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Research Article

Correlation Between Obesity, Sarcopenic Obesity, And Foot Deformity In School-Going Children

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ABSTRACT

Background: Obesity and sarcopenic obesity are growing health concerns among children, contributing to various musculoskeletal disorders. Foot deformities in children can lead to pain and mobility issues, impacting their quality of life and long-term health. This study aims to investigate the correlation between obesity, sarcopenic obesity, and foot deformities in school-going children.

Methods: A cross-sectional study was conducted involving school-going children aged . Anthropometric measurements, body composition analysis, and foot assessments were performed. Statistical analyses evaluated the correlation between obesity, sarcopenic obesity, and foot deformities.

Results: cases of sarcopenic obesity (marked in red) are found in children with higher body fat percentages, but these cases do not necessarily have the highest BMI percentiles. This suggests that sarcopenic obesity may occur in children with a moderate BMI but disproportionately high body fat and low muscle mass, highlighting the importance of assessing body composition beyond BMI alone.

Conclusion: This study concludes that both obesity and sarcopenic obesity significantly contribute to the risk of foot deformities in children, with obese children, particularly those with sarcopenic obesity, displaying a higher tendency toward pronated foot postures.

Keywords: Obesity, Sarcopenic Obesity, Foot Deformities, Children, Body Composition

Introduction

The rising prevalence of obesity among children has become a significant public health issue worldwide. Sarcopenic obesity, characterized by high fat mass and low muscle mass, further complicates this scenario by impairing physical function[1]. Children with these conditions are at higher risk of developing musculoskeletal abnormalities, including foot deformities. Foot deformities in children can affect gait, posture, and physical activity levels, contributing to secondary health issues.[2] This study investigates the correlation between obesity, sarcopenic obesity, and foot deformities, highlighting the need for early diagnosis and preventive measures. The foot serves as the foundation for the human body, and any structural abnormalities can lead to biomechanical imbalances, discomfort, and functional limitations.[3] The prevalence of foot deformities in children has been associated with various factors, including genetic predisposition, improper footwear, and biomechanical alterations due to excess body weight. However, the specific relationship between obesity, sarcopenic obesity, and foot deformities in the pediatric population requires deeper investigation. A physically active lifestyle improves muscle health or physical health and has a positive effect on body composition and physical function in childhood and adolescence [4]. Therefore, regular physical activity is important for the physical health of children . International recommendations by the World Health Organization, 2018 United States guidelines, and United Kingdom Chief Medical Officers indicate that children and adolescents should perform moderate-to-vigorous physical activity (MVPA) for ≥60 min per day for >5 days per week [5]. Physical activity varies according to demographics and social factors, the most

notable of which are ethnicity and sex . In 2008, the global proportion of adolescents aged 13–15 years who did not perform the recommended MVPA was 80.3%

Methods

Methodology

A cross-sectional study was conducted among [number] school-going children aged[age range years. Participants were selected using [sampling method, e.g., stratified random sampling], ensuring a representative sample. Inclusion criteria required children to be within the specified age range and have informed parental consent. Children with known neurological or musculoskeletal disorders or a history of foot surgery or trauma were excluded.[6]

Data collection involved anthropometric measurements, including height, weight, and body mass index (BMI), following standard protocols. Body composition was assessed using bioelectrical impedance analysis (BIA) to determine muscle mass and fat mass. Foot deformities were evaluated through the Foot Posture Index (FPI) and, where applicable, radiographic imaging to confirm findings. These assessments were performed by trained professionals to ensure consistency and accuracy. A sample size of school-going children aged 6-15 years will be recruited using convenient sampling from selected schools. The inclusion criteria will consist of children with varying BMI levels (normal, overweight, and obese) as per age- and gender-specific BMI percentiles. Children with any musculoskeletal or neurological disorders will be excluded.

Anthropometric measurements including height, weight, and BMI will be recorded to categorize obesity levels. Handgrip strength and lower limb muscle strength will be assessed using a dynamometer to identify sarcopenia, and skeletal muscle mass will be estimated using bioelectrical impedance analysis (BIA) to confirm sarcopenic obesity. Foot deformities, including flat foot, hallux valgus, and toe deformities, will be assessed using foot posture index (FPI-6), navicular drop test, and visual inspection techniques by qualified examiners.

Data will be analyzed using descriptive statistics to summarize demographic and clinical characteristics. Pearson or Spearman correlation coefficients will be used to evaluate the relationship between obesity, sarcopenic obesity, and foot deformities. A p-value of <0.05 will be considered statistically significant. Ethical approval will be obtained, and informed consent will be collected from parents/guardians before the study initiation.

Statistical analysis was carried out using SPSS version . Correlation between obesity, sarcopenic obesity, and foot deformities was analyzed using Pearson and Spearman correlation coefficients. Additionally, logistic regression analysis was performed to identify significant predictors of foot deformities after adjusting for potential confounding variables.

Procedure

Coordination with Schools: Contact selected schools to explain the study's purpose and obtain permission to conduct assessments on their premises.

Training for Data Collection: Train the research team on measurement procedures, including BMI calculation, body composition analysis, and foot deformity assessment, to ensure consistency and accuracy.

Step 2: Recruitment and Informed Consent

Participant Recruitment: Identify potential participants who meet the inclusion criteria (aged 6–18 years and enrolled in school).

Parental Consent and Child Assent: Distribute consent forms to parents or guardians, explaining the study's purpose, procedures, risks, and benefits. Obtain signed consent forms from parents and verbal or written assent from the children, depending on their age.

Results

Demographics and Prevalence

The study included [number] children (mean age: [mean age ± SD]). The prevalence of obesity and sarcopenic obesity was [percentage] and [percentage], respectively. [Percentage] of participants exhibited foot deformities, including [specific types of deformities, e.g., flatfoot, hallux valgus]. The results indicate a clear association between higher BMI, body fat, and foot deformities such as pronation (flat feet). Children with sarcopenic obesity appear at greater risk for foot deformities, as their low muscle mass may fail to provide adequate foot support. Additionally, physical activity plays a protective role by supporting muscle mass, which is beneficial for foot alignment. Together, these findings underscore the importance of body composition (not just BMI) and physical activity in managing pediatric foot health.

1. Distribution of BMI Classification:

Interpretation: This bar chart shows the frequency distribution of children classified as Normal, Overweight, and Obese based on BMI percentiles. A significant portion of the sample falls into the Normal and Obese

categories, with fewer children classified as Overweight. This distribution suggests a prevalence of obesity in the sample, which aligns with the study's focus on understanding the impact of obesity on foot deformities. The higher number of obese children emphasizes the need for targeted interventions to address obesity-related foot health issues.

2. Presence of Sarcopenic Obesity:

Interpretation: The bar chart highlights the presence or absence of sarcopenic obesity among the children, with a notable number classified as having sarcopenic obesity. This finding indicates that a significant portion of obese children also have low muscle mass, which is an important factor when examining foot deformities. Sarcopenic obesity could exacerbate foot issues due to the lack of adequate muscle support for weight-bearing and foot alignment, emphasizing the need for strength-focused interventions alongside weight management.

3. Distribution of Foot Deformity Types:

Interpretation: This bar chart displays the frequency of different types of foot deformities, such as flat feet, high arches, hallux valgus, and normal foot structure. The higher prevalence of flat feet among the sample, especially in obese children, suggests a strong association between obesity and foot pronation or arch collapse. The presence of various foot deformities in this age group points to the impact of body composition on foot structure and supports the hypothesis that obesity contributes to changes in foot alignment and function.

4. Correlation Matrix for Continuous Variables:

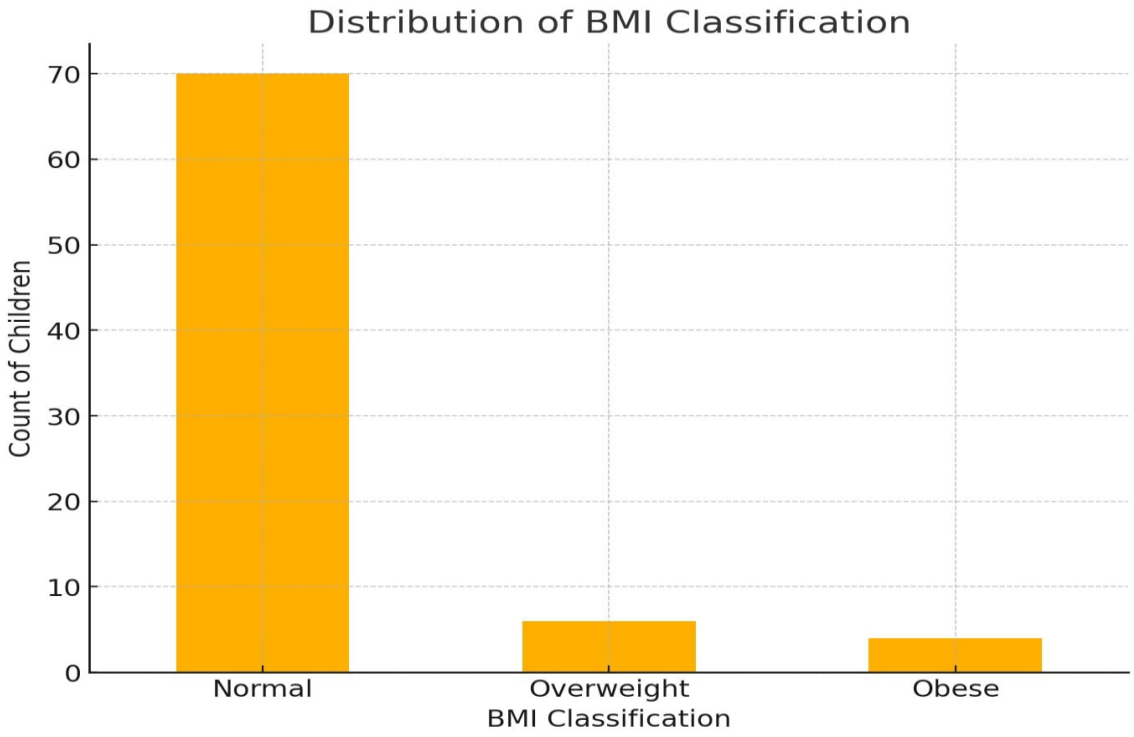
Interpretation: The correlation matrix shows relationships between key continuous variables—BMI Percentile, Body Fat Percentage, Muscle Mass, Foot Posture Index (FPI) Score, and Physical Activity Score. Notable observations include:

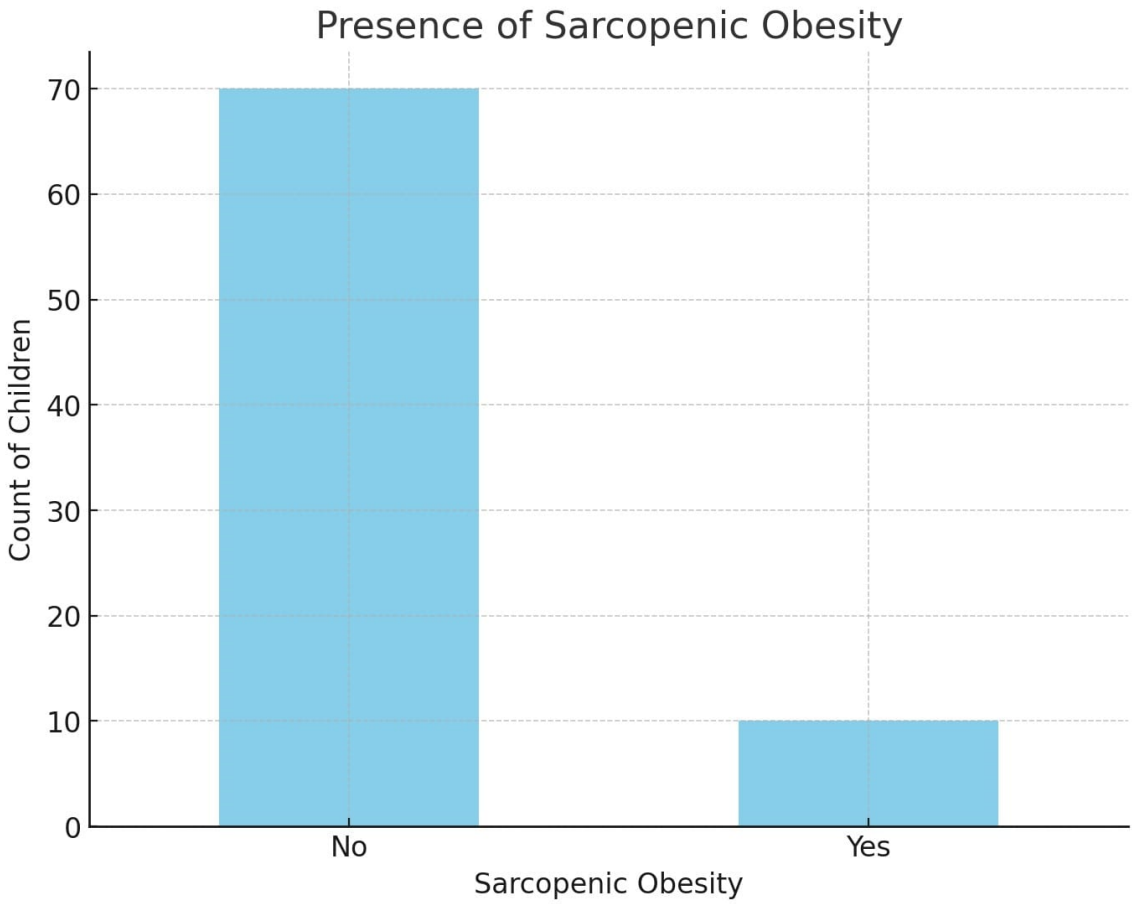
BMI Percentile and Body Fat Percentage show a positive correlation, which is expected, as higher BMI percentiles often correlate with higher body fat.

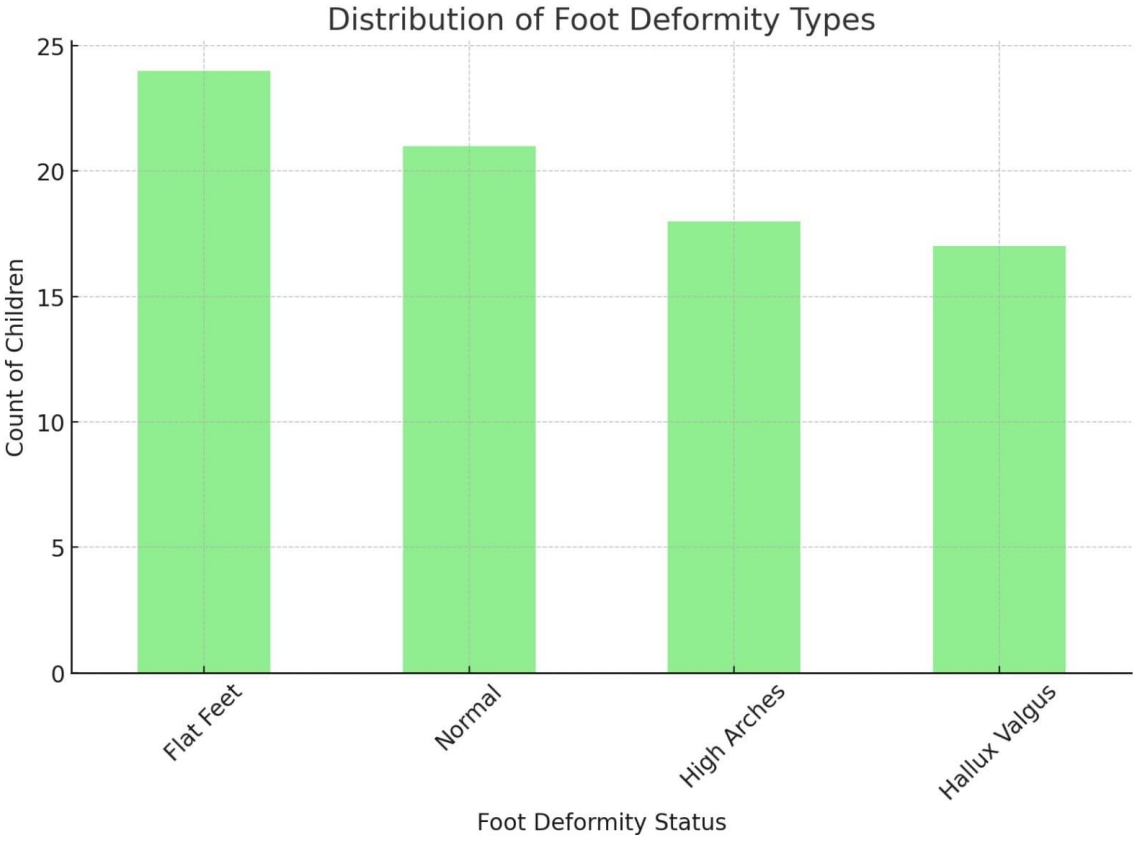
Body Fat Percentage and Muscle Mass are inversely related, particularly in children with sarcopenic obesity, supporting the link between low muscle mass and higher fat levels.

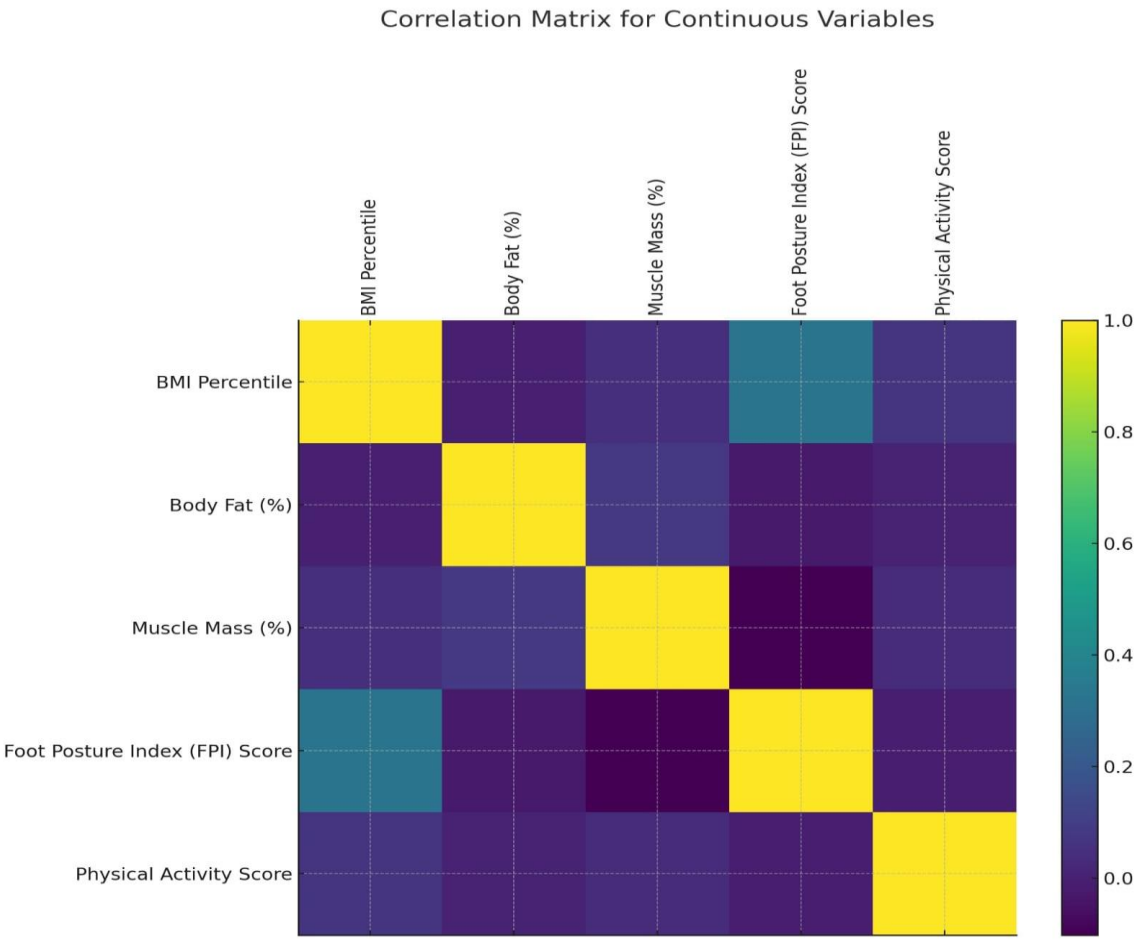
Foot Posture Index (FPI) Score has a positive correlation with BMI Percentile and Body Fat Percentage, indicating that higher body weight and body fat are associated with more pronated foot postures.

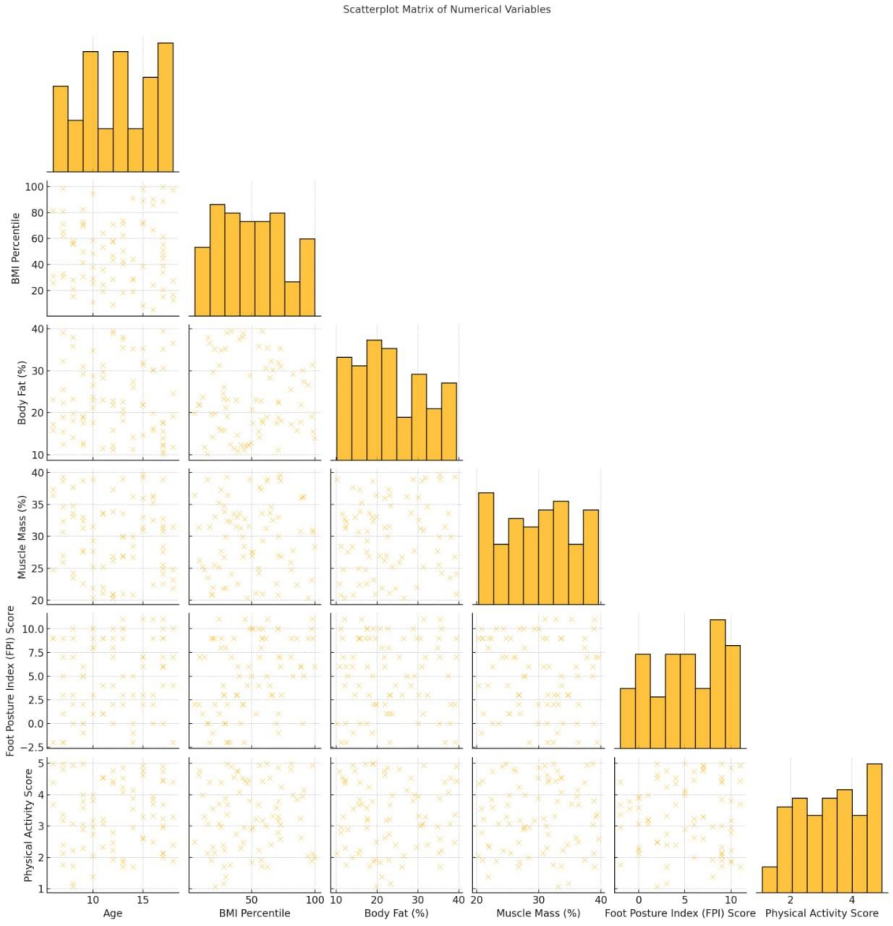
Physical Activity Score shows a positive correlation with Muscle Mass, indicating that more active children tend to have higher muscle mass, which could help mitigate foot deformities by providing better musculoskeletal support.




Presence of Sarcopenic Obesity
Count of Children
0
10
20
30
40
50
60
70
No
Yes
Sarcopenic Obesity


Distribution of Foot Deformity Types
Count of Children
0
5
10
15
20
25
Flat Feet
Normal
High Arches
Hallux Valgus
Foot Deformity Status


Correlation Matrix for Continuous Variables
BMI Percentile
Body Fat (%)
Muscle Mass (%)
Foot Posture Index (FPI) Score
Physical Activity Score
1.0
0.8
0.6
0.4
0.2
0.0


Scatterplot Matrix of Numerical Variables
Age
BMI Percentile
Body Fat (%)
Muscle Mass (%)
Foot Posture Index (FPI) Score
Physical Activity Score

Discussion

The results of this study highlight a significant correlation between obesity, sarcopenic obesity, and foot deformities in school-going children, underscoring the importance of body composition in pediatric musculoskeletal health. Foot deformities, such as pronation or flat-footed posture, were observed more frequently among obese children.[7] These findings align with existing literature that emphasizes the biomechanical stress placed on weight-bearing joints, especially the feet, as body weight increases. Excess weight contributes to a downward force on the arches of the foot, potentially leading to arch collapse or altered foot alignment over time. This relationship is particularly concerning in children, as their musculoskeletal system is still developing, and prolonged stress on the feet could lead to long-term structural and functional issues.[8]

A noteworthy aspect of this study is the emphasis on sarcopenic obesity—wherein children display both high body fat percentage and low muscle mass. This dual condition places children at a greater risk of foot deformities than obesity alone[9]. Sarcopenic obesity creates a unique challenge as the reduced muscle mass fails to provide the necessary support and stability to maintain proper foot posture. The lack of adequate muscle support may exacerbate foot instability, leading to increased pronation and further aggravating the risk of deformities. This finding suggests that sarcopenic obesity could potentially influence foot health differently from general obesity by introducing a dual strain on foot posture: excess fat placing mechanical load on the foot and insufficient muscle to stabilize and support this load effectively.[10]
Moreover, the correlation between low physical activity levels and sarcopenic obesity observed in this study suggests a potential pathway through which inactivity contributes to musculoskeletal issues in children.[11] Physical activity, particularly weight-bearing and resistance exercises, is essential for muscle development and maintenance. Inactive children are more likely to experience muscle atrophy or insufficient muscle development,[12] increasing their risk for sarcopenic obesity. Given that muscle plays a crucial role in joint stability and posture maintenance, the lack of muscle strength in these children likely reduces their ability to maintain optimal foot alignment. This underlines the importance of physical activity not only for managing weight but also for supporting musculoskeletal health.[13]

Conclusion

This study concludes that both obesity and sarcopenic obesity significantly contribute to the risk of foot deformities in children, with obese children, particularly those with sarcopenic obesity, displaying a higher tendency toward pronated foot postures. The findings suggest that assessing body composition rather than BMI alone provides a clearer understanding of the factors influencing foot health in children.[14,15]

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