



Nutritional Status and Food Consumption of Preschool-age Children: An Observational Cross-Sectional Study Carried Out in Schools Covered by the Brazilian School Feeding Program

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Abstract

Introduction: Excess weight in children is a complex and multifactorial condition, resulting from the interaction between genetic and environmental factors. For the treatment and prevention of obesity in childhood, an effective intervention must involve the main relationships and contexts in which the individual is inserted, such as the family and school environment. In Brazil, the National School Feeding Program (PNAE) is an important tool for the prevention of childhood obesity in the country, since the program aims to provide healthy school meals and food and nutrition education to students of all ages enrolled in public schools. **Objective:** This study aimed to identify the excess weight prevalence and analyze the food consumption of preschool-age students enrolled in schools registered in the National School Feeding Program in Sertãozinho-SP. **Methods:** This descriptive, observational, cross-sectional study was approved by the Research Ethics Committee of Ribeirão Preto Medical School, University of São Paulo (CAAE 53673421.0.0000.5440; Opinion No. 5.229.786). Written informed consent was obtained from the parents or legal guardians of all participating children, and age-appropriate assent was obtained from the children before participation. The preschool children underwent measurements of weight, height, triceps skinfold thickness, and abdominal circumference. A validated quantitative food frequency questionnaire was used to collect food

consumption data. **Results:** 153 students were included in the sample, 81 (52.94%) were boys and 72 (47.06%) were girls. In total, 109 (71.24%) children were between 4 and 5 years old. According to the Body Mass Index (BMI) classification for age, 1 (0.65%) child presented the situation of severely thin, 10 (6.54%) students were classified as thin, 89 (58.17%) were eutrophic, 12 (7.84%) at risk of overweight, 22 (14.38%) with overweight, 12 (7.84%) with obesity and 7 (4.58%) with severe obesity. A significant association was found between the variables BMI for age and tricipital skinfold ($p < 0,0010$), and the same association was observed for Abdominal Circumference measurements ($p < 0,001$). Regarding food consumption, it was found that for vegetables, frequency of consumption equal to or less than 1 to 3 times a month was the most mentioned by the majority of the guardians. Among the sugar, sweets, and snacks groups, more than 50% of respondents reported consuming powdered chocolate (63%) and sugar (53%) at a frequency greater than or equal to 2 to 4 times a week. **Conclusion:** A high prevalence of overweight was found, approximately 35%. Severe thinness and thinness conditions were observed in 7% of children. Furthermore, a low frequency of vegetable consumption and a high intake of ultraprocessed foods were observed.

Keywords: Obesity in Childhood. Childhood Overweight. Child Nutrition Disorder. Preschool Child.

Introduction

Obesity is a chronic disease characterized by excessive body fat accumulation in quantities that might compromise health [1], contributing to increased mortality and premature deaths, as excess weight is a significant risk factor for the emergence of diseases such as type 2 diabetes mellitus, high blood pressure, dyslipidemia, myocardial infarction, stroke, and other chronic non-communicable diseases [2]. Excess weight in children is associated with comorbidities that affect almost every organ and physiological process in the body, including the endocrine, gastrointestinal, pulmonary, cardiovascular, muscle, and bone systems [3-5].

In recent decades, the overweight and obesity prevalence among children over the age of 5 has grown significantly, increasing from 4% in 1975 to 18% in 2016, becoming a severe global public health problem [6]. In 2020, worldwide, nearly 39 million children aged up to five years old worldwide were identified as either overweight or obese [6,7]. In Brazil, 3 in 10 children aged between 5 and 9 years old are overweight and it is estimated that, by 2030, the obesity prevalence in this age group will be greater than 20% [8].

In light of this situation, it is important to assess the quantity and quality of food consumed by the pediatric population in their first years of life, to gather the information that can be used in obesity prevention programs. Eating habits develop from the beginning of life and both behavior and food preferences are influenced by several factors of biological, social, and environmental origins, determining the quality of the diet [9,10].

The purpose of this study was to identify the prevalence of excess weight and analyze the food consumption of preschool-age students, enrolled in municipal schools in Sertãozinho (SP), and registered in the National School Feeding Program.

Material and Methods

Study Design

A cross-sectional, observational, and descriptive study with a probabilistic and randomized sample of children aged between 3 and 6 years, enrolled in municipal school units listed in the School Census of the National Education Development Fund as served by the National School Feeding Program (PNAE), in the city of Sertãozinho (SP), during 2021.

Sampling and Participants Eligibility

For the sample calculation, the population size of 2,750 preschool-aged children in these units was considered, estimating the prevalence of around 30% of preschool-age children in the city with an overweight diagnosis, according to the data extracted from the Food and Nutrition Surveillance System (SISVAN) [11]. Accepting a tolerable absolute error of 5% and a confidence coefficient of 95%, the estimated necessary sample was 289 children. The existence of chronic diseases or those that interfere with growth and that could hinder the assessment of nutritional status was adopted as an exclusion criterion. The schools were sampled in a probabilistic and random manner based on the total number of preschools in the city, with the sampling unit being the preschools that were drawn consecutively until the number of participants estimated by the sample calculation was fulfilled. Considering the frequent absences of students in the aforementioned age group and the difficulties in obtaining questionnaires completed by family members, a total of 153 children were included in the study.

Anthropometric Data Collection

The anthropometric assessment was performed by measuring weight (kg) and height (m) to calculate the body mass index [$BMI = \text{weight (Kg)} / \text{height (m)}^2$], adopting the World Health Organization standards as the standard for these measurements (WHO) [12]. To obtain the weight, a portable digital scale, model Tecsilver, from the Techline® brand, was used, with a capacity of 100 kg and 100 g of precision. The child was weighed without shoes and with as little clothing as possible, standing on the scale, adopting an upright position and arms along the body [13]. Height was obtained using a scientific stadiometer model ES-2040, from the Sanny® brand, graduated in centimeters and millimeters. To this end, the child was barefoot, with light clothing and loose hair, standing erect, head up, looking at a fixed point at eye level, heels together, and arms extended along the body [13].

The triceps skinfold thickness was measured on the posterior aspect of the arm, parallel to the longitudinal axis, at the point that comprises the halfway distance between the superolateral edge of the acromion and the olecranon. To obtain the triceps skinfold thickness, children were instructed to stand with the arm flexed towards the chest, forming a 90° angle. At this moment, the midpoint between the acromion and olecranon was determined using a flexible and inelastic graduated tape measure in

millimeters (mm). The measurement of triceps skinfold thickness was performed using a Cescorf® scientific skinfold caliper, with a sensitivity of 0.1mm, a reading range of 85 mm, and a pressure of 10g/mm². The classification of triceps skinfold thickness adequacy was based on the reference proposed by Frisancho (1990) [14].

Abdominal circumference was measured in centimeters with the child in an upright position, with the abdomen relaxed (at the end of expiration), arms extended along the body, and legs closed. An inelastic graduated tape measure in millimeters was positioned on the skin at the space corresponding to the smallest circumference between the iliac crest and the costal margin. The reference used for abdominal circumference assessment is that proposed by Freedman [15].

Food Consumption Data Collection

To collect data on food consumption, a quantitative food frequency questionnaire was used, validated, and developed to assess the common consumption of children aged between 2 and 5 years [16].

Statistical Analysis

For the procedure of Statistical analysis anthropometric measurements were transformed into z-scores based on the WHO [12] reference with the help of WHO Anthro and WHO Anthro Plus software, for subsequent classification of nutritional status and analysis. Statistical analyses were performed using the free software R (R version 4.2.2). For numerical variables, mean, median and standard deviation were calculated. For categorical variables, frequency and relative frequency were calculated. All statistical tests were evaluated using p-value, with a significance level of 5%. To test the normality of the samples, the Shapiro-Wilk test was used. For nominal variables that split the population into two categories and a numerical variable to be compared, the T-test was used. The Mann-Whitney test was used for nominal variables that split the population into two categories.

Ethical Approval

The study was approved by the Research Ethics Committee of Ribeirão Preto Medical School, University of São Paulo (CAAE 53673421.0.0000.5440; Opinion No. 5.229.786). Written informed consent was obtained from the parents or legal guardians of all participating children, and age-appropriate assent was obtained from the children before any study procedures were performed.

Results

Among the 153 children included in the study, 81 (52.9%) were male and 72 (47.1%) were female, with the majority, 109 (71.2%), aged between 4 and 5 years old. According to the weight-for-age classification, 125 (81.7%) had an adequate weight for their age, while 28 (18.3%) were overweight for their age. The vast majority of children (99.3%) had adequate height for their age, with a z score ≥ -2 . Only one child (0.65%) was short for their age, being classified between $\geq$ z score -3 and $<$ z score 2.

The average BMI found in the sample was 16.2 kg/m², with the average being 15.2 kg/m². Regarding the BMI for age classification for all ages, in total, 1 (0.65%) child was severely thin, 10 (6.54%) were classified as thin, 89 (58.1%) were eutrophic, 12 (7.8%) were at risk of being overweight, 22 (14.3%) with overweight, 12 (7.8%) with obesity and 7 (4.5%) with severe obesity. No statistical evidence was found through the Spearman correlation test to reject the null hypothesis of no correlation between age and BMI z-score by age among the study participants ($p=0.736$). The coefficient of determination was also calculated, indicating 0.08% of shared variance between the two variables, suggesting an absence of correlation. Table 1 and Table 2 show the distribution of nutritional status according to Body Mass Index (BMI) for age, based on cut-off points proposed by WHO, 2006 [12] for children up to 60 months and WHO, 2007 [17] for students with 61 months to 6 years.

Table 1. Classification of nutrition status in preschool-age children (Birth to 60 months) based on body mass index (BMI) for age according to WHO, 2006 [12].

Condition	Cut-off	Gender		Total
		Females	Males	
		30 (46.87%)	34 (53.12%)	64 (100%)
Possible risk of overweight	> 1 SD	5 (16.66)	7 (20.58)	12 (18.75)
Overweight	> 2 SD	2 (6.66)	3 (8.82)	5 (7.81)
Obese	> 3 SD	1 (3.33)	1 (2.94)	2 (3.12)
Adequate	> -2 to < 1 SD	21 (70.00)	20 (58.82)	41 (64.06)
Thin	< -2 to -3 SD	1 (3.33)	3 (8.82)	4 (6.25)
Severely thin	< -3 SD	0 (0.00)	0 (0.00)	0 (0.00)

Source: Own authorship.

Table 2. Classification of nutrition conditions in preschool-age children (61 months to 6 years) based on body mass index (BMI) for age according to WHO, 2007 [17].

Condition	Cut-off	Gender		Total
		Females	Males	
		43 (46.23%)	50 (53.76%)	93 (100%)
Overweight	> 1 SD	8 (18.60)	9 (18.00)	17 (18.27)
Obese	> 2 SD	7 (16.27)	10 (20.00)	17 (18.27)
Adequate	> -2 to < 1 SD	26 (60.46)	26 (52.00)	52 (55.91)
Thin	< -2 to -3 SD	2 (4.65)	4 (8.00)	6 (6.45)
Severely thin	< -3 SD	0 (0.00)	1 (2.00)	1 (1.07)

Source: Own authorship.

Regarding to the classification of triceps skinfold thickness, it was observed that the majority of evaluated children, 130 (82.80%), had measurements between the 5th and 95th percentiles, what is considered appropriated. Additionally, it was found that 4 (2.54%) and 19 (12.10%) of the participants were classified with triceps skinfold thickness below the 5th percentile and above the 95th percentile, which are risk ranges for malnutrition and obesity, respectively. In the sample, it was noticed that 21 (13.37%) of the children had abdominal circumference values above the 90th percentile, exceeding the recommended values for this measurement.

In the correlation test between the measurements obtained for triceps skinfold thickness (mm) and BMI z-score by age, a direct relationship between the variables was observed ($p < 0.001$). The correlation test rejected the null hypothesis of no correlation ($p\text{-value} < 0.001$), indicating a direct and significant relationship between the variables BMI by age and abdominal circumference. In other words, a higher BMI z-score corresponds to larger abdominal circumference measurements.

The assessment of food consumption was conducted according to the different food groups, with those consumed with a frequency equal to or greater than two to four times a week being cooked rice (94%), beans (77%), and bread (65%). Regarding the intake of vegetables, it was found that only tomatoes are consumed with a frequency equal to or greater than 2 to 4 times a week. For the other foods in the group, the frequency of consumption equal to or less than 1 to 3 times a month was the most mentioned by the majority of the guardians. More than half of those responsible reported that the consumption of bananas (69%), apples/pears (60%), fruit juice (56%), oranges (53%) and orange juice (52%) happen equal to or more than 2 to 4 times a week. Papaya and guava did not present a high frequency of consumption, and for these fruits, more than 85% reported intake equal to or less than 1 to 3 times a month.

Regarding the consumption of foods belonging to the meat and egg group, the foods eaten most frequently by more than half of the children were chicken (64%), eggs (60%), steak (56%), and cooked meat (56%). The least frequently consumed items were fish (71%) and beef liver steak (87%). Milk was the food consumed most frequently, with 80% reporting consumption equal to or greater than 2 to 4 times a week. Among the sugar, sweets, and snacks groups, more than 50% of respondents reported

consuming powdered chocolate (63%) and sugar (53%) at a frequency greater than or equal to 2 to 4 times a week. The frequency of consumption for foods that make up the savory and preparations group was low, less than 50% for all items. Savory foods such as cheese bread, pastries, and *coxinha* [a typical Brazilian dish similar to a chicken croquette] are the foods most frequently consumed by the participants, with 42% of children eating such foods at a frequency equal to or greater than 2 to 4 times a week. The most consumed drink was water, with 99% of participants reporting drinking more than twice a day. Soda and artificial juice are consumed more frequently than or equal to 2 to 4 times a week by 47% and 44%, respectively.

Discussion

In this study, 153 children were evaluated, with an average age of 4.8 years, with a predominance of boys (52.9%) over girls (47.1%). Correlation tests found no significant association between age or gender and BMI-for-age z-score.

Regarding the characterization of the children's nutritional status, anthropometric data, and the classification of BMI for age, in total 7.2% of the children assessed were severely thin or thin, 58.1% were eutrophic and 34.5% were classified as excess weight, which was obtained by summing the prevalence of risk of overweight (7.8%), overweight (14.3%), obesity (7.8%) or severe obesity (4.6%). Similarities with this distribution were found in a systematic review and meta-analysis study on childhood obesity in Brazil, in which it was found that the general prevalence of obesity in children aged from 6 to 9 years, in the period between 1986-2015, was 8.2%, with increasing trends in these frequencies, and in the 2010s the prevalence of obesity among children was 12%, mainly in the most economically developed regions of the country [18].

In another study conducted in the countryside of São Paulo state, with children aged between 2 and 3 years, an overweight prevalence was found to be 28.86% and 0.89% of children with below ideal weight [19]. The data regarding weight deficit obtained in the present study are striking, since they are higher than those verified in the aforementioned research and are greater than the frequency reported in reports on the nutritional status of children under 5 years of age from the Food and Nutrition Surveillance System (SISVAN), which was 5.49% of children with thinness or severe thinness in the state of São Paulo [19,20].

About the values of triceps skinfold thickness, it is noteworthy that ranges between the 5th and 15th percentiles, and the 85th and 95th percentiles,

warrant careful monitoring, as they signify risk categories for undernutrition and obesity, respectively [21]. Abdominal circumference indices above the 90th percentile were observed in a portion of 13.37% of the children evaluated, who are also indicated for nutritional monitoring since abdominal circumference has an important correlation with the development of chronic non-communicable diseases, such as dyslipidemia, high blood pressure, and insulin resistance [21].

In the correlation test between the triceps skinfold thickness values and BMI z-score for age, a significant association was found, with the two variables directly related, that means, as the BMI z-score for age increases, the triceps skinfold thickness measurements are also higher, similar behavior was observed between abdominal circumference and BMI z-score for age.

The data cited reinforce the idea that the measurements obtained through triceps skinfold thickness measurement allow a good prediction of body fat percentage and nutritional status for the pediatric population in research and clinical environments, being an important complement to BMI limitations in the assessment of adiposity in lean children [22].

Regarding food consumption, the WHO considers the intake of fruits and vegetables to be a key factor in the protection and prevention of chronic non-communicable diseases, such as cardiovascular and neoplastic diseases. The current recommendation for the consumption of these foods is 400g/day, on five or more days a week [23]. In Brazil, it was found that the daily consumption of fruits and vegetables is below recommendations, corresponding to around a quarter of the recommended amount [24].

The low consumption of vegetables was also found in the present study, with the majority of foods included in the questionnaire being consumed less than or equal to 1 to 3 times a month by more than 50% of the participants and, given the relevance of such foods in preventing diseases and improving quality of life, it is necessary to continue monitoring food consumption for possible interventions aimed at increasing the intake of such foods. The fruit consumption found in this study, nevertheless, can be considered higher in comparison to vegetables, since for more than 50% of participants the intake occurs more frequently than 2 to 4 times a week. The results found in this study are similar to those found among the Brazilian population of the same age group [24].

Ultra-processed foods, also known as *junk food*,

such as sandwich cookies, chocolates, snacks, soft drinks, and processed juices were described as having a high consumption frequency, being eaten more than once a week by more than 50% of children, which can be explained because, commonly, the foods preferred by children are those with a sweet taste and high calories. This preference occurs due to the attachment to the sweet taste being innate and more pleasant to human beings [21]. Furthermore, recent studies on how the pandemic caused by COVID-19 impacted food consumption, it was found that social isolation contributed to an increase in the consumption of ultra-processed foods [25,26].

The high consumption of junk foods is concerning, since these foods are associated with obesity due to their high energy content, excessive amounts of fat and sugar, chemical additives, and sodium, in addition to the low fiber and nutrient content, characteristics capable of increasing the food intake through palatability and reduction of satiety mechanisms [27]. Another concern with food consumption is related to the sugar intake increase among children and the reduction in fruit and vegetable consumption [28-29]. In the United States, 60% of children do not consume fruit following daily recommendations, while 93% eat insufficient amounts of vegetables. The aforementioned problem occurs similarly in Europe and other parts of the world [30,31].

The consumption of drinks rich in sugar, including fruit juices, is also a key factor that largely contributes to the development of obesity in children, because sweetened drinks are highly caloric and do not contribute to satiety, in addition to being poor in nutrients and fiber [27]. In research conducted with the United States population, it was concluded that sugary drinks contribute, on average, 270 kcal/day, representing approximately 10 to 15% of daily caloric intake [32].

With the greater availability of food in Brazil in recent years, there has been a notable increase in the consumption of ultra-processed foods, accompanied by a decrease in the intake of fresh and minimally processed foods [33,34]. Currently, ultra-processed foods represent more than a fifth of the calories purchased by households in Brazil, a worrying fact, since the consumption of these foods generates negative consequences for health, such as an increase in chronic non-communicable diseases prevalence and excess weight [33-35].

This study had limitations regarding the age range and small sample size, as it was conducted only with children enrolled in municipal preschools, not

reflecting the real distribution of the general population of the city. Furthermore, any omission of data may interfere with obtaining more reliable results. However, it stands out as having great relevance for the discussion on the development of public policies aimed at controlling and preventing obesity in children at the municipal and even national level, which used food consumption and not nutrient measures, given that Brazil is still considered a country with an emerging economy, marked by discrepant social inequalities, where national surveys to assess obesity and health conditions, especially in the pediatric population, are still little conducted [18], with irregular frequency and, often, end up being obsolete or with outdated data, which makes it difficult to assess this important public health problem further.

Conclusion

The children evaluated in the present study were aged between 3 and 6 years. The prevalence of early overweight was found in approximately 35% of participants, and this percentage is considered high and includes students classified as at risk of overweight, overweight, obesity, and severe obesity. Severe wasting and emaciation were observed in around 7% of the children evaluated. Regarding food, a low frequency of consumption of vegetables was observed among the children evaluated, and a high intake of ultra-processed foods, belonging to the sugar, sweets, and snacks group.

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Ethical Approval

The study was approved by the Research Ethics Committee of Ribeirão Preto Medical School, University of São Paulo (CAAE 53673421.0.0000.5440; Opinion No. 5.229.786).

Informed Consent

Written informed consent was obtained from the parents or legal guardians of all participating children. Age-appropriate assent was also obtained from the children before participation.

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Data Sharing Statement

No additional data are available.

Conflict of Interest

The authors declare no conflict of interest.

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