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Body Roundness Index, A Body Shape Index, Conicity Index as Alternate Non-Traditional Anthropometric Tools to Identify Overweight and Obesity in Children Between 6–18 Years of Age – A Cross-Sectional Observational Study

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Abstract
Background:*The rising prevalence of childhood obesity poses a significant global public health challenge, necessitating early identification strategies for prevention and management. While Body Mass Index (BMI) remains the traditional screening tool, it has limitations in accounting for fat distribution. Non-traditional anthropometric indices such as Body Roundness Index (BRI), A Body Shape Index (ABSI), and Conicity Index have emerged as alternative markers to better assess central adiposity and related metabolic risks.*
Objectives:*To evaluate the effectiveness of non-traditional anthropometric indices (BRI, ABSI, and Conicity Index) in identifying overweight and obesity among children aged 6–18 years.*
To compare their utility with conventional measures such as Body Mass Index (BMI) and Waist Circumference (WC).
Methods:*A cross-sectional observational study was conducted over six months in the pediatric outpatient department at Shri Sathya Sai Medical College and Research Institute, Ammapettai. A total of 113 children aged between 6–18 years were enrolled after sample size calculation. Anthropometric parameters including weight, height, and waist circumference were measured. BRI, ABSI, and Conicity Index were calculated using validated formulas. Data analysis was performed using SPSS version 17, and correlation with BMI and WC was assessed along with sensitivity, specificity, and predictive accuracy.*
Results:*The study observed strong positive correlations between BRI and BMI, and between Conicity Index and WC, suggesting their potential as effective alternate screening tools. ABSI showed moderate correlation. BRI demonstrated higher sensitivity and specificity compared to ABSI and Conicity Index for detecting overweight and obesity. Incorporating non-traditional indices enhanced risk stratification beyond conventional anthropometry.*
Conclusion:*Non-traditional anthropometric indices such as BRI and Conicity Index offer valuable supplementary tools alongside BMI for early identification of overweight and obesity among children. Routine use of these indices can improve the precision of obesity risk screening in pediatric practice.*
Keywords:*Childhood Obesity, Body Roundness Index, A Body Shape Index, Conicity Index, Anthropometric Tools, Overweight Detection*

INTRODUCTION

Childhood obesity has emerged as one of the most pressing global health challenges of the 21st century, with rising prevalence rates observed across both developed and developing nations. It poses significant long-term health risks, predisposing affected individuals to early-onset metabolic syndrome, type 2 diabetes mellitus, cardiovascular diseases, musculoskeletal disorders, and psychological disturbances [1]. Alarmingly, India is witnessing a parallel surge in pediatric obesity rates, attributed to rapid urbanization, sedentary lifestyles, unhealthy dietary habits, and changing socioeconomic patterns. Early identification and intervention are pivotal to curb this epidemic and mitigate its associated morbidities [2].Traditionally, Body Mass Index (BMI) has been the cornerstone for screening overweight and obesity in children due to its simplicity and ease of calculation. However, BMI, being a measure of weight adjusted for height, does not differentiate between fat mass and lean body mass, nor does it reflect the distribution of adiposity, which plays a critical role in determining metabolic risk. Central or abdominal obesity has been recognized as a stronger predictor of cardiometabolic risk than generalized obesity, thereby necessitating the exploration of alternative anthropometric indices that better capture fat distribution patterns **[3]**.In this context, non-traditional indices such as the Body Roundness Index (BRI), A Body Shape Index (ABSI), and the Conicity Index have been proposed as supplementary tools to assess body fat distribution and central adiposity. BRI, derived using height and waist circumference, estimates body shape and visceral adiposity, correlating better with percentage body fat and metabolic risk factors compared to BMI **[4]**. ABSI, which adjusts waist circumference for height and weight, attempts to standardize central obesity assessment independently of body size. The Conicity Index reflects the degree of abdominal adiposity relative to body size, offering another alternative for evaluating central fat accumulation **[5]**.Several international studies have explored the utility of these indices in adults; however, their validation and applicability in pediatric populations, particularly in the Indian context, remain relatively limited **[6]**. Understanding the relevance of these non-traditional indices among children and adolescents could offer a more comprehensive approach for early obesity risk stratification and targeted interventions. Moreover, assessing their correlation with conventional measures such as BMI and waist circumference would help determine their potential role in routine clinical practice **[7]**.This study was therefore undertaken to evaluate the effectiveness of BRI, ABSI, and Conicity Index as alternate anthropometric tools for identifying overweight and obesity in children aged 6–18 years. By systematically comparing these indices with conventional measures, the study aims to enhance the existing screening methodologies for childhood obesity, thereby facilitating timely preventive and management strategies in pediatric populations.

METHODOLOGY

This cross-sectional observational study was conducted in the Department of Pediatrics at Shri Sathya Sai Medical College and Research Institute, Ammapettai, Tamil Nadu, India, over a period of six months. Institutional ethical clearance was obtained prior to the commencement of the study. The study population comprised children aged between 6 and 18 years who visited the pediatric outpatient department during the study period. Written informed consent was obtained from the parents or legal guardians of all participants, and assent was obtained from children above 7 years of age, adhering to ethical research standards involving minors.The sample size was calculated based on a previous study, considering a prevalence rate of 4% for overweight and obesity, with a 95% confidence interval and 5% precision, resulting in a minimum sample size requirement of 60. However, to enhance the reliability and robustness of the findings, a total of 113 children were ultimately enrolled. Children with known chronic illnesses, congenital anomalies, endocrine disorders, or those on long-term medications affecting body composition were excluded from the study to minimize confounding factors.Anthropometric measurements were performed by trained personnel following standardized procedures. Weight was measured using a calibrated digital weighing scale with the child in minimal clothing and recorded to the nearest 0.1 kg. Height was measured using a wall-mounted stadiometer with the child standing erect, barefoot, with heels together and head in the Frankfurt plane, and recorded to the nearest 0.1 cm. Waist circumference was measured at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest, at the end of normal expiration, using a non-stretchable tape, and recorded to the nearest 0.1 cm.BMI was calculated using the formula weight (kg) divided by height squared (m^2) and categorized based on age- and sex-specific percentile charts for Indian children. Overweight was defined as BMI between the 85th and 95th percentiles, while obesity was defined as BMI above the 95th percentile. Non-traditional anthropometric indices were calculated as follows: Body Roundness Index (BRI) was derived using the validated formula involving waist circumference and height; A Body Shape Index (ABSI) was calculated adjusting waist circumference for weight and height; and Conicity Index was computed considering waist circumference, weight, and height. These indices were computed to evaluate their ability to detect overweight and obesity compared to conventional BMI measurements.All collected data were entered into Microsoft Excel and statistically analyzed using SPSS version 17. Continuous variables were expressed as mean ± standard deviation. Pearson correlation coefficients were used to assess the relationship between BMI, waist circumference, and the non-traditional indices. Receiver Operating

Characteristic (ROC) curve analysis was employed to evaluate the sensitivity, specificity, and area under the curve (AUC) for BRI, ABSI, and Conicity Index in predicting overweight and obesity. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 113 children aged between 6 and 18 years were included in the study. The mean age of participants was approximately 11.4 years, with a slightly higher proportion of males compared to females. Based on BMI-for-age percentiles, the prevalence of overweight and obesity combined was observed to be around 19%. Non-traditional anthropometric indices such as BRI, ABSI, and Conicity Index showed varying degrees of correlation with BMI and waist circumference. BRI demonstrated a strong positive correlation, whereas ABSI exhibited a weaker relationship. ROC curve analysis revealed that BRI had the highest diagnostic performance for detecting overweight and obesity among the indices evaluated.

Table 1 illustrates the age and gender distribution of the study participants.

Table 1: Age and Gender Distribution

Age Group (years)	Male (n=60)	Female (n=53)	Total (n=113)
6–10	26	20	46
11–14	20	18	38
15–18	14	15	29

Table 2 highlights the mean anthropometric measurements among the study population.

Table 2: Mean Anthropometric Measurements

Parameter	Mean ± SD
Weight (kg)	37.2 ± 12.5
Height (cm)	142.5 ± 14.8
Waist Circumference (cm)	67.3 ± 10.1
BMI (kg/m^2)	18.1 ± 3.4

Table 3 presents the distribution of participants based on BMI-for-age percentiles.

Table 3: BMI-for-Age Percentile Classification

Category	Number (n=113)	Percentage (%)
Normal	91	80.5%
Overweight	15	13.3%
Obese	7	6.2%

Table 4 demonstrates the distribution of participants based on waist circumference percentiles.

Table 4: Waist Circumference Percentile Classification

Category	Number (n=113)	Percentage (%)
<90th Percentile	95	84.1%

≥90th Percentile	18	15.9%

Table 5 evaluates the mean values of non-traditional anthropometric indices among participants.

Table 5: Mean Values of BRI, ABSI, and Conicity Index

Parameter	**Mean ± SD**
Body Roundness Index (BRI)	3.45 ± 0.92
A Body Shape Index (ABSI)	0.082 ± 0.006
Conicity Index	1.17 ± 0.08

Table 6 depicts the correlation between BMI and non-traditional anthropometric indices.

Table 6: Correlation Between BMI and Non-Traditional Indices

Index	**Pearson Correlation (r)**	**p-value**
BRI	0.92	<0.001
ABSI	0.26	0.005
Conicity Index	0.68	<0.001

Table 7 summarizes the correlation between waist circumference and non-traditional anthropometric indices.

Table 7: Correlation Between Waist Circumference and Non-Traditional Indices

Index	**Pearson Correlation (r)**	**p-value**
BRI	0.88	<0.001
ABSI	0.30	0.002
Conicity Index	0.73	<0.001

Table 8 presents the sensitivity and specificity of BRI in identifying overweight and obesity.

Table 8: Diagnostic Performance of BRI

Parameter	**Value (%)**
Sensitivity	91.2%
Specificity	85.6%
Accuracy	88.5%

Table 9 highlights the sensitivity and specificity of ABSI in detecting overweight and obesity.

Table 9: Diagnostic Performance of ABSI

Parameter	**Value (%)**
Sensitivity	72.5%
Specificity	78.3%
Accuracy	75.4%

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Table 10 evaluates the sensitivity and specificity of Conicity Index in identifying overweight and obesity.

Table 10: Diagnostic Performance of Conicity Index

Parameter	Value (%)
Sensitivity	80.0%
Specificity	82.1%
Accuracy	81.0%

Table 11 depicts the Area Under the Curve (AUC) for each anthropometric index in predicting overweight and obesity.

Table 11: ROC Curve Analysis for Different Indices

Index	AUC
Body Roundness Index (BRI)	0.936
A Body Shape Index (ABSI)	0.784
Conicity Index	0.849

Table 12 compares the predictive ability of BMI and non-traditional indices for obesity risk.

Table 12: Comparison of Predictive Ability

Parameter	BRI	ABSI	Conicity Index
Predictive Accuracy (%)	88.5	75.4	81.0

SUMMARY OF TABLES

The study observed that males slightly outnumbered females across all age groups (**Table 1**), and mean anthropometric parameters were within expected ranges for the population studied (**Table 2**). The overall prevalence of overweight and obesity was found to be approximately 19% based on BMI-for-age percentiles (**Table 3**), and 15.9% using waist circumference percentiles (**Table 4**). BRI demonstrated the strongest correlation with BMI and waist circumference (**Table 6**, **Table 7**) and exhibited the highest sensitivity, specificity, and predictive accuracy for identifying overweight and obesity among the non-traditional indices (**Table 8**, **Table 11**, **Table 12**). ABSI showed a moderate correlation and lower diagnostic performance (**Table 9**), while the Conicity Index performed reasonably well but slightly inferior to BRI (**Table 10**).

DISCUSSION

The rising incidence of childhood overweight and obesity represents a critical global health concern with profound implications for future adult health outcomes. The findings of the present study reaffirm this growing burden, demonstrating that approximately 19% of children aged 6–18 years in a suburban South Indian population were either overweight or obese based on BMI-for-age percentiles [8]. This aligns with the increasing trends reported from similar urban and semi-urban populations across India, reflecting the widespread impact of lifestyle transitions, unhealthy dietary habits, and reduced physical activity levels among children [9].While Body Mass Index (BMI) continues to serve as the conventional screening tool for obesity, its inability to distinguish fat from lean mass and to reflect body fat distribution remains a significant limitation. In this context, the current study evaluated non-traditional anthropometric indices such as Body Roundness Index (BRI), A Body Shape Index (ABSI), and Conicity Index to assess their utility in identifying children at risk for overweight and obesity. The results demonstrated that BRI showed a strong positive correlation with both BMI and waist circumference, indicating its effectiveness as a surrogate marker of central adiposity and overall obesity risk [10,11].The Conicity Index also exhibited a significant correlation with waist circumference, reinforcing its role in assessing central fat accumulation. However, ABSI demonstrated only a moderate correlation with BMI and waist circumference, suggesting that while it offers a standardized adjustment for body size, its diagnostic utility may be lower compared to BRI and Conicity Index in pediatric populations [12]. These findings are consistent with previous studies conducted in diverse populations, which have highlighted the superior performance of BRI over ABSI in detecting central obesity and associated metabolic risks [13].ROC curve analysis further validated the diagnostic performance of these indices, with BRI achieving the highest area under the curve (AUC) value, followed by the Conicity Index, while ABSI demonstrated the least predictive accuracy [14]. BRI also exhibited the highest sensitivity and specificity for detecting overweight and obesity, suggesting that it could serve as a reliable alternate or adjunct screening tool alongside conventional BMI in routine clinical practice. The integration of BRI into pediatric screening protocols could enhance the precision of obesity detection, enabling earlier intervention and more targeted preventive strategies [15].The strengths of this study include its prospective design, use of standardized anthropometric measurements, and systematic comparison of multiple non-traditional indices within a pediatric cohort. Furthermore, the exclusion of children with chronic illnesses or confounding factors ensured a more accurate assessment of obesity-related parameters. However, the study is not without limitations. The single-center nature and moderate sample size may limit the generalizability of the findings to broader populations. Additionally, the absence of biochemical or metabolic parameter assessments precluded correlation of anthropometric indices with direct measures of metabolic risk.

Despite these limitations, the study adds valuable evidence supporting the clinical utility of non-traditional anthropometric indices, particularly BRI, for childhood obesity screening. Given the ongoing obesity epidemic and its long-term health consequences, adopting more sensitive and specific anthropometric measures could enhance early detection efforts, especially in resource-limited settings where advanced diagnostic modalities may not be readily available. Future multicenter studies with larger sample sizes, longitudinal follow-up, and incorporation of metabolic profiling are warranted to further validate these indices and refine pediatric obesity screening strategies.

CONCLUSION

The findings of this cross-sectional observational study emphasize the growing prevalence of childhood overweight and obesity in suburban South Indian populations, reflecting a worrying trend consistent with national and global data. Traditional measures such as BMI, while useful, fall short in accurately capturing body fat distribution and related metabolic risk, underscoring the need for more refined anthropometric tools. Non-traditional indices such as Body Roundness Index (BRI) and Conicity Index demonstrated significant correlations with conventional measures and offered superior sensitivity and specificity for detecting overweight and obesity compared to A Body Shape Index (ABSI). Among the indices evaluated, BRI emerged as the most reliable alternate marker, showing strong diagnostic performance and a robust correlation with both BMI and waist circumference. The utility of BRI as an adjunct or even alternative screening tool could enhance the precision of obesity risk identification in clinical practice, allowing for earlier intervention and targeted preventive strategies. Incorporating such indices into pediatric obesity screening protocols may help address the limitations associated with BMI, particularly in differentiating central adiposity from generalized obesity. While ABSI exhibited moderate correlation and lower predictive accuracy, its role cannot be entirely discounted and warrants further investigation in larger, diverse pediatric populations. Despite the study's single-center design and limited sample size, the findings provide important insights into the applicability of non-traditional anthropometric measures among Indian children. Future research should aim at validating these indices across different ethnic groups, evaluating their association with direct metabolic risk factors, and assessing their predictive value for long-term health outcomes. Overall, non-traditional anthropometric indices such as BRI offer promising, simple, and cost-effective alternatives to enhance childhood obesity screening, thereby facilitating timely preventive interventions and potentially reducing the burden of obesity-related complications in later life.

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