



## ORIGINAL ARTICLE

# Association between body mass index and individual characteristics and the school context: a multilevel study with Portuguese children<sup>☆</sup>

Rafael S. Henrique<sup>a,\*</sup>, Thayse N. Gomes<sup>b</sup>, Go Tani<sup>c</sup>, José A.R. Maia<sup>b</sup>

<sup>a</sup> Universidade de Pernambuco (UPE), Escola Superior de Educação Física, Recife, PE, Brazil

<sup>b</sup> Universidade do Porto, Faculdade de Desporto, Laboratório de Cineantropometria e Estatística Aplicada, Porto, Portugal

<sup>c</sup> Universidade de São Paulo, Escola de Educação Física e Esportes, São Paulo, SP, Brazil

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**KEYWORDS**

Body mass index;  
Child;  
Schools;  
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Multilevel analysis

**Abstract**

**Objective:** The aim of this study was to examine the association between individual and school context characteristics with the body mass index of Portuguese children.

**Methods:** The sample comprised 1641 children (847 boys) aged 6–10 years from the North and Central regions of Portugal. Regarding the individual characteristics, age, gender, city of residence, levels of physical activity, and physical fitness were assessed. Concerning the school context characteristics, the surrounding environment, school size, presence of recreational characteristics and space, and presence of a sports court and of physical education classes were considered. Children's body mass index was the dependent variable. The multilevel analysis was carried out in HLM 7.0 software.

**Results:** The predictors of the child and the school context explained, respectively, 97.3% and 2.7% of the total body mass index variance. Regarding the individual characteristics, older children, boys, and those who had lower performance at the 1-mile run/walk, curl-up, push-up, and higher performance in trunk lift tests showed higher BMI. Further, urban schools with higher recreational spaces were positively associated with children's body mass index.

**Conclusion:** School context variables have a reduced effect on body mass index variation compared to the children's biological and behavioral characteristics. The authors therefore encourage strategies that aim to increasing children's physical fitness levels to help prevent excess weight.

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\* Corresponding author.

E-mail: [rdshenrique@hotmail.com](mailto:rdshenrique@hotmail.com) (R.S. Henrique).

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**PALAVRAS-CHAVE**

Índice de massa corporal;  
Criança;  
Escolas;  
Planejamento ambiental;  
Análise multinível

## Relação entre o índice de massa corporal e as características individuais e do contexto escolar: um estudo multinível com crianças portuguesas

**Resumo**

**Objetivo:** Examinar a associação de características individuais e do contexto escolar no índice de massa corporal de crianças portuguesas.

**Método:** A amostra compreendeu 1641 crianças (847 meninos) de 6 a 10 anos de idade. Em relação às características individuais foram utilizadas informações relativas ao sexo, à idade, à residência, à atividade física e à aptidão física. Em termos de contexto escolar, foram considerados o meio ambiente, o tamanho da escola, a presença de recreio, as características e dimensões do espaço disponível para o recreio, a existência de quadra poliesportiva e de aulas de Educação Física. O índice de massa corporal [ $\text{kg}/(\text{m}^2)$ ] foi a variável dependente. A análise multinível foi efetuada no software HLM 7.0.

**Resultados:** Os preditores da criança e do contexto escolar explicaram, respectivamente, 97,3% e 2,7% da variância total do índice de massa corporal. Quanto às características individuais, a idade (mais velhos) e o sexo (meninos), bem como o desempenho reduzido nas provas de corrida/marcha da milha, do *curl-up*, do *push-up* e valores elevados no *trunk lift* estiveram associados ao aumento no índice de massa corporal. Escolas do meio urbano e escolas com maiores espaços para o recreio também estiveram positivamente associadas ao aumento do índice de massa corporal.

**Conclusões:** As variáveis do contexto escolar têm um efeito reduzido na variação do índice de massa corporal comparativamente às características biológicas e comportamentais das crianças. Sugere-se a aplicação de programas visando o incremento dos níveis de aptidão física das crianças para prevenir o excesso de peso na infância.

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**Introduction**

The high prevalence of overweight and obesity in childhood is a serious public health problem.<sup>1</sup> Additionally, it is known that childhood obesity increases the risk of developing other comorbidities that persist into adolescence and adult life.<sup>2</sup>

Studies on agents that may influence overweight in childhood have also focused on modifiable risk factors, such as physical activity (PA) and physical fitness (PF).<sup>3</sup> Studies have reported that more active children tend to have lower values of body mass index (BMI) and/or a more adequate nutritional status.<sup>4,5</sup> However, other studies failed to corroborate these results.<sup>6,7</sup> PF, and especially its cardiorespiratory component, has been described as inversely associated with children's BMI.<sup>8</sup> In turn, research on the associations of other components of PF, such as musculoskeletal fitness and flexibility with BMI, is scarce.<sup>9</sup>

The influence of the school context on health education, especially in childhood, is significant in a developmental perspective.<sup>10,11</sup> The school is one of the most relevant educational contexts in children's development, especially regarding opportunities for engaging in varied PAs,<sup>5,12</sup> rich in playfulness, in addition to preventive actions regarding health behaviors,<sup>12</sup> and its association with individual characteristics, such as BMI, despite its apparently limited effect.<sup>13,14</sup>

In recent years, epidemiological research has focused on ecological approaches to interpret, in a more integrated manner, the relevance of individual and contextual factors in health behaviors<sup>15</sup>; multilevel modeling is a valuable tool to

simultaneously assess the hierarchical influence of variables from different levels.<sup>16</sup> However, studies with multilevel modeling have shown a reduced effect of school characteristics on BMI variation or on the children's nutritional status.<sup>13,14</sup>

For instance, Leatherdale<sup>13</sup> showed that, in Canadian children, participation in sports competitions among schools accounted for 5.4% of the variation in the chance of being overweight. When assessing the BMI of English children, Palfan et al.<sup>14</sup> also found a small amount of variance attributed to schools (0.9–4.2%); among the analyzed predictors, the number of sports activities offered were significant, as well as participation in interscholastic competitions. However, such evidence has focused on the effect of programs offered at schools, so that other aspects of the school context, such as surroundings, size, and infrastructures, have not been systematically considered in studies with children.

Therefore, the present study evaluated the association of individual characteristics and of the school context with the BMI variation of Portuguese children, using the multilevel approach.

**Methods****Sample**

The sample consisted of 1641 children (847 boys) aged 6–10 years, from 63 public and private schools in the North (Maia,  $n=20$ ) and Central regions (Vouzela,  $n=18$ ;

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