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Original Article

School food in child daycare centers: Poor in macro and micronutrients

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SUMMARY

Background & Aims: School food nutritional composition is important to guarantee the feeding and nutritional health of the children who attend early education institutions. In this way, we aimed to evaluate the school feeding, about the supply of energy and nutrients of school meals and verify compliance with the recommendations of the Brazilian National School Feeding Program (PNAE).

Methods: Cross-sectional study that evaluated the school food supply to children from six-to-56 months old in child daycare centers, from February to September 2014, for two non-consecutive days, by means of direct individualized weighing of all meals prepared by the schools. Energy, macronutrients, calcium, magnesium, iron, zinc, vitamins A and C, and fiber were analyzed. Data were shown as median, interquartile range and compared to PNAE recommendation.

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Results: We found that 767 children participated in the study. In full-time care, only the supply of calcium and zinc to 6–11 months old met the minimal recommendations of PNAE, whilst for 1–3 years old children, only vitamin C and zinc reach that. In part-time care, none of the nutrients for children from 1-3 years met the minimum recommended by PNAE, whilst for children older than 3 years, only the supply of vitamin C met the recommendations.
Conclusion: The current evaluation shows that the nutrient supply was insufficient to reach the desired PNAE's parameters in both, part- and full time. In order to promote an adequate nutritional status and healthy food consumption, the need for improvement of school nutrient supply is indisputable. Furthermore, this study points to the need for monitoring the quantity and quality of the food supplied by the school, to guarantee the food and nutritional safety of this population.

Introduction

Adequate feeding in infancy is essential for the maintenance of health in the short and long term [1]. The formation of eating habits begins in the first years of life and involves a complex network of both genetic and environmental factors [2]. The innate preference for sweet taste is genetically determined, however, the environment in which the child lives, whether home or school, exerts a strong influence on the formation of eating habits due to its role of choice, preparation and supply of food to the child, as well as in relation to the eating behavior of the people responsible for food supply [2,3].

In Brazil, basic education includes early childhood education, elementary education and high school. Early childhood education, the first stage of basic education, is offered in day care centers and pre-schools, also known as Municipal Child Daycare Centers (CMEIs - *Centros Municipais de Educação Infantil*) where service is offered by the state. Generally, daycare centers are characterized as non-domestic institutional spaces constituted in public or private educational establishments that educate and care for children from zero to 5 years of age in daytime, full or part time, regulated and supervised by competent body of the Brazilian education system [4].

There are, in Brazil, more than 5 million children enrolled in daycare centers/preschools, which benefit from the National School Feeding Program (PNAE - *Programa Nacional de Alimentação Escolar*) [5]. PNAE provides free food for students of all degrees of public basic education during their stay in school. According to its regulation, all children attending CMEIs have the right to receive school feeding, with no costs, to supply their nutritional needs during period they are at the daycare center. For part-time staying, CMEIs should provide at least two meals for children, while for a full-time staying, it should be at least four [6,7].

The nutritional status of Brazilian children has been changing the last decades, with a reduction in the prevalence of low height-for-age and an apparently plateau in the obesity rates [8]. On the other hand, the iron-deficiency anemia prevalence is high [9] while micronutrient intake (including iron) is low and the energetic consumption is high [10]. It is observed a greater relative participation of ultraprocessed food to the detriment of lower consumption of natural and minimally processed foods in the diet of children younger than 6, and it increases with age [11].

PNAE recommends that the school food must provide 70% of the dietary reference intake (DRI) for the children who stay full-time in school, whilst those who stay part-time must receive 30% of the DRI. The recommended values are explicitly expressed in the Program's resolutions [6,7]. Considering

Brazilian population is experiencing a double burden of malnutrition [12], PNAE regulations show the importance of school trying to guarantee Food and Nutritional health of the children [13].

Most of the studies conducted in Brazil in school environments analyzed the energy and nutrients intake at school, comparing with international nutritional recommendations. However, rare are the studies that analyzed the individual supply of food, the nutritional composition and if the schools are meeting the recommendations of PNAE.

Considering the importance of the school food nutritional composition to guarantee the feeding and nutritional health of the children who attend early education institutions, the aim of the present study was to evaluate the food and nutrient supply of school food in the five municipal child daycare in Guaratuba (Paraná, Southern Brazil) and if it meets the recommendations of PNAE.

Methods

This is a cross-sectional school-based study that is part of a broad project entitled "Food and Nutrition Security in the School Environment", which aims to evaluate the food consumption of children attending CMEIs in municipalities in the state of Paraná, south of Brazil. In this country, CMEIs are the main public education policy to assist children in the age group studied.

The present study was conducted in the municipality of Guaratuba, Paraná coast, with children. Inclusion criteria were children from six to 56 months old, both male and female, who attended to CMEIs in the municipality of Guaratuba full or part-time. Exclusion criteria: 1) individuals who received exclusively breastfeeding, as defined by the World Health Organization [14]; 2) children with specific nutritional needs, such as celiac disease, diabetes, hypertension, allergies and food intolerances; 3) children with missing data for socioeconomic, demographic and health information; and 4) children with no food consumption data for one or two days. All the eligible children were included. In 2013, a pilot study was conducted to standardize the methods to be used, in which researchers and the field team spent two weeks in a CMEI to test the instruments, evaluate the standardized procedures and adjust the logistics of the fieldwork.

Data collection

The data collection was carried at all the five existing CMEIs in the city out from February to September 2014, from Monday to Friday. A theoretical and practical training has been given to the interviewers to standardize their performance and the procedures of data collection about food consumption. The training was offered by a team of nutritionists from the Federal University of Paraná research reference center, based on the pilot study experience.

Socioeconomic, demographic and health data were collected directly at the CMEIs through interviews with the parents (95.6%) or guardians (2.8% of grandmothers, and 1.6% of other guardians, such as sisters, aunts, and guardianship council professionals). Whenever available, the child health card was used to extract data from birth. Data were collected as continuous variables and were later categorized: age of the child (<2 years and 2–4.66 years); gender (female and male); birth weight (<2500g and $\geq$ 2500g); maternal age (<20 years and $\geq$ 20 years); and maternal schooling (<11 years and $\geq$ 11 years).

Data on weight and height were measured in duplicate. Weight was measured in kilograms using a calibrated digital scale, model Glass-6, accuracy: 100 g (G-Tech®, USA), whereas height was measured in centimeters using a portable stadiometer affixed to the wall without base board, model 206, accuracy: 1 mm (Seca®, USA). Height data for children younger than 2 years were adjusted by adding 0.7 cm to the measurement [15] since children in this age group should be measured in the recumbent position.

The classification of nutritional status was determined based on z-score values of body mass index (BMI)-for-age and cutoffs proposed by the World Health Organization [14] (<−2 SD; ≥−2 SD and ≤+1 SD; >+1 SD and ≤+2 SD; >+2 SD). Children were then categorized as underweight, normal weight, overweight or obese, respectively.

School meals supply data were collected through direct food weighing for two non-consecutive days in each CMEI [16]. This study evaluated food consumption at school, considering only meals

offered by the CMEIs. When children were receiving formula along with complementary feeding, their parents sent formula cans to be served to them during the day in the CMEIs. In these situations, formulas were included in our evaluation. For meals made in the CMEIs, we weigh all the ingredients used. After food handling, we weigh up the final plate to verify its yield.

During the meal service, all the eating utensils were identified with the children names, to control the individual food consumption. All food offered in breakfast, lunch, afternoon snack, and dinner was weighted. Solid foods were weighted separately, one by one (rice, beans, meat, vegetables, snacks and other packaged foods etc.), as they were being served on the children's plates, on a digital scale of the brand Plena® (Brazil) with capacity of 5kg and precision of 1g. Drinks (such as juice and formula) were measured in a graduated test tube, with capacity of 250mL and division of 10mL. All food and/or drink repetition and/or waste were individually weighted. The total amount of food and drink consumed by each child was calculated by adding repetition portions and subtracting wasted food from the first portions served.

Analysis of collected data

Socioeconomic, demographic and health data collected were uploaded at the digital storage service *Google Drive*®, with a double upload as to minimize errors. Data on food supply were double-typed, inserted into the *Brazil Nutri*® software and analyzed using the Food Composition Table of the Brazilian Institute of Geography and Statistics [17]. For packaged foods (including formulas), the data contained in the products nutritional tables were used.

The average nutritional composition of school food supplied by the CMEIs was compared to PNAE recommendations [7] for energy, macronutrients, vitamins A and C, calcium (Ca), magnesium (Mg), iron (Fe), zinc (Zn), and fiber, according to age range (6–11 months, 1–3 years, and> 3 years). The analysis was also stratified by the children's length of stay in the CMEIs, because school feeding should provide more nutrients for children who stay full-time at school than for those attending part-time [7].

The average energy and nutrients supply for each child was obtained by the arithmetic mean of the two collected days. Because of the non-parametric behavior of the children intake, the amount of energy and nutrients supply by CMEIs was obtained by the median values found for all the children, stratified by age group and length of stay.

Data were analyzed in the statistical software *Statistical Package for Social Sciences - SPSS*®, version 20.0. The variables of the characterization were presented in absolute (n) and relative (%) numbers. The variables of food consumption were shown as median, interquartile range and percentage of the PNAE recommendation that was met by the median offered. Nutrient offer was considered sufficient when it reached PNAE recommended values (100%) or more.

Ethical aspects

This study was conducted according to the Declaration of Helsinki and all procedures involving human subjects were approved by the Committee on Ethics in Research in Human Beings of the Health Science Sector of the Federal University of Paraná (UFPR - *Universidade Federal do Paraná*), CAAE n. 11312612.5.0000.0102 and advice n. 316.185. Written informed consent was obtained from parents or children's caregivers.

Results

In 2014, the five CMEIs in the city of Guaratuba took care of 767 children ranging from six to 56 months old part-time (in the morning or in the afternoon) or full-time (the child stays morning and afternoon at school). For children attending school part-time, one or two meals were provided a day for the morning shift (breakfast or breakfast and lunch) and one or two meals a day for the afternoon shift (afternoon snack or afternoon snack and dinner). Still in 2014, CMEIs took care of children from zero to three years old full-time to which there were provided four meals a day: breakfast, lunch, afternoon snack and dinner (Table 1).

Table 1
Scheme of meals offered to children under 5 years old attending Municipal Child Daycare Centers, according to time scale and age group. Guaratuba, Paraná, Brazil, 2014

	Time scale	Number of children			Offered meals
		6–11 m	1-3 y	> 3y	
Full-time	7 a.m. to 6 p.m.	57	374	0	Breakfast, morning snack, lunch, afternoon snack, and dinner
Part-time	7 a.m. to 12 noon, or 1 p.m. to 6 p.m.	0	174	52	Breakfast or breakfast and lunch Afternoon snack or afternoon snack and dinner

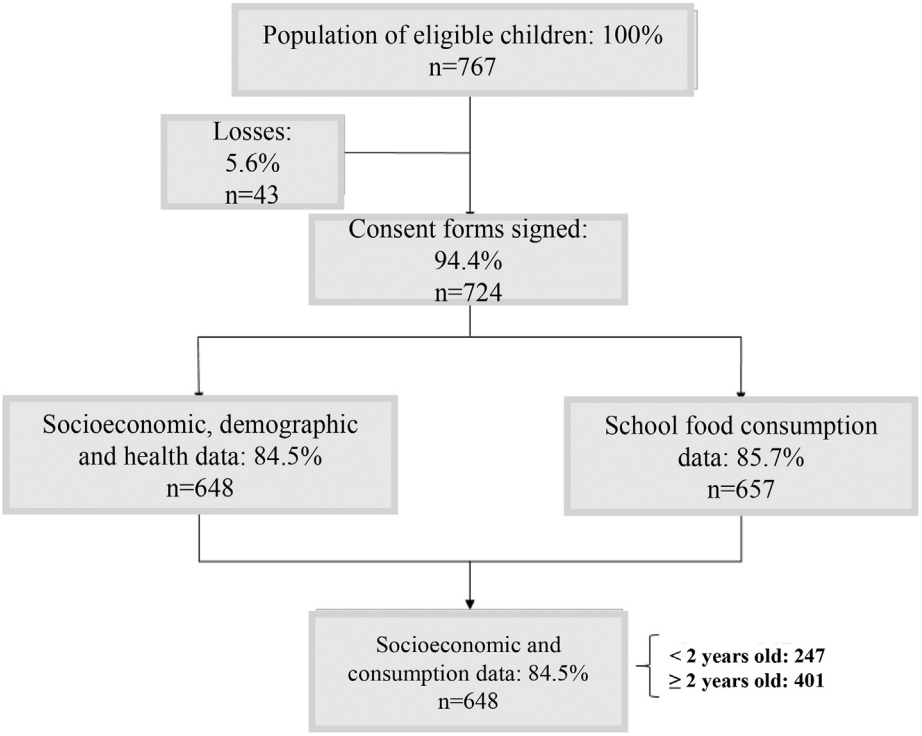

Fig. 1. Flowchart of eligible and included subjects. Guaratuba, Paraná, Brazil, 2014.

Fig. 1 shows the number of participant children in each stage of the research. There was a loss of 43 children (5.6%) due to them being in exclusive breastfeeding or not being present in the two days of data collection. Since data collection was conducted inside the schools, we achieved a good participation rate. At the end, children with data for food consumption but not for socioeconomics, demographics and health data were excluded, and the final sample totalized 648 participants.

Characterization of the study population

Table 2 shows the characterization of the study population. The majority of the children were male (n = 350), older than 2 years old (n = 401), who had adequate birth weight (n = 588) and birthed to non-adolescent mothers (n = 595) with less than 11 years of study (n = 408).

Table 2
Socioeconomic, demographic and health characteristics of children under 5 years old attending Municipal Child Daycare Centers. Guaratuba, Paraná, Brazil, 2014

Characteristics[a]	n (%)
Sex	
Female	298 (46.0)
Male	350 (54.0)
Age	
< 2 years	247 (38.1)
≥ 2 years	401 (61.9)
Weight at birth (n= 644)	
< 2,500g	56 (8.7)
≥ 2,500g	588 (91.3)
Nutritional status (n = 652)	
Underweight-to-age	9 (1.4)
Normal weight-to-age	529 (81.1)
Overweight-to-age	101 (15.5)
Obese-to-age	13 (2.0)
Maternal age at the time of interview (n = 647)	
< 20 years	53 (8.2)
≥ 20 years	594 (91.8)
Maternal education (n = 633)	
< 11 years of study	398 (62.9)
≥ 11 years of study	235 (37.1)

[a] Variables had missing data. The numbers in parentheses next to the variable's labels refer to the number of answers in each one.

Food supply at CMEIs

We followed the school feeding for 52 days in the municipality, 10 days at each CMEI in average. For the children who attended CMEIs full-time, it was observed that the four meals recommended by the PNAE were supplied in all of the data collection days. In the same way, the two meals recommended to those less than 3 years old who attended CMEIs part-time were supplied. However, for those older than 3 who attended part-time, only one CMEI supplied two meals, the minimum recommended by PNAE. The other CMEIs supplied only one meal a day.

In Table 3 we present the medium portions offered to children in each meal, separately for the age groups. The menu was similar among the CMEIs, because they follow a municipality's standardization. We can see in Table 3 the small number of food items, which are repeated over the weeks. Table 4 shows the median of energy and nutrients supplied by the municipality's school feeding, the interquartile range, the nutritional recommendations of PNAE and the percentage of the recommendation that is met by the median of the energy and nutrients offered by the CMEIs, stratified by length of stay in the CMEI and age group.

Among children younger than 1 year old attending full-time, most of the nutrients did not meet the requirements of the PNAE. Iron supply was the lowest, reaching 39% of the minimum value recommended by law. Only the supply of Ca and Zn met the minimum recommendations. For the age group of 1–3 years in full-time, only vitamin C and Zn reached the minimum recommendations of the PNAE, while Fe and fiber offered reached less than 50% of the recommended amount.

Among children from 1 to 3 years attending part-time, none of the nutrients was supplied according to the minimum recommended by law. Vitamin A, Fe and fibers reached less than 35% of the recommendations, while energy and carbohydrates were below 50%. For those who were older than three, in part-time, only vitamin C met the minimum recommendation of PNAE. Ca, Fe and fibers reached less than 50% of the recommended values.

Table 3
Median portions offered to children attending Municipal Child Daycare Centers, according to meal and age of group. Guaratuba, Paraná, Brazil, 2014

Meal	Food item	Medium portion (g)			
		6–11 months		1–3 years old	
		Mean	SD	Mean	SD
Breakfast	Bread with fruit jelly	13.9	13.6	-	-
	Chocolate milk	122.8	53.5	-	-
	Coffee with milk	103.9	37.7	112.9	13.1
	Bread with margarine	15.6	8.7	16.7	9.3
Morning snack	Bread with margarine	16.3	6.7	27.7	13.4
	Coffee with milk	89.5	31.2	106.8	48.7
	Salty pie	-	-	56.7	26.7
Lunch	Risotto	67.4	23.9	-	-
	Vegetable nuggets	111.9	10.6	-	-
	Meat balls	168.5	40.5	-	-
	Meat in sauce	109.2	54.6	-	-
	Roasted kebab	108.4	13.2	-	-
	Chicken fingers	53.7	52.4	-	-
	Rice	68.5	25.6	63.7	22.6
	Beans	97.8	50.7	127.0	41.6
	Fruits (papaya, banana, apple, watermelon)	35.0	13.1	34.8	12.3
	Ground beef	14.6	4.3	72.2	56.7
	Eggs	139.0	44.5	141.5	45.3
	Leafy	9.2	5.5	13.6	5.8
	Pumpkin	155.4	41.6	158.3	48.1
	Crumbs	93.7	80.9	131.3	37.3
	Legumes	9.0	5.5	7.2	0.8
	Chicken with potatoes	-	-	123.1	79.9
Afternoon Snack	Corn porridge	152.8	41.3	-	-
	Fruits (orange, banana)	22.8	6.8	48.4	15.4
	Cookies/biscuits	10.3	4.1	14.8	8.7
	Fruit juice	74.2	16.1	93.6	29.3
	Milk drink	100.3	36.6	105.0	28.8
	Fruit blended with milk (as milk shake)	60.0	0.0	60.0	0.0
	Cake	23.2	6.3	31.8	17.5
	Bread with fruit jelly	-	-	18.0	2.6
	Tea	-	-	73.6	36.3
	Polenta	-	-	140.8	34.6
	Sausage	-	-	39.3	8.2
	Coffee with milk	-	-	105.8	23.9
	Sweet corn pudding (canjica)	-	-	220.3	107.8
	Cheese bread	-	-	35.0	12.9
	Bread with ham	-	-	43.1	11.8
	Salty pie	-	-	46.0	13.6
Dinner	Polenta	119.2	26.1	-	-
	Meat balls	152.3	18.7	-	-
	Soups	140.7	46.1	184.5	73.2
	Fruits (apple, banana)	29.3	19.4	46.0	13.6

SD, standard deviation.

Discussion

The aim of this study was to evaluate the supply of energy and nutrients of school feeding in the CMEIs of Guaratuba, coast of Paraná, Brazil, and to determine if PNAE recommendations were met. The results show that only the amounts of Ca and Zn were adequate for children less than one year old; Vitamin C and Zn for children between one and three years old who attended the CMEI full-time; and vitamin C for the children over 3 years old. Furthermore, none of the age groups had their PNAE recommendation met for energy, macronutrients, vitamin A, Mg, Fe, and fiber.

Table 4
Amount of energy and nutrients supplied by the school feeding (median and interquartile range), PNAE recommendation and percentage of the recommendation reached by the supplied amount, by length of stay in Municipal Child Daycare Centers, and age group. Guaratuba, Paraná, Brazil, 2014

	FULL-TIME[a]							
	6–11 months (n= 57)				1–3 years (n= 374)			
Energy and nutrients	Supplied median	Interquartile range (p25-p75)	PNAE recommendation	% PNAE recommendation	Supplied median	Interquartile range (p25-p75)	PNAE recommendation	% PNAE recommendation
Energy (kJ/kcal)	1415.1/338.0	(1230.9–1683.1) /(294.0–402.0)	1884.0/450.0	75.1	1723.7/411.7	(1423.5–2106.0) /(340.0–503.0)	2930.8/700.0	58.8
Protein (g/day)	12.0	(10.0–15.0)	14.0	85.7	15.6	(8.1–13.2)	21.9	71.2
Carbohydrate (g/day)	53.0	(46.0–66.0)	73.1	72.5	64.0	(52.3–77.3)	114.9	55.7
Lipid (g/day)	11.0	(8.0–16.0)	11.3	97.3	10.1	(8.1–13.2)	17.5	57.7
Fiber (g)	4.0	(3.0–5.0)	[b]	[b]	3.5	(2.6–4.2)	13.3	26.3
Vitamin C (mg)	27.0	(18.0–43.0)	35.0	77.1	18.5	(8.8–34.7)	12.0	154.2
Vitamin A (mcg)	243.0	(174.0–404.0)	350.0	69.4	142.8	(90.0–211.8)	210.0	68.0
Calcium (mg)	277.0	(225.0–449.0)	189.0	146.6	189.8	(129.9–285.4)	350.0	54.2
Magnesium (mg)	45.0	(37.0–52.0)	54.0	83.3	50.6	(41.9–62.7)	56.0	90.4
Iron (mg)	3.0	(2.0–7.0)	7.7	39.0	2.2	(1.7–2.7)	4.9	44.9
Zinc (mg)	3.0	(2.0–4.0)	2.1	142.9	2.7	(2.2–3.4)	2.1	128.6
	PART-TIME[a]							
	1–3 years (n= 174)				> 3 years (n= 52)			
Energy and nutrients	Supplied median	Interquartile range (p25-p75)	PNAE recommendation	% PNAE recommendation	Supplied median	Interquartile range (p25-p75)	PNAE recommendation	% PNAE recommendation
Energy (kJ/kcal)	624.3/149.1	(450.9–792.6)/(107.7 –189.3)	1256.0/300.0	49.7	968.0/231.2	(718.5–1270.7)/(171.6 –303.5)	1674.7/400.0	57.8
Protein (g/day)	5.1	(3.5–6.8)	9.4	54.3	7.0	(5.3–9.6)	12.5	56.0
Carbohydrate (g/day)	22.1	(15.0–30.3)	48.8	45.3	34.9	(26.8–49.7)	65.0	53.7
Lipid (g/day)	4.3	(2.5–5.9)	7.5	57.3	5.8	(3.7–8.3)	10.0	58.0
Fiber (g)	1.1	(0.6–1.8)	5.7	19.3	1.9	(1.5–2.6)	7.5	25.3
Vitamin C (mg)	4.6	(0.0–12.8)	5.0	92.0	8.6	(4.2–17.3)	8.0	107.5
Vitamin A (mcg)	31.1	(16.0–64.8)	90.0	34.6	60.6	(37.1–102.1)	120.0	50.5
Calcium (mg)	91.4	(30.0–124.1)	150.0	60.9	112.9	(62.7–161.4)	240.0	47.0
Magnesium (mg)	16.0	(10.1–22.3)	24.0	66.7	28.9	(19.7–38.4)	39.0	74.1
Iron (mg)	0.6	(0.3–0.9)	2.1	28.6	0.8	(0.5–1.2)	3.0	26.7
Zinc (mg)	0.7	(0.4–1.1)	0.9	77.8	0.9	(0.7–1.2)	1.5	60.0

PNAE, National School Feeding Program.
[a] PNAE recommendation for those who attend full-time: 70% of daily needs; PNAE recommendation for those who attend part-time: 30% of daily needs.
[b] Recommended amount for fiber ingestion is not defined for this age group.

Regarding the population characteristics, the prevalence of low birth weight observed in the study (8.7%) was slightly higher than the national prevalence, of 8.4% in 2015 [18]. Low birth weight is an important predictor of child survival, since it is associated with the risk of the child mortality before completing its first year of life [19]. The association between low birth weight and adult illnesses, such as type II diabetes mellitus, hypertension, obesity, and metabolic syndrome has also been investigated in the literature [20–22]. Therefore, it is relevant that school feeding could offer adequate nutritional support to encourage the proper child catch-up growth.

Most of the nutrients did not reach the minimum recommended by PNAE, for all the age groups and both periods of stay in the CMEI. The energy supplied for the age group from 6 to 11 months old was the one that came the closest to the energetic recommendations by PNAE.

The fiber supply reaches the worst nutrient score, in relation to the PNAE recommendations. We observed raw salads used to be offered to children after the main dishes, when child could be satisfied and the time for the meal may be running out. This practice could reduce the fiber intake. A study conducted with Dutch children ranging from 1 to 3 years old, which evaluated food consumption in daycare centers and at home, found that only about 17% of children met the country's recommendation for daily dietary fiber [13]. The authors justified these findings because few children ate fruits and vegetables [13]. The recommendations for an increase in dietary fiber intake in childhood are based on increased consumption of fruits, vegetables, cereals, and whole grains [23]. This is essential for the maintenance of healthy body weight and protection against chronic diseases [24]. Fiber intake has been associated with health benefits in childhood, such as the promotion of a normal gastrointestinal function, prevention and treatment of obesity, maintenance of normal blood glucose levels, blood pressure within standards, and reducing the risk of future chronic diseases such as cancer, cardiovascular disease, and type 2 diabetes. In addition, children with a higher fiber intake also tend to have a dietary consumption of recommended amounts of other essential nutrients [23]. To increase fiber supply and stimulate the promotion of healthy eating habits in the school environment, PNAE legislation recommends that at least 200g of fruit and vegetables per student per week should be offered by school feeding [6,7]. Based on median portions observed, it is possible to reach this goal, if fruits and vegetables are offered every day, along the day.

The supply of vitamin C in CMEIs met the PNAE recommendation, except for children ranging from six to eleven months of age. This may be due to the little amount of fresh fruit offered, which was observed during the data collection. The consumption of vitamin C below the recommendations may be attributed to the low consumption of fruits and vegetables. We could observe the predominance of milk feeding in the menu offered to the children, especially for those from six to eleven months. Vitamin C is a water-soluble vitamin with an antioxidant capacity, which plays an important role as an enzymatic cofactor; in the body defense; and in chronic non-communicable diseases prevention. Besides that, vitamin C can increase iron bioavailability [25].

The supply of vitamin A was insufficient for every age group and periods of stay, in special for children from 1 to 3 years old in part-time stay. The low supply of vitamin A observed in our study may be explained by the low supply of food sources of carotenoids in raw or cooked form (Table 3). Besides, the served amount of animal sources of vitamin A in active form varied: viscera were not observed, and the median portion of meats dishes ranged from 14.6 ± 4.3g (ground beef) to 168.5 ± 40.5g (meat balls). The deficiency of vitamin A is one of the biggest public health problems in developing countries and can lead to blindness. Vitamin A has a central role in the immune system. Because of that, in cases of mild deficiency, child resistance to infections such as diarrhea and measles is reduced [26]. Vitamin A further plays an important role in vision; participates in the skin, hair, and mucous membrane formation and maintenance; it is important for growth, development, and the reproductive system. The main sources of vitamin A in its active form are animal food, such as eggs, liver, milk, and dairy products. Plant foods contain vitamin A precursors, the retinoids, which are present mainly in yellow, orange, dark green vegetables, and some fruits such as papaya, mango, kaki, acerola, and others [27].

Calcium supply from school food for children over one year old did not meet the PNAE recommendations. It can be explained by the portion sizes and food items offered to children. Portion sizes offered to children older than one do not increase proportionally to their requirements when compared to children younger than one year of age [7]. In addition, we observed that some culinary preparations containing milk (such as chocolate milk and corn porridge) were offered to younger

children but not to the older ones. An adequate Ca intake is important for healthy and strong bone formation during growth. Diet must supply it to lead the child to reach its genetic potential for bone mass [28]. An insufficient Ca intake results in low serum Ca levels, which start a pathophysiological mechanism that hinder bone growth. This panorama leads to calcium-induced rickets, which is characterized by deformities of the long bones and ribs, enlargement in the sites of bone growth in pulses, ankles and ribs, bone pain, and impaired bone growth [29]. Although peak bone mass is mainly determined by genetics, Ca intake during childhood and adolescence plays a key role in bone health [30]. Studies in Brazil have observed an insufficient supply of Ca from school food for children attending daycare centers [31,32]. In the United States, a study conducted with 398 middle and high schools found that most of the participating schools in the School Meals Initiative for Healthy Children (SMI) met their requirements for Ca [33].

Magnesium supplied by school food did not meet the PNAE recommendation. This lack was more profound for children who attend the CMEI part-time. It can be explained by the small amount of food sources of Mg, as deep green vegetables, nuts, and oilseeds [25]. Mg is an essential cofactor for many different enzymatic systems. It plays an important role in neurotransmission and peripheral vasodilation [34] and acts in intestinal nutrient absorption [35]. Mg deficiency is commonly observed in a lot of clinical condition, such as malabsorption in energy-protein malnutrition, hypoalbuminemia, sepsis, hypothermia, among others. These conditions could be frequently observed among children, especially in developing countries [34].

Iron was the nutrient with the lowest supply by school food in all the age groups. This result may be due to the variation in the size of the meat portion provided by the CMEIs. Meats are the main iron source, and this irregular amount offered could be insufficient to meet the children's requirement of iron for the period of stay in the school. The main risk factors for Fe deficiency among children is the low intake of this mineral in a stage of life when its demand is high. The excessive consumption of cow milk also can lead to an iron deficiency because of competition in the absorption sites between Ca and Fe. To reach an adequate nutritional state of iron, healthy and varied eating is crucial; this includes food sources of this mineral, such as animal-origin foods and dark green vegetables, and an adequate Ca amount [36,37]. Other authors [31,32,38] have also observed a low supply of Fe in school food, not reaching PNAE recommendations.

Zinc supply for children who attended CMEIs part-time did not meet PNAE recommendations. The meals supplied at CMEIs contained foods such as milk and red meat, considered two of the best Zn sources [39]. It suggests that an insufficient supply of this mineral could be because of the smaller amount of foods supplied to the children who attended CMEI part-time compared to those offered to children attending full-time. Zinc deficiency is related to inhibition of growth, impaired immune function and even the presence of diarrhea, contributing to recurrent infections [40]. The increase of Zn demand for growth and the decrease of its intake, due to inadequate eating habits, predispose preschool children to deficiency of this mineral, especially those living in low socioeconomic status communities [41]. A low Zn supply by school food may contribute for deficiency in children, especially if home feeding is insufficient to meet the daily recommendations for this micronutrient.

Fruits and vegetables are food sources of vitamins, minerals, fiber, phytochemical compounds with antioxidant capacity, phytoestrogens, anti-inflammatory agents, and other protective components [42]. Their consumption is associated with health benefits. An effective and economical way to encourage children to consume it is to stimulate this behavior in the school environment [43]. During data collection, we observed that salads were offered to children after the main course, that is, it was not being served along with the meals, in the children's dish. Besides that, there was no incentive for vegetable consumption by the caregivers at school. In this way, the mealtime has not been used for pedagogical practice and for the formation of healthy eating habits. Studies have shown that the lack of knowledge of caregivers at school about healthy infant feeding and the difficulty for feeding young children at a short period of time affect the type and amount of food offered to children at school [31,44].

During data collection, we observed situations that may help to explain the findings of the present study. The number of caregivers at school is insufficient to assist children at mealtime. Classes from children under one year old contained about 11–15 children, while in classes from children over one year old, this number reached 28 in some cases. In each classroom, there were two teachers to develop

pedagogical activities with the children. During mealtime, in the classes for children under two years old, a third person joined the first two to help feeding the children. This poor assistance to children can lead to a reduction in food consumption by them. The short period available for meals – about fifteen to twenty minutes for food consumption by all the children in the class [45] – is also incompatible with the development of children from different age groups. Day care attendants may have a positive influence on children's food intake by serving healthy food in sufficient quantities [13,46] and using a family-like style to serving meals. Therefore, children will be able to choose to consume healthy foods (because they will be available to them). Another approach is that caregivers sit down to eat healthy foods with the children and take the time to talk about healthy feeding to the children [13].

It was also observed that the size of the supplied portions did not follow any standards, or had any distinction by age group. Another point is that the classes had to take turns to eat because even though CMEIs had canteens to children sit to eat the meals, these physical spaces were small. Therefore, some classes ate the meals in the canteen, with reduced available time because of the need to sort the children to fit in the eating environment [45]. Other classes, usually those from children from 6 to eleven months of age, used to eat their meals in the classroom.

For children aged six months to three years, the period of stay in school was a parent's decision. On the other hand, for children over 3 years old, only part-time vacancies were available. We observed that four out of five evaluated CMEIs supplied only one meal for children older than 3 years (who attended part-time). This goes against the PNAE rules and leads to a reduction in the energy and nutrients supply for these children. According to the Resolution n. 26/2013 [7], daycare centers must offer at least two meals for children who attend part-time to reach at least 30% of the dietary reference intakes of preschoolers. The offer of only one meal has contributed to not meeting the PNAE recommendations.

The previously exposed conditions may interfere in the student's food intake. It is necessary to review the application in actual practice of PNAE recommendations. We can list some crucial points to improve, such as the number of caregivers adequate to the number of children per class; training of these professionals on portion sizes-for-age, since energy, macro and micronutrient requirements change with age; longer and adequate time for children to eat; restructuring of the canteens physical space to have the meals in the CMEI; reassessment of the menus prepared for school feeding in order to meet nutritional needs and ensure food and nutritional security during the children's stay in the CMEI; and an increase in the financial funding. Municipalities have to complement the funding with a financial contribution that is often higher than the Federal contribution. Likewise, it is necessary to implement food and nutrition education actions, because the school is an enabling environment for the development of new skills and to acquire new habits.

Even though the food supply did not meet the recommendation for most nutrients, it is important to highlight the crucial role of family in complementing the feeding received at school. Actions are also important for that matter, as to promote an adequate, safe, and healthier feeding for children in the family setting. In this sense, more studies in the field are important to assess the quality of food consumed by these children, both at home and in the school environment.

The Brazilian government published, in 2020, a new resolution [47], which modified some parameters of macro and micronutrients to be observed by school feeding. The Resolution FNDE n. 6/2020 [47] had to be enforced since January 2021. Nonetheless, face-to-face classes in Brazil were suspended in 2020–2021, given the pandemic scenario. In this way, we expect to see this Resolution put into practice for the 2022 school year. The main differences between the 2013 and 2020 Resolutions, in terms of macro and micronutrients recommendations, are summarized in Supplemental Material S1.

We could reflect upon the limitations of using food composition tables to determine the nutritional profile of school meals. Even though a national food composition table was used, Brazil is a continental country, and the ranging in soil composition affects the food nutrient content. We have to highlight that results reflect the reality of the children who attended child daycare centers in Guaratuba, because all the CMEIs were included in this study, but cannot be extrapolated for other realities because the findings are not representative of Brazilian children below 3. On the other hand, we can highlight strong points, such as the choice of the food survey method, since the direct food weighing has been performed in all the meals taken by the children in the school environment, individually, and the data collection has been performed in all the CMEIs of the municipality.

Conclusion

In summary, the results of this study show the insufficient supply of nutrients by school feeding in CMEIs from Guaratuba, especially Fe, Ca, vitamin A and fiber that, for some age groups, reached less than 50% of PNAE recommendations. Therefore, it is evident the need to improve the school feeding in the municipality to ensure an adequate food supply and stimulate healthy food consumption. Besides the adequacy of the meals supplied in the school environment, it is necessary to 1) customize the portion sizing of the meals; 2) optimize time and physical space of canteens destined for the meals; 3) improve the number of caregivers and their qualification; 4) make different menus for each age group or classes, according to their needs; 5) to diversify the menu, respecting local food habits and including different food items; and 6) encourage fruit and vegetable consumption, including raw leafy vegetables.

The results of the present study can lead to subsidize actions to the improvement of school feeding in the municipality, to guarantee a school environment which ensures the best child growth and development. More studies to assess in a qualitative way the global diet consumed by this population are necessary. Since 2021, Municipalities have to work to adequate meals to the Resolution n. 06/2020. It provides a new question for future scientific research.

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Authorship

ECVO and FPM worked in all stages of the research, such as project design, data collection, interpretation of the collected data and writing of the manuscript; AR worked in interpretation of the collected data and writing of the manuscript; CCBA guided all steps of the research, such as project design, collection, analysis and interpretation of the data, manuscript idealization and revision of the final text; MMOC contributed to the project design, interpretation of the collected data and revision of the manuscript. All the authors read and approved the final version of the manuscript.

Ethics of human subject participation

This study's project was approved by the Committee on Ethics in Research in Human Beings of the Health Sciences Sector of the Federal University of Paraná (UFPR, Portuguese acronym for Universidade Federal do Paraná). The Department of Education of Guaratuba city authorized project conduction.

Conflict of interest

The authors declare that there are no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.nutos.2022.05.003.

References

[1] Schwartz C, Scholtens PA, Lalanne A, Weenen H, Nicklaus S. Development of healthy eating habits early in life. Review of recent evidence and selected guidelines. Appetite 2011;57:796–807.
[2] Scaglioni S, Arrizza C, Vecchi F, Tedeschi S. Determinants of children's eating behavior. Am J Clin Nutr 2011;94:2006S–11S.
[3] Scaglioni S, Salvioni M, Galimberti C. Influence of parental attitudes in the development of children eating behaviour. Br J Nutr 2008;99(Suppl 1):S22–5.
[4] Brasil. Ministério da Educação. Secretaria de Educação Básica. Secretaria de Educação Continuada, Alfabetização, Diversidade e Inclusão. Conselho Nacional da Educação. Diretrizes Curriculares Nacionais Gerais da Educação Básica 2013. https://goo.gl/WumZmb. [Accessed 13 January 2019].
[5] INEP INdEePEAT. Censo escolar 2014. Brasília: INEP; 2014.
[6] Brasil. Resolução/CD/FNDE nº 38, de 16 de julho de 2009. Brasília, DF: FNDE; 2009.
[7] Brasil. Resolução/CD/FNDE nº 26, de 17 de junho de 2013. Brasília, DF: FNDE; 2013.
[8] Brasil. Pesquisa Nacional de Demografia e Saúde da Criança e da Mulher – PNDS 2006 : dimensões do processo reprodutivo e da saúde da criança. Brasília: Ministério da Saúde; 2009.
[9] Jordão RE, Bernardi JLD, Barros Filho AdA. Prevalência de anemia ferropriva no Brasil: uma revisão sistemática. Rev Paul de Pediatr 2009;27:90–8.
[10] Carvalho Cad, Fonsêca PcdA, Priore SE, Franceschini SCC, Novaes JF. Food consumption and nutritional adequacy in Brazilian children: a systematic review. Rev Paul de Pediatr 2015;33:211–21.
[11] Karnopp EV, Vaz JD, Schafer AA, Muniz LC, Souza RL, Santos ID, et al. Food consumption of children younger than 6 years according to the degree of food processing. J de Pediatr 2017;93:70–8.
[12] World Health Organization. Global status report on noncommunicable diseases 2014. 2014. https://goo.gl/6UCJqP. [Accessed 9 January 2019].
[13] Gubbels JS, Raaijmakers LG, Gerards SM, Kremers SP. Dietary intake by Dutch 1- to 3-year-old children at childcare and at home. Nutrients 2014;6:304–18.
[14] WHO (World Health Organization). Infant and young child feeding: model chapter for textbooks for medical students and allied health professionals. Geneva: WHO; 2009.
[15] Vieira DadS, Castro MA, Fisberg M, Fisberg RM. Nutritional quality of dietary patterns of children: are there differences inside and outside school? J de pediatr 2017;93:47–57.
[16] Rodrigo CPS, Bartrina JA. Diário o registro dietético: métodos de doble pesada. In: BJ Majem LS, Verdú JM, editors. Nutricion y salud publica; métodos, bases científicas y aplicaciones. Barcelona: Masson; 1995. p. 107–19.
[17] IBGE. Pesquisa de Orçamentos Familiares (POF), 2008–2009. Tabela de composição nutricional dos alimentos consumidos no Brasil. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; 2011.
[18] Adolescente FAOdCed. Nascidos vivos com baixo peso ao nascer, de acordo com o Sistema de Informações sobre Nascidos Vivos (SINASC). 2017.
[19] Luginaah IN, Lee KS, Abernathy TJ, Sheehan D, Webster G. Trends and variations in perinatal mortality and low birthweight: the contribution of socio-economic factors. Can J Public Health 1999;90:377–81. Revue canadienne de sante publique.
[20] Bismarck-Nasr EM, Frutuoso MF, Gambardella AM. The correlation between birth weight index and excess weight in young individuals. Cadernos de saude publica 2007;23:2064–71.
[21] Ribeiro AM, Lima Mde C, de Lira PI, da Silva GA. Low birth weight and obesity: causal or casual association? Rev paul de pediatr 2015;33:341–9. orgao oficial da Sociedade de Pediatria de Sao Paulo.
[22] Santos SPd, Oliveira LMB. Low birth weight and its relationship to obesity and metabolic syndrome in childhood and adolescence. J Med Biolo Sci 2011;10:329–36.
[23] Anderson JW, Baird P, Davis Jr RH, Ferreri S, Knudtson M, Koraym A, et al. Health benefits of dietary fiber. Nutr Rev 2009;67:188–205.
[24] Sweitzer SJ, Briley ME, Roberts-Gray C, Hoelscher DM, Harrist RB, Staskel DM, et al. Lunch is in the bag: increasing fruits, vegetables, and whole grains in sack lunches of preschool-aged children. J Am Diet Assoc 2010;110:1058–64.
[25] Cozzolino SMF. Biodisponibilidade de nutrientes. Barueri, SP: Manole; 2012.
[26] Brasil. Cadernos de Atenção Básica: carências de Micronutrientes Brasília: Ministério da Saúde. Unicef; 2007.
[27] Yuyama L, al i-o-a-d-ce. inserir título do capítulo. In: Cozzolino SMF, Cominett IC, editors. Bases bioquímicas e fisiológicas da nutrição: nas diferentes fases da vida, na saúde e na doença. 1 ed. Barueri, SP: Manole; 2013.
[28] Black RE, Williams SM, Jones IE, Goulding A. Children who avoid drinking cow milk have low dietary calcium intakes and poor bone health. Am J Clin Nutr 2002;76:675–80.
[29] Thacher TD, Abrams SA. Relationship of calcium absorption with 25(OH)D and calcium intake in children with rickets. Nutr Rev 2010;68:682–8.
[30] Huybrechts I, Lin Y, De Keyzer W, Sioen I, Mouratidou T, Moreno LA, et al. Dietary sources and sociodemographic and economic factors affecting vitamin D and calcium intakes in Flemish preschoolers. Eur J Clin Nutr 2011;65:1039–47.
[31] Longo-Silva G, Toloni MHA, Goulart RMM, Taddei JAAC. Evaluation of food consumption at public day care centers in São Paulo, Brazil. Rev Paul de Pediatr 2012;30:35–41.
[32] Inoue DY, Osório MM, Taconeli CA, Schmidt ST, Almeida CCB. Food consumption in 12-30-month-old children attending Municipal Daycare Centers in the municipality of Colombo, Southern Brazil. Braz J Nutr 2015;28:523–32.
[33] Crepinsek MK, Gordon AR, McKinney PM, Condon EM, Wilson A. Meals offered and served in US public schools: do they meet nutrient standards? J Am Diet Assoc 2009;109:S31–43.
[34] Amare B, Moges B, Fantahun B, Tafess K, Woldeyohannes D, Yismaw G, et al. Micronutrient levels and nutritional status of school children living in Northwest Ethiopia. Nutr J 2012;11:108.
[35] Falade O, Otemuyiwa I, Oluwasola O, Oladipo W, Adewusi S. School Feeding Programme in Nigeria: The Nutritional Status of Pupils in a Public Primary School in Ile-Ife, Osun State, Nigeria. Food Nutr Sci 2012;3:596–605.
[36] Moshe G, Amitai Y, Korchia G, Korchia L, Tenenbaum A, Rosenblum J, et al. Anemia and iron deficiency in children: association with red meat and poultry consumption. J Pediatr Gastro Nutr 2013;57:722–7.

[37] Wong C. Iron deficiency anaemia. Paediatr Child Health 2017;27:527–9.
[38] Retondario A, Silva DL, Salgado SM, Alves MA, Ferreira SM. Nutritional composition of school meals serving children from 7 to 36 months of age in municipal day-care centres in the metropolitan area of Curitiba, Parana, Brazil. British J Nutr 2016; 115:2203–11.
[39] Fidelis CMF, Osório MM. Consumo alimentar de macro e micronutrientes de crianças menores de cinco anos no Estado de Pernambuco, Brasil. Rev Bras de Saúde Matern Infant 2007;7:63–74.
[40] Best C, Neufingerl N, van Geel L, van der Briel T, Osendarp S. The nutritional status of school-aged children: why should we care? Food Nutr Bull 2010;31:400–17.
[41] Dhingra U, Hiremath G, Menon VP, Dhingra P, Sarkar A, Sazawal S. Zinc deficiency: descriptive epidemiology and morbidity among preschool children in peri-urban population in Delhi, India. J Health, Popul Nutr 2009;27:632–9.
[42] Slavin JL, Lloyd B. Health benefits of fruits and vegetables. Adv Nutr 2012;3:506–16.
[43] Horne PJ, Greenhalgh J, Erjavec M, Lowe CF, Viktor S, Whitaker CJ. Increasing pre-school children's consumption of fruit and vegetables. A modelling and rewards intervention. Appetite 2011;56:375–85.
[44] Shimabukuro EE, Oliveira MdN, Taddei JAdAC. Conhecimentos de educadores de creches sobre alimentação infantil. Rev Paul Pediatr 2008;26:231–7.
[45] Madruga FP. A atuação dos professores na educação alimentar e nutricional. In: IV SIPASE - Seminário Internacional Pessoa Adulta, Saúde e Educação. Porto Alegre, RS: PUCRS; 2017.
[46] Parker M, Lloyd-Williams F, Weston G, Macklin J, McFadden K. Nursery nutrition in Liverpool: an exploration of practice and nutritional analysis of food provided. Public Health Nutr 2011;14:1867–75.
[47] Brasil. Dispõe sobre o atendimento da alimentação escolar aos alunos da educação básica no âmbito do Programa Nacional de Alimentação Escolar – PNAE, vol. Resolução/CD/FNDE nº 06, de 08 de maio de 2020. Brasília, DF: FNDE; 2020.