



ORIGINAL ARTICLE

# A higher number of school meals is associated with a less-processed diet<sup>☆,☆☆</sup>



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## KEYWORDS

Child;  
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## Abstract

**Objective:** To compare the participation of food groups – fresh and minimally processed, processed, and ultra-processed – in the diet of students ( $n = 1357$ ) from Belo Horizonte, MG, Brazil, in accordance with the number of school meals consumed daily.

**Methods:** Four groups were defined: children that did not consume school meals and children that consumed one, two, or three school meals daily. Food groups participation, in g/1000 kcal, was obtained using two 24-hour recalls. Three linear regression models were analyzed, in which the consumption of each of the food groups was the dependent variable, the number of school meals was the independent variable, and sociodemographic data (gender, age, health vulnerability) and overweight condition were the control variables.

**Results:** Children that consumed 2 or 3 school meals daily showed, respectively, 7.3% and 10.5% higher ingestion of fresh and minimally processed food in comparison to children that did not consume school meals. Moreover, ultra-processed food participation was 18.0% lower among students that consumed two school meals and 26.0% lower among children that consumed three meals daily, in comparison to students that did not consume school meals.

**Conclusion:** The study showed a possible dose-response effect in children's daily diets with two or three school meals and highlighted the relevance of the prolonged stay at school for healthy eating promotion in children.

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<sup>☆☆</sup> Study carried out at Universidade Federal de Minas Gerais, Escola de Enfermagem, Departamento de Nutrição, Belo Horizonte, MG, Brazil.

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**PALAVRAS-CHAVE**

Criança;  
Alimentos;  
Escola;  
Fatores  
epidemiológicos

**Maior número de refeições nas escolas está associado a uma alimentação menos processada****Resumo**

**Objetivo:** Comparar a participação dos alimentos *in natura* e minimamente processados, processados e ultraprocessados na alimentação de 1.357 escolares de Belo Horizonte (MG) de acordo com o número de refeições escolares consumidas diariamente.

**Métodos:** Foram definidos quatro grupos de estudo: crianças que não consumiam a alimentação escolar e crianças que consumiam uma, duas ou três refeições escolares diariamente. A participação na dieta dos grupos de alimentos, em g/1.000kcal, foi obtida a partir de dois recordatórios alimentares de 24 horas. Foram analisados três modelos de regressão linear, nos quais o consumo de cada um dos três grupos de alimentos constituiu a variável dependente, o número de refeições escolares consumidas diariamente constituiu a variável independente e os dados sociodemográficos (sexo, idade, índice de vulnerabilidade à saúde) e de excesso de peso, por sua vez, constituíram-se as variáveis de ajuste.

**Resultados:** Verificou-se que as crianças que consumiam duas e três refeições escolares diariamente apresentaram, respectivamente, 7,3% e 10,5% maior ingestão de alimentos *in natura* e minimamente processados quando comparadas às crianças que não consumiam a alimentação escolar. Além disso, a participação de ultraprocessados foi 18,0% menor na alimentação das crianças que consumiam duas refeições escolares e 26,0% menor entre as que consumiam três refeições escolares diariamente, em comparação àquelas que não consumiam a alimentação escolar.

**Conclusão:** O estudo apontou possível efeito dose-resposta na proteção da alimentação dos estudantes a partir do consumo de duas refeições escolares diárias, destacando a relevância da permanência da criança em período integral na escola para a promoção da alimentação saudável.

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**Introduction**

Obesity is a serious public health problem in Brazil, with alarming rates observed in children and adolescents.<sup>1,2</sup> In less than 30 years, the prevalence rates of obesity have increased by more than six-fold in children between 5 and 10 years of age; and the condition currently affects 16.8% and 11.8% of male and female schoolchildren, respectively.<sup>3</sup> Among adolescents aged 12–17 years, the obesity rate is 8.4%.<sup>4</sup>

Obesity is an important risk factor for cardiovascular diseases and the main cause of mortality in the country, being associated with lower quality of life and life expectancy, as well as higher costs in the health sector.<sup>5</sup> Intervening on this problem is one of the current challenges of the Brazilian Ministry of Health, which in 2014 launched the Intersectoral Strategy for the Prevention and Control of Obesity<sup>6</sup> and signed the Action Plan for the Prevention of Obesity in Children and Adolescents (2015–2019).<sup>7</sup> The publication of the Food Guide for the Brazilian Population that year was also the result of an effort to encourage healthy eating and to control obesity in the country.<sup>8</sup>

The golden rule proposed by the Brazilian food guide recommends prioritizing the consumption of fresh and minimally processed food instead of ultraprocessed products.<sup>8</sup> However, in a country that has experienced an increase in the consumption of ultraprocessed food from 18.7% to 29.6% in 20 years, while the intake of fresh and minimally processed foods decreased from 44.0% to 38.9%,<sup>9</sup> complying with this rule is a great challenge.

In the school environment, aiming at health promotion and childhood obesity prevention, priority is given to a greater offer of fresh and minimally processed foods.<sup>1,10</sup> The National School Feeding Program (Programa Nacional de Alimentação Escolar [PNAE])<sup>1,11</sup> and the Integrated School Program (Programa Escola Integrada [PEI])<sup>12</sup> in Belo Horizonte, state of Minas Gerais (MG), Brazil, are examples of strategies for childhood obesity prevention in the country and in Belo Horizonte, respectively. In this second program, children and adolescents between 6 and 15 years of age can stay at school full-time, having access to three daily school meals and several extracurricular activities on sports, leisure, environment, citizenship, arts, and feeding.<sup>12</sup>

There is a lack of information about the participation of fresh and minimally processed, processed, and ultraprocessed foods in the diet of children who have a higher number of school meals, due to the longer school length of stay. Thus, this study aimed to compare the participation of fresh and minimally processed foods, processed, and ultraprocessed foods in the diet of schoolchildren from Belo Horizonte who do not consume school meals or consume one, two, or three school meals daily.

**Method**

This is a cross-sectional study carried out with students attending the fourth year of elementary school in the Belo Horizonte municipal education network between March 2013 and August 2015. In this city, all municipal schools

participate in PEI<sup>12</sup> and the children's adherence to the program is decided by each family.

The sample calculation required the participation of at least 1067 children considering a 50% proportion estimate for a given characteristic (a number that provides the largest sample size for a finite population), setting the significance level at 5% and the sample error at 3%.

From this number, municipal schools of the nine administrative regional sectors of Belo Horizonte were randomly selected to participate in the study. The number of participating schools was defined according to the number of children enrolled in each administrative region of the municipality in the beginning of 2013. In the selected schools, all fourth-year classes were enrolled in the study and all children were invited to participate, except those who had a mental impairment that hindered child's report, as reported by the pedagogical coordination of the schools.

Based on these criteria, 1599 children from 26 schools were invited to participate in the study. Of these, 185 (11.6%) were not present on the data collection day and 53 (3.3%) showed difficulties in reporting food consumption and were considered as data loss, whereas four (0.3%) refused to participate in the study. Thus, the final sample included 1357 children.

The number of school meals consumed daily by students was assessed through a face-to-face interview carried out by nutritionists and nutrition undergraduate students who were adequately trained, as well as members of the research team. The children were asked if they consumed school meals at least three times a week. If so, they were asked about the type of meal (breakfast, lunch, and snack) eaten daily at school. Based on this information, the sample was classified into four categories: the student does not consume school meals or consumes one, two, or three school meals daily. It is worth mentioning that, in the study sample, 46.3% of the children are covered by the PEI and, therefore, receive three school meals that are served daily. Those who study only part-time can have the meals served at recess and lunch.

As for the participation of the fresh and minimally processed, processed, and ultraprocessed food groups in the children's diet, the information was obtained from the analysis of two non-consecutive days of a 24-hour food recall (24hR), which included all foods consumed by the children in a 24-hour period, including those consumed at school. It should be noted that in data collections held on Mondays or after holidays, feeding data were collected for the weekend and holidays, respectively.

Real household measures commonly used for food (such as cups and spoons) were shown to the children to encourage a more precise account of the amounts of food consumed. The maximum interval between the two 24-hour periods was seven days.

Food consumption information reported as household measures was transformed into weight measures, and food preparations were broken down into their basic ingredients, according to a methodology developed by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística [IBGE]).<sup>13</sup> Subsequently, the participation of the three food groups (fresh and minimally processed, processed and ultraprocessed) in grams/1000 kcal was evaluated.

Fresh and minimally processed foods were considered those consumed in their original form, without being altered for consumption (such as vegetables and fruits); as for the minimally processed food, they included foods that underwent small alterations through industrial processes (such as flours, pasteurized milk, and cuts of meat). Processed foods, in turn, included fresh foods to which oil/fat, salt, or sugar were added, such as canned fruit in syrup, canned vegetables, and canned sardines. The ultraprocessed food group considered foods who underwent several stages of industrial processing and addition of several ingredients, such as preservatives and stabilizers, in addition to those also used in processed foods. Sandwich cookies, artificial juices, chips, and soft drinks, among others, were included in this group.<sup>8,14</sup>

The information "daily number of school meals" and "participation of food groups in the children's diet" were included into three linear regression models. In each of them, the consumption of a food group constituted the dependent variable and the number of school meals was the independent variable (the "non-consumption of school meals" category was considered as a reference in comparison with the categories "consumption of one, two, and three meals a day").

Additionally, the log transformation of the dependent variable (*i.e.*, consumption of food groups) was carried out in all models, because it did not adhere to the normal distribution, according to the Shapiro–Wilk test. As the dependent variable was in logarithmic units in the models, the non-standardized beta coefficients ( $\beta$ ) were interpreted as percentages, with the following calculation for the positive and negative coefficients: exponential ( $\beta$ )  $- 1 \times 100$  and  $1 - \text{exponential}(\beta) \times 100$ , respectively.

The students' sociodemographic and nutritional status data were also obtained, aiming to adjust the regression models for possible confounders. Data on gender, age, and address were obtained from the students' school records. Based on the children's address, the health vulnerability risk (medium, low, high, and very high) was estimated using the 2012 Health Vulnerability Index (IVS-2012),<sup>15</sup> a tool that classifies the health vulnerability risk of the population of Belo Horizonte based on indicators of sanitary and socioeconomic dimensions.<sup>15</sup>

The students' nutritional status was evaluated through the body mass index (BMI)-for-age, calculated from the data of weight and height, measured by nutritionists from the study research team, using the techniques described in the literature.<sup>16</sup> Pre-established parameters of the Food and Nutrition Surveillance System (Sistema de Vigilância Alimentar e Nutricional [SISVAN]) were used for the definition of overweight (z-score  $\geq +1$ ) and obesity (z-score  $\geq +2$ ).<sup>17</sup>

In the three linear regression models, the standard error was adjusted by the clusters of school institutions (26 schools), since individuals who study at the same school are likely to share similar attributes because of their common background. Thus, the adjustment by the clusters makes the standard error estimates and the hypothesis test more adequate. The regression model residuals were evaluated according to the assumptions of normality, homoscedasticity, linearity, and independence. Additionally, the multicollinearity between the variables included in the

**Table 1** Study sample description ( $n=1357$ ). Belo Horizonte, MG, Brazil, 2013–2015.

Variable	Frequency (%)
<i>Gender</i>	
Male	49.3
Female	50.7
<i>Classification of body mass index for age</i>	
Low weight	1.8
Normal weight	67.2
Overweight	19.1
Obesity	11.9
<i>Health vulnerability risk</i>	
Low	17.8
Medium	36.6
High	33.9
Very high	11.7
<i>Number of meals consumed at school a day</i>	
Zero	27.2
One	32.9
Two	20.8
Three	19.1

models was verified. The level of significance was set at 5% ( $p < 0.05$ ).

Data analysis was performed using Stata software (Released 2007. SPSS for Windows, Version 12.0. Chicago, USA). The descriptive analysis included the calculation of frequency distribution, medians and interquartile range (IQR; 25th percentile–75th percentile).

The study was approved by the Research Ethics Committee of Universidade Federal de Minas Gerais (UFMG), CAAE Project No. 00734412.0.0000.5149. The children's parents or legal guardians signed the informed consent form authorizing the participation of the students in the study, as determined by Resolution 466/2012 of the National Health Council.

## Results

The sample consisted of 1357 students with a median age of 9.6 (IQR: 9.4–10.0) years. Table 1 shows the sample

participation according to gender, nutritional status, health vulnerability risk, and number of school meals consumed daily.

The median of fresh and minimally processed food consumption was 528.2 (IQR: 415.2–647.6) g/1000 kcal. Processed and ultraprocessed food participated in the children's diet as 51.2 (IQR: 26.5–84.7) g/1000 kcal and 157.2 (IQR: 76.3–257.0) g/1000 kcal, respectively.

Children who consumed two or three school meals daily had, respectively, 7.3% and 10.5% higher ingestion of fresh and minimally processed foods when compared with those who reported consuming no meals on the school menu. Moreover, the participation of ultraprocessed foods in the diet of children who consumed two school meals a day was 18.0% lower than those who did not consume school meals. Among those who consumed three school meals, this decrease was even higher, at 26.0%. There was no difference among the children who consumed only one school meal day (Table 2).

## Discussion

The present study demonstrated that the daily consumption of two or three school meals was associated with a lower consumption of ultraprocessed products and a greater participation of fresh and minimally processed foods in the students' diets, in comparison with those who did not consume school meals. This protective effect was not observed in the comparison among children who consumed only one school meal a day. These findings were identified regardless of the children's gender, age, health vulnerability, and nutritional status. Thus, the study pointed to a possible dose-response effect regarding the protection of students' diet based on the daily consumption of two school meals daily and, thus, highlighted the relevance of the longer school stay as a means of promoting healthy eating.

The greater participation of fresh and minimally processed foods in the diet of schoolchildren consuming two or three school meals a day is a relevant finding for public health. Natural foods of animal origin are great sources of protein, vitamins, and minerals. In turn, fresh fruit and vegetables provide fibers, antioxidants and low caloric density, while cereals contribute to the adequate calorie and complex carbohydrate content in the diet.

**Table 2** Linear regression models for the prediction of consumption of fresh and minimally processed, processed and ultraprocessed food based on the number of school meals consumed in the sample ( $n=1357$ ). Belo Horizonte, MG, Brazil 2013–2015.

Number of meals consumed at school	Fresh and minimally processed		Processed		Ultraprocessed	
	$\beta$ (SE)	$p$ -value <sup>a</sup>	$\beta$ (SE)	$p$ -value <sup>a</sup>	$\beta$ (SE)	$p$ -value <sup>a</sup>
0	0	–	0	–	0	–
1	0.037 (0.03)	0.268	–0.024 (0.06)	0.717	–0.107 (0.07)	0.182
2	0.071 (0.03)	<b>0.046</b>	–0.114 (0.07)	0.130	–0.199 (0.08)	<b>0.024</b>
3	0.100 (0.04)	<b>0.019</b>	–0.149 (0.09)	0.130	–0.302 (0.08)	<b>0.002</b>

$\beta$ , non-standardized beta coefficient; SE, standard error.

Bold values represent statistically significant values at 5% ( $p < 0.05$ )

<sup>a</sup> In all models, there was a log transformation of the dependent variable food consumption (in g/1000 kcal). All models were adjusted by the 2012 Health Vulnerability Index, body mass index-for-age, gender, and age of the child. The standard error was adjusted by clusters of school institutions (26 schools).

Additionally, fresh foods result in a lower environmental impact and are produced by farmers who depend on this production for their survival and, therefore, benefit directly from the higher consumption of these products.<sup>8</sup>

The lower consumption of ultraprocessed food among children consuming two or three school meals a day is an even more relevant result, considering the numerical impact of this reduction – 18.0% for children who consume two meals and 26.0% in those consuming three school meals daily. These products have low nutritional density and are hyperpalatable, which may contribute to nutritional deficiencies, despite the consumption of large amounts.<sup>14,18</sup>

Excessive consumption of ultraprocessed products has been positively associated with the occurrence of dyslipidemia in children,<sup>19</sup> metabolic syndrome in adolescents,<sup>20</sup> and obesity at all age ranges.<sup>21</sup>

Other studies have indicated the protective role of school meals for healthy eating practices.<sup>1,11</sup> A study carried out in a sample of children aged 2–6 years in Caxias do Sul, RS, identified higher energy and lipid consumption in household meals when compared with school meals.<sup>22</sup> Data from the National Student Health Survey (Pesquisa Nacional de Saúde do Escolar [PeNSE]) carried out in 2015 showed lower consumption of sugar, sugary drinks, and processed and ultraprocessed foods among students from public schools when compared with those who attended private schools, a fact that can be explained by the long-term access to PNAE among these students.<sup>23</sup> In a sample of schoolchildren aged 6–14 years of age from Belo Horizonte (MG) participating in the PEI and, thus, consuming more school meals, was associated with more adequate carbohydrate consumption and higher fruit consumption.<sup>24</sup>

Despite this preexisting evidence, the present study was a pioneer in showing that there is a dose-response association between the number of school meals consumed and the participation of fresh and minimally processed, and ultraprocessed foods in the diet of schoolchildren based on the daily consumption of two meals at school. This result has a great implication for public policies in the area of child health, as it indicates the relevance of programs, such as PEI, that extend the child's length of stay at the school environment and the provision of a higher number of meals a day. These programs provide to the students, in addition to school meals, access to educational activities that include food and nutrition information, which may have contributed to the results found.

Additionally, the relevance of PNAE investments was demonstrated, aiming to further improve its effectiveness, as a program to promote food and nutritional security.<sup>11,25</sup> Under the current program legislation, fresh and minimally-processed foods are prioritized, since at least three portions of fruit and vegetables (or 200 g) must be provided in school meals per student per week and 30% of all the resources destined to PNAE must be used in the acquisition of products from family agriculture. Ultraprocessed products, such as beverages with low nutritional value, canned foods, processed meats, and sweets, are prohibited or have a restricted participation in the school menu.<sup>26</sup>

The study also highlights the importance of encouraging healthy eating at home, since the findings indicate that the differences in the consumption of food groups among children can be explained by the higher consumption of school

meals. It is therefore challenging and urgent to include parents and caregivers in child nutrition interventions aiming to improve the supply of fresh and minimally processed foods and limit ultraprocessed food consumption also in the children's homes.

Finally, it is worth mentioning the study limitations, which include the inability to generalize the results obtained to the entire population of schoolchildren in Belo Horizonte, with external validity only for students attending the fourth year of municipal schools in this city, and the possibility of bias due to the application of the 24hR to children aged 9–10 years of age, considering the challenge of obtaining reliable data on food consumption in this age group, due to restricted cognitive and memory abilities, as well as knowledge in nutrition.<sup>27</sup>

Nonetheless, the literature shows good quality in the food consumption report by children of that age when compared to the results obtained from direct observation methods and the doubly labeled water (DLW) technique.<sup>28</sup>

Additionally, the sociodemographic evaluation of the children was performed based on the IVS-2012, since it was not possible to obtain socioeconomic information directly from the students' reports, and the study assessed the subjects' reports regarding the number of usually consumed school meals.

Nevertheless, the study contributes to the knowledge about effective actions and strategies for the practice of a healthier and less processed-food diet, which is essential for coping with the high prevalence of obesity among children and adolescents in Brazil. The continuing investigation in this line of research may show that students who remain full-time at school and consume all school meals actually ingest less processed food and have a better nutritional status than students who do not consume school meals or who remain at school part-time.

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## Conflicts of interest

The authors declare no conflicts of interest.

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