



ORIGINAL ARTICLE

## Reference curves of the body fat index in adolescents and their association with anthropometric variables<sup>☆</sup>



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### KEYWORDS

Adolescents;  
Sexual maturation;  
Fat;  
Skin folds

### Abstract

**Objectives:** To develop reference curves for the body fat index (BFI) in the pediatric population, in adolescents from the city of São Paulo, Brazil, and verify their association with body mass index and body fat percentage.

**Methods:** The study is part of the research project “Nutritional Profile of Adolescents from Public and Private Schools of São Paulo” that was performed in 2004-2005. A total of 4,686 adolescents (2,130 boys and 2,556 girls) aged 10-15 years were divided into two groups: 10-12 and 13-15 years of age. Body mass, height, body mass index, hip circumference, body fat percentage, body fat index, and sexual maturation performed by the self-assessment method (prepubertal, pubertal, and postpubertal) were analyzed. ANOVA was performed, as well as percentile distribution, Pearson’s correlation, and Bland-Altman plot.

**Results:** In boys, there was an increase in body mass, height, body mass index, and hip circumference with advancing age and Tanner stage. In girls, there was an increase in body fat index and body fat percentage with advancing age and stage of sexual maturation. An association was found between body fat index and body mass index ( $r = 0.67$  in boys and  $0.80$  in girls,  $p < 0.001$ ) and body fat percentage ( $r = 0.71$  in boys and  $0.68$  in girls,  $p < 0.001$ ).

**Conclusion:** The body fat index seems to reflect well the phenomena of sexual dimorphism in adolescence, is easy to perform, and represents a method that should be used in population samples.

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**PALAVRAS-CHAVE**

Adolescentes;  
Maturação sexual;  
Adiposidade;  
Pregas cutâneas

**Curvas de referência do índice de adiposidade corporal de adolescentes e sua relação com variáveis antropométricas****Resumo**

*Objetivos:* Desenvolver curvas de referência do índice de adiposidade corporal para população pediátrica, em adolescentes da cidade de São Paulo, Brasil, e verificar a sua relação com o índice de massa corporal e percentual de gordura corporal.

*Métodos:* O estudo faz parte do projeto de pesquisa "Perfil Nutricional de Adolescentes de escolas Públicas e Privadas de São Paulo" realizado em 2004/2005. 4.686 adolescentes (2.130 meninos e 2.556 meninas) de 10-15 anos foram divididos em dois grupos: 10-12 e 13-15 anos. Massa corporal, estatura, índice de massa corporal, circunferência de quadril, porcentagem de gordura corporal, índice de adiposidade corporal e maturação sexual realizada pelo método de autoavaliação (pré-púbere, púbere e pós-púbere) foram analisadas. Foi feito ANOVA, distribuição percentilar, correlação de Pearson e o gráfico de Bland-Altman.

*Resultados:* Nos meninos, ocorreu aumento da massa corporal, estatura, índice de massa corporal e circunferência do quadril com o avanço da idade e estágio de Tanner. Nas meninas, ocorreu aumento do índice de adiposidade corporal e do percentual de gordura corporal com o avanço da idade e estágio de maturação. Foi encontrada uma associação entre o índice de adiposidade corporal com o índice de massa corporal ( $r=0,67$  nos meninos e  $0,80$  nas meninas;  $p<0,001$ ) e com o percentual de gordura ( $r=0,71$  nos meninos e  $0,68$  nas meninas;  $p<0,001$ ).

*Conclusão:* O índice de adiposidade corporal parece refletir bem os fenômenos do dimorfismo sexual na adolescência, sendo um método de fácil realização que deveria ser mais utilizado em amostras populacionais.

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**Introduction**

In recent decades, the prevalence of overweight and obesity has increased alarmingly worldwide, which is considered a public health problem.<sup>1,2</sup> The period of greatest risk for the incidence of obesity is the transition between adolescence and the early stages of adulthood in both genders and several ethnic groups,<sup>3</sup> in addition to also representing a major risk factor for cardiovascular disease.<sup>4</sup> Although the clinical manifestations of these diseases occur in adulthood, studies have shown that comorbidities such as dyslipidemia, hypertension, and insulin resistance may be present as early as in childhood and adolescence,<sup>4</sup> and are responsible for the increased risk of morbidity and mortality in adult life.<sup>5</sup>

In addition to increasing the chances of obesity in adulthood,<sup>3,4</sup> the strong association of excess weight in childhood with metabolic alterations (lipid profile and blood pressure) has resulted in the development of several techniques (hydrostatic weighing and dual-energy X-ray absorptiometry) to accurately determine body fat; however, most methods are complex, time consuming, and expensive to be routinely applied.<sup>6,7</sup> Thus, anthropometric assessment constitutes an important diagnostic method, as it is easy to perform, inexpensive, noninvasive, universally applicable, has good acceptance by the population, and is universally accepted and proposed by the World Health Organization.<sup>8,9</sup> In addition to the measurement of body weight and body fat percentage (BF%), the body mass index (BMI) is the most commonly used approach to characterize obesity in individual subjects.<sup>7-9</sup>

Although the BMI is used to characterize body growth of children, this measure is routinely applied, not only in epidemiological studies, but also in clinical practice.<sup>1,9,10</sup> When used indiscriminately, it can lead to false results, as it is a still controversial measure, in addition to the fact that it is particularly difficult to determine body fat in children.<sup>10,11</sup>

Bergman et al. proposed the Body Fat Index (BFI) for adults, a new parameter to assess body composition based on two anthropometric measures, both easily reproducible - height, in meters, and hip circumference (HC), in cm.<sup>7</sup> The BFI has been developed and applied in adults from different countries,<sup>6,7</sup> but this index is still scarcely applied in Brazilian adolescents.

Thus, the aim of this study was to develop BFI reference curves for the pediatric population, using adolescents living in the city of São Paulo, Brazil as models, as well as verify their association with BMI and BF%.

**Methods****Study population and school sampling**

The present study is part of a research on the life habits and nutritional status of adolescents, entitled "Nutritional Profile for Adolescents from Public and Private schools in São Paulo." The project was coordinated by researchers at the Centro de Atendimento e Apoio ao Adolescente of the Discipline of Pediatric Specialties of the Department of Pediatrics, Universidade Federal de São Paulo (UNIFESP).

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