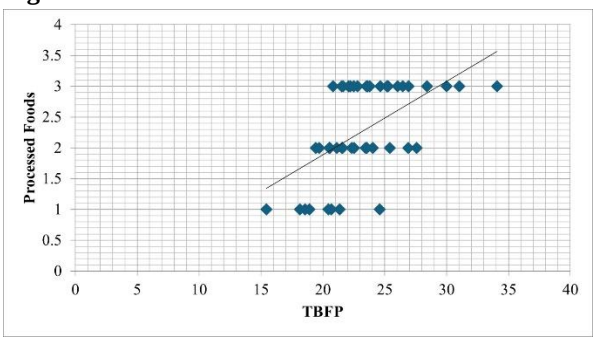


Figure 2:

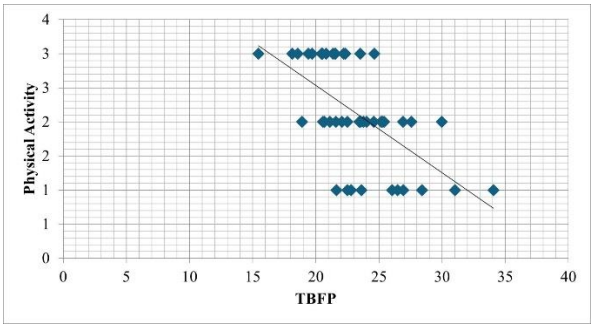
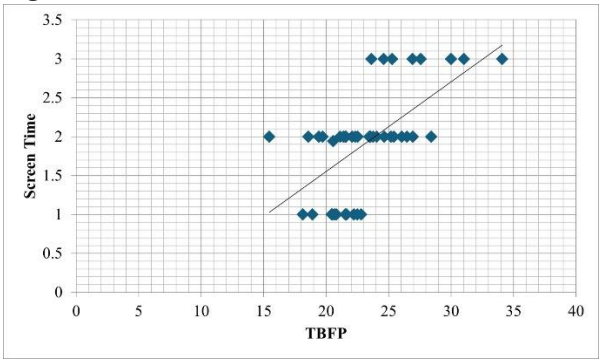


Figure 3:



DISCUSSION

This study evaluated body composition in overweight children aged 5–12 years using DEXA and examined behavioral correlates of adiposity. The key findings include a notably high total body fat percentage (TBFP), elevated android-to-gynoid (A:G) fat distribution ratios, and a significant association between increased processed food consumption and screen time with higher adiposity levels. No statistically significant association was observed between physical activity and TBFP. Carter et al. also observed that body fat percentages measured through DEXA were closely associated with eating habits and levels of sedentary behavior among school-aged children (20). Additionally, Falbe et al. found that screen exposure, regardless of physical activity levels, has been identified as a strong indicator of abdominal fat accumulation and associated metabolic health risks in children (21).

Interpretation and Contextualization

The elevated TBFP and A:G ratio observed among overweight children suggest that BMI alone may underestimate central adiposity, a critical determinant of future cardiometabolic risk. While BMI is often used in pediatric assessments, it does not differentiate between fat mass and lean mass, nor does it indicate fat distribution—limitations that DEXA overcomes through its precise segmentation of body components. These findings support existing literature emphasizing the clinical value of DEXA in pediatric obesity research and assessment, particularly in identifying children at risk of visceral adiposity-related complications. This is consistent with findings by Bauer et al., who demonstrated that children with normal BMI could still have elevated visceral fat as measured by DEXA, highlighting the method's superior sensitivity in detecting metabolically significant fat deposits (22). Additional research demonstrates that trunk fat assessed using DEXA exhibits a stronger and more precise association with key cardiometabolic risk factors including insulin resistance and unfavorable lipid profiles compared to commonly used measures like BMI or waist circumference. This suggests that DEXA provides a superior evaluation of central adiposity, which is crucial for identifying children at higher risk of developing metabolic complications (23). Central fat distribution measured by DEXA provides a more accurate indication of metabolic health risks compared to conventional measures such as BMI or waist circumference, highlighting the need to include advanced body composition techniques in pediatric evaluations for improved identification of children at risk and more effective obesity prevention (24)

Our study further reinforces the influence of behavioral factors—particularly dietary habits and screen time- on adiposity in children. The observed association between processed food intake and TBFP highlights the nutritional transition in many urban Indian households, where increased availability of calorie-dense, nutrient-poor foods is contributing to early-onset overweight and

obesity. Although physical activity is widely promoted as a preventive measure, its lack of significant association with TBFP in this study may be due to variability in intensity, overreporting, or inadequate measurement methods. These findings align with those of Kelishadi et al. who reported that poor dietary quality and increased sedentary behaviors were more strongly linked to central obesity in children than physical activity levels, suggesting the need for targeted dietary interventions (25). Furthermore, research has identified a strong correlation between extended screen time and increased waist circumference in Indian school-aged children, highlighting the adverse metabolic consequences associated with prolonged sedentary behavior (26). Similarly, research has shown that greater exposure to screen-based media is linked to higher levels of body fat in children, regardless of their physical activity levels, emphasizing the distinct role of sedentary behaviors in contributing to childhood adiposity (27).

Novel Contributions

This study adds to the limited body of DEXA-based pediatric research in India by quantifying body composition and behavioral influences in overweight children—a demographic of increasing concern given India's dual burden of malnutrition. Importantly, the use of DEXA allowed for a more nuanced assessment of adiposity than BMI alone, revealing insights into fat distribution that are often clinically underrecognized. Khadilkar et al. (2011) developed body fat reference percentiles for Indian children using DEXA and highlighted its greater accuracy in identifying central obesity compared to traditional anthropometric methods (28). Similarly, Misra et al. reported that Indian children exhibit a tendency toward higher body fat and central adiposity even at lower BMIs, underscoring the value of DEXA in capturing these ethnic-specific adiposity patterns (29). Furthermore, Das et al. demonstrated the effectiveness of DEXA in correlating fat distribution with insulin resistance markers in urban Indian children, reinforcing its role in risk stratification (30).

Sex and Age Considerations

Although this study did not detect statistically significant sex differences in TBFP or A:G ratio due to sample size limitations, descriptive trends indicated slightly higher adiposity in girls, consistent with global data. For example, Wells and Fewtrell reported sex-related differences in body composition emerging during childhood, with girls generally showing higher fat accumulation (31). Similarly, Taylor et al. found that girls had greater central fat deposition compared to boys in pre- to post pubertal stages (32). Additionally, Goran et al. demonstrated sex-specific patterns of fat distribution and accumulation during puberty, highlighting increased central adiposity in females (33). Furthermore, Borrud et al. observed that adolescent girls tend to accumulate more total and regional body fat than boys, reflecting physiological and hormonal influences (34).

Limitations

Several limitations merit consideration. First, the sample size was relatively small and drawn from a single tertiary care center, limiting generalizability. Second, the cross-sectional design precludes causal inferences. Third, behavioral data were based on parent-reported questionnaires, which may introduce recall or social desirability bias. Finally, socioeconomic and pubertal status, which may influence adiposity, were not formally assessed.

Implications for Research and Policy

These findings support the integration of body composition analysis- particularly via DEXA or validated field-based alternatives- in pediatric obesity screening protocols. Further research with larger, diverse populations and longitudinal designs is warranted to explore causality and the role of age, sex, pubertal status, and socioeconomic determinants in adiposity patterns.

Conclusion

This study demonstrates that overweight children aged 5–12 years exhibit elevated total and central adiposity, which may not be captured by BMI alone. Processed food consumption and screen time emerged as significant behavioral predictors of higher TBFP, while physical activity did not show a statistically meaningful association. These findings underscore the need for multifactorial, behaviourally targeted interventions and more sophisticated body composition tools to guide early identification and management of pediatric adiposity.

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