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Food Quality and Nutritional Profile of Students from a Public School in Brazil

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Abstract

Feeding is directly related to nutritional status and alterations as obesity and malnutrition, affecting human body and increasing the risk of morbidity and mortality. This study aimed to evaluate the nutritional status of children and adolescents in a public school located in Uberaba MG Brazil by comparing macro and micronutrients on the school menu with PNAE (Brazilian government program) recommendations. A descriptive cross-sectional study including 547 individuals was carried out. Nutritional assessment was done based on anthropometric Z-score analysis. Only the food ingestion made at the school was considered, in order to verify if the meals offered by the school meet the percentage of nutrients recommended by PNAE. With regard to the nutritional status, there was a small proportion of students (0.18%) with low weight (-3 ≥ Z < -2). There was 15% prevalence of overweight (overweight, obesity, and severe obesity) among students. Menus composition revealed that macronutrients, fiber, and energy intake was lower than that recommended by PNAE for all age groups studied. The prevalence of a considerable number of overweight students is a warning for interventions to prevent obesity. A small percentage of students classified as low weight represents a nutritional transition trend in recent years.

Keywords

school meals, nutritional status, nutritional education

1. Introduction

Overweight and obesity among school children (aged five to nine years) and adolescents almost tripled in the last 20 years, reaching one-fifth of children and one-third of teens (Brazilian Institute of Geography and Statistics, 2010). Food consumption is related to obesity, including not only the volume of food intake but also the quality of diet (Triches & Giugliani, 2005).

In this context, public health policies work as a tool for governments around the world to reverse the

epidemiological situation (Silva, 2010). School Health Programs aim at development of promotion, prevention, and health care in the school environment, besides monitoring the nutritional status of students (Ministry of Health, 2009). At school, children can try other foods and new preparations, and change eating habits (Fisberg et al., 2000).

In this context, the Brazilian National School Feeding Program (PNAE) has proposed to meet the nutritional needs of students during their stay in school to contribute to food security and nutrition (Ministry of Education, 2006).

Therefore, the present study aimed to evaluate the nutritional status of children and adolescents (aged 7-16 years) in a state school in Uberaba MG-Brazil; to compare macro and micronutrients in school menu and the recommendations by PNAE.

2. Method

2.1 Population

This research is a descriptive cross-sectional study including children and adolescents. Data were collected during the school year of 2014 and first half of 2015. The school Director was asked to select all students enrolled in the afternoon shift. Five hundred and forty-seven (547) students of the State school, of both sexes aged 7 to 16 years were assessed.

In this research, only the food ingestion made at the school was considered, in order to verify if the meals offered by the school meet the percentage of nutrients recommended by the PNAE.

The study was approved by the Ethics and Research Committee of the Universidade Federal do Triângulo Mineiro-Brazil, register number 877.724 and the inclusion of students in the study occurred only after obtaining the Term of Consent signed by parents or guardians.

2.2 Identification Questionnaire

A structured questionnaire was used to assess the name, sex, and birth date of the participants according to the school enrollment registers. Age was calculated as the difference between anthropometric measurement and birth dates.

2.3 Nutritional Status

To calculate the Body Mass Index (BMI) and characterize the nutritional status, an anthropometric evaluation from measurements of weight (kg) and height (m) was performed.

The weight measurements were carried out in a platform electronic scale (Filizola), with 300 kg capacity and height measurements were done using an inelastic tape measuring 1.5 m length, fixed to the wall at 1 meter from the floor. For the experiment, individuals dressed light clothes and did not wear shoes. Individuals were classified according to Body Mass Index (BMI). Body Mass Index (BMI) was calculated by dividing weight (kg) by height squared (m^2).

The Z score is considered an effective method to study population, since age and gender factors are taken into account (World Health Organization, 2007). Z score is given by the ratio of the difference between the value measured at the individual and the value of the reference population, divided by the

standard deviation of the same population (Ministry of Health, 2011), according to the following equation:

$$Zscore = \frac{observed\ \ value\ \ -\ \ average\ of\ \ reference\ \ \ population}{s\tan dard\ \ deviation\ of\ \ reference\ \ \ population}$$

Anthropometric indexes used to assess the nutritional status of students aged 6-10 years were weight for age (W/A), height for age (H/A), and BMI for age (BMI/A) measured as Z scores. Height for age (H/A) and BMI for age (BMI/A) measured as Z scores were used to evaluate the nutritional status of students aged 11-17 years.

The classification criterion used was the recommended by WHO, and adopted by the Brazilian Ministry of Health (Ministry of Health, 2011), as shown in Tables 1 and 2.

Table 1. Nutritional Status of Children Aged 5-10 Years for Each Anthropometric Index

Critical values	Anthropometric index		
	Weight for age	**Height for age**	**BMI for age**
< Z score -3	Severely underweight	Severely stunted	Severely wasted
≥ Z score Z -3 < Z score -2	Underweight	Wasted	Wasted
≥ Z score -2 e < score -1	Adequate weight for age	Adequate height for age	Eutrophia
≥Z score -1 ≤ Z score +1			
>Z score +1 ≤ Z score +2			Overweight
> Z score +2 ≤Z score +3	High weight for age		Obesity
> Z score +3			Severly obesity

Source: Adapted from Ministry of Health (Ministry of Health, 2011).

Table 2. Nutritional Status of Adolescents for Each Anthropometric Index

Critical values	Anthropometric index	
	Height for age	**BMI for age**
< Z score -3	Severly stunted	Severly wasted
≥ Z score -3 e < Z score -2	Stunted	Wasted
≥ Z score -2 e < Z score -1	Adequate height for age	Eutrophia
≥ Z score -1 e ≤ Z score +1		
> Z score +1 e ≤ Z score +2		Overweight
> Z score +2 e ≤ Z score +3		Obesity
> Z score +3		Severe obesity

Source: Adapted from Ministry of Health (Ministry of Health, 2011).

2.4 Nutrition Analysis of School Meals

Weekly menus of the full month of June, 2015 were studied. French bread was served in the morning throughout the research period, together with chocolate milk or mate tea. Menus for lunch and afternoon snack were prepared for five weeks, returning to the beginning of the menu after the fifth week.

DietWin® software was used to calculate the nutrients and energy consumed by students in school meals, after updating the information about nutrients and portion sizes and registering receipts. For registration of recipes not included in the software, a food composition table developed by the Center for Studies and Research in Food-NEPA, Universidade Estadual de Campinas-Unicamp (UNICAMP, 2011) was used.

Energy, macronutrients (carbohydrates, proteins, and lipids), fiber, vitamins A and C, and minerals (calcium, iron, magnesium and zinc) intake was investigated, as suggested by PNAE.

The analyses on nutrient intake according to students' needs were carried out using the values set by PNAE as a reference. Table 3 shows the PNAE recommendations for students according to age group.

Table 3. Reference Values for Energy and Nutrients, According to Age Group, Established by the National School Feeding Program (PNAE) to Meet 70% of the Daily Nutritional Needs

Energy and Nutrients	Age group		
	06 to 10	**11 to 15**	**16 to 18**
Energy (kcal)	1000	1500	1700
Carbohydrate (g)	162.5	243.8	276.3
Protein (g)	31.2	46.9	50.0
Lipids (g)	25.0	37.5	42.5
Fiber (g)	18.7	21.1	22.4
Vitamin A (μg)	350.0	490.0	560.0
Vitamin C (mg)	26.0	42.0	49.0
Ca (mg)	735.0	910.0	910.0
Fe (mg)	6.3	7.5	9.1
Mg (mg)	131.0	222.0	271.0
Zn (mg)	4.7	6.3	7.0

Source: National School Feeding Program-PNAE (Ministry of Education, 2013).

2.5 Statistical Analysis

Data to assess the nutritional status were processed in Microsoft Office Excel 2007 software; the DietWin® software was used to calculate macro and micro nutrients in school meals.

3. Result

3.1 Nutritional Status

The results for the nutritional status of the students (n = 547), based on the body mass index Z scores are shown in Table 4. There was a prevalence of 10.9% overweight (≥ 1 Z < 2) and 3.2% obesity (≥2 Z ≤ 3) among students. A percentile of 0.9% students was classified with severe obesity (Z > 3), while 0.18% students were classified with low weight index (≥ -3 Z <-2).

Table 4. Distribution of Students According to Age and Nutritional Status (Based on BMI Z Scores)

Age (years)	Gender	*n*	%	Low weight		Eutrophia		Overweight		Obesity		Severe obesity	
				≥ -3 *Z* < -2		≥ -2 *Z* < 1		≥ 1 *Z* < 2		≥ 2 *Z* ≤ 3		*Z* > 3	
				N	%	N	%	n	%	n	%	N	%
	Male	20	3.5	0	0.00	18	3.30	1	0.18	1	0.18	0	0.00
< 9	Female	111	20.3	1	0.18	97	17.7	8	1.50	5	0.90	0	0.00
	Male	28	5.1	0	0.00	26	4.70	1	0.18	0	0.00	1	0.18
9 I- 11	Female	114	20.8	0	0.00	89	16.2	18	3.30	6	1.10	1	0.18
	Male	36	6.6	0	0.00	35	6.40	1	0.18	0	0.00	0	0.00
11 I- 13	Female	110	20.1	0	0.00	96	17.5	13	2.40	1	0.18	0	0.00
	Male	34	6.1	0	0.00	24	4.40	7	1.20	3	0.50	0	0.00
13 I- 15	Female	65	11.9	0	0.00	54	9.90	8	1.40	2	0.36	1	0.18
	Male	12	2.2	0	0.00	9	1.60	2	0.36	0	0.00	1	0.18
> 15	Female	17	3.2	0	0.00	13	2.40	1	0.20	2	0.3	1	0.18
Total		547	100	1	0.18	461	84.1	60	10.9	20	3.52	5	0.9

The classification of students according to the height-age index is shown in Table 5. The results demonstrated that 2.75% students have low height for age.

Table 5. Distribution of Students According to the Height-Age Index for Children

Age (years)	Gender	*n*	%	Low height for age		Adequate height for age	
				>= -3 and < -2		>= -2	
				n	%	n	%
< 9	Male	20	3.6	1	0.18	19	3.5
	Female	111	20.3	2	0.36	109	20
9 I- 11	Male	28	5.1	1	0.18	27	5
	Female	114	20.8	7	1.3	107	19.5
11 I- 13	Male	36	6.6	0	0	36	6.5
	Female	110	20.1	4	0.73	106	19.3

13 I- 15	Male	34	6.2	0	0	34	6.2
	Female	65	11.9	0	0	65	11.8
> 15	Male	12	2.2	0	0	12	2.2
	Female	17	3.2	0	0	17	3.2
Total		547	100	15	2.75	532	97.2

The classification of students according to weight-age index is shown in Table 6. The results showed that 4.06% of female students and 0.50% of male students have high weight for age.

Table 6. Distribution of Students According to the Weight-Age and High Weight for Age Index for Children

Age (years)	Gender	*n*	%	Adequate weight for age		High weight for age	
				>= -2 *Z* < 2		*Z* > 2	
				N	%	n	%
≤ 9	Male	*35*	17.8	34	17.2	1	0.50
	Female	162	82.2	154	78.2	8	4.06
Total		197	100	188	95.4	9	4.56

3.2 Nutritional Analysis of School Meals

Table 7 shows the school menus used at the school during the research period.

Table 7. Menus Used at the School During the Research Period

Meal	**Menu**
Breakfast	French bread, chocolate milk
	French bread, mate tea
Lunch	cooked white rice, cooked carioca beans, polenta bolognese, lettuce salad
	cooked white rice, pasta with white sauce and ham
	cooked white rice, *feijoada*
	cooked white rice, cooked carioca beans, polenta bolognese
	cooked white rice, cooked carioca beans, ground beef with potato
	seasoned rice, chicken mayonnaise
	cooked white rice, cooked carioca beans, polenta bolognese, cooked cabotia pumpkin
	cooked white rice, minced beef with carrots, vinaigrette and banana
Snack	Cornmeal Soup
	cooked white rice, cooked carioca beans, crumbs banana
	sweet rice

	cooked white rice, chicken salad
	Rice, beans drover
	Avocado, papaya and banana smoothie
	Vegetable soup and noodles
	cooked white rice, cooked carioca beans, crumbs with ground beef and cabotia pumpkin

Table 8 shows the average energy, macronutrients, micronutrients, fiber, calcium, iron, magnesium, zinc, and vitamins A and C intake of school meals.

The number of calories consumed at breakfast, lunch, and snack was 124.87, 290.48, and 266.62 kcal, respectively. Regarding the macronutrients, carbohydrate was the most consumed item, especially at lunch, averaging 50.77 g, while protein intake at breakfast, lunch, and snack was on average 3.85 g, 10.62 g, and 11.6 g, respectively.

Regarding lipids intake, an increase was observed as the meals were served, from 4.21 g and 5.01 g at breakfast and lunch, respectively, reaching 8.22 g at afternoon snack. A low fiber intake was verified at breakfast, with 0.56 g, which was higher at lunch and snack, being 4.81 g and 4.83 g respectively.

A difference in vitamin A intake was also observed among the periods, with values of 32.14 g, 2.64 g, and 9.94 g at breakfast, lunch, and snack, respectively. The vitamin C intake at lunch was 4.98 g, while at snack and breakfast the values were 4.97 and 0.58 g, respectively.

Regarding the calcium intake, breakfast represented the highest intake, with 72.51 g, followed by 17.95 g at lunch and 52.96 g at snack. The average iron intake was 0.57 g, 1.3 g, and 1.31 g at breakfast, lunch, and snack, respectively. With regard to magnesium, the highest intake was observed at lunch with 38.19 g, followed by 33.18 g and 13.37 g at snack and breakfast, respectively. Zinc intake was higher at snack, with 2.37 g, when compared to lunch and breakfast with values of 1.98 g, and 0.42 g.

Table 8. Energy and Nutrient Intake per School Meal

Nutrient/Meal	Breakfast	Lunch	Afternoon snack
Energy (kcal)	124.87 ±27.17	290.48 ±116.52	266.62 ±132.99
Carbohydrate (g)	17.96 ±2.87	50.77 ±22.93	36.45 ±21.79
Protein (g)	3.85 ±1.17	10.62 ±4.35	11.6 ±9.01
Lipids (g)	4.21 ±1.3	5.01 ±2.76	8.22 ±5.14
Fiber (g)	0.56 ±0.06	4.81 ±2.44	4.83 ±4.87
Vitamin A	32.14 ±15.00	2.64 ±5.09	9.94 ±14.84
Vitamin C	0.58 ±0.37	4.98 ±5.83	4.97 ±5.73
Ca	72.51 ±42.91	17.95 ±8.70	52.96 ±47.38
Fe	0.57 ±0.08	1.3 ±0.84	1.31 ±1.27
Mg	13.37 ±3.42	38.19 ±30.10	33.18 ±33.67
Zn	0.42 ±0.15	1.98 ±1.12	2.37 ±268

Regarding the composition of school meals, the energy, macronutrients, and fiber intake was below the recommended value by PNAE, as shown in Table 9. The energy value was only 69.19% of the recommended value for the group aged 6-10 years, 45.46% for the group aged 11-15, and 40.11% for students aged 16-18 years. The carbohydrates intake reached 64.72%, 43.14%, and 38.06% of the recommended value for the students aged 6 -10, 11-15, and 16-18 years, respectively.

The average protein intake reached 83.5% of the recommended value for the students aged up to 10 years. In contrast, for the students aged 11-15 and 16-18 years, the protein intake was 55.6% and 52.14% of the recommended value, respectively.

Lipids intake was 69.76% of the recommended value for children aged 6-10 years, and 46.50% for the group aged 11-15 years. For the group aged 16-18 years, the average intake reached 41.03% of the recommendations.

Fiber intake was 54.5%, 48.3%, and 45.5% of the recommended value by the PNAE for the groups aged 6-10, 11-15, and 16-18 years, respectively.

Table 9. Energy and Macronutrients Composition of School Meals When Compared to 70% of the Daily Nutritional Needs Recommended by PNAE According to Age Group

Nutrient	6-10 years old	11-15 years old	16-18 years old	Provided by the
	Recommended	Recommended	Recommended	School
Energy (kcal)	1000	1500	1700	681.97
Carbohydrate (g)	162.5	243.8	276.3	105.18
Protein (g)	31.2	46.9	50	26.07
Lipids (g)	25	37.5	42.5	17.44
Fiber (g)	18.7	21.1	22.4	10.2

The composition of micronutrients of school meals when compared to 70% of the daily nutritional needs recommended by PNAE for full day students is presented in Table 10.

Calcium intake was 19.5% and 16.8% of the recommended value for students aged 6-10 years and over 11 years old, respectively. Iron intake was 50.5%, 42.4%, and 35%, for the groups aged 6-10, 11-15, and 16-18 years, respectively. With respect to magnesium intake, percentages of 64.6%, 38.2%, and 31.27% were observed for students aged 6-10, 11-15, and 16-18 years, respectively.

The average vitamin C intake was 40.5%, 25.07%, and 21.5% of the recommended value by the PNAE for students aged 6-10, 11-15, and 16-18 years, while vitamin A intake reached 12.8%, 9.1%, and 21.49% of the recommended value by the PNAE for those age groups, respectively.

As regards the average zinc intake for the group aged 6-10 years, the school meal supplied the recommendations proposed by the PNAE. In contrast, for those aged 11-15 years and 16-18 years, zinc intake supplied 75.7% and 68.1% of the recommended value, respectively.

Table 10. Micronutrients of School Meals When Compared to 70% of the Daily Nutritional Needs Recommended by PNAE

Nutrient	6-10 years old	11-15 years old	16-18 years old	Provided by the school
	Recommended	Recommended	Recommended	
Calcium (mg)	735	910	910	143.42
Iron (mg)	6.3	7.5	9.1	3.18
Magnesium (mg)	131	222	271	84.74
Vitamin A (μg)	350	490	560	44.72
Vitamin C (mg)	26	42	49	10.53
Zinc (mg)	4.7	6.3	7	4.77

4. Discussion

4.1 Nutritional Status

Although only one school has been investigated in the present study, it followed the trend in the literature about the decline in malnutrition and increase in overweight and obesity.

Studies on obesity and underweight in school-age children and adolescents in Brazil, China, United States, and Russia have found that low weight increased only in Russia. In contrast, Brazil, China, and the United States have shown an increase in the prevalence of overweight (Wang et al., 2002).

Pegolo and Silva (2008) assessed the nutritional status of schoolchildren aged 7-14 years and found 4% students with low height for age. As for the analysis of BMI, 10.7% students were underweight, while 1.6% was classified as obese.

Koga (2005) investigated schoolchildren aged 7-10 years, and reported prevalence of 4.5% underweight and 11% overweight. Regarding the height for age index, stunting of 2.3% was observed.

A study in Spain found obesity in 16.8% of pre-school children aged 4 years, especially girls. The increase in chronological age raises obesity rates for 32.6% of 8-year-old girls. A decline in female obesity is observed among teenagers, probably due to negative social connotations associated with excess body fat, since vanity is aroused in adolescence (Trav é et al., 2012).

A study in Japan investigated children from primary school to high school, by evaluating weight and height every year. The results showed that approximately 50% of obese children in primary school remained obese at age 17. At high school, 40% of obese continued overweight at age 17, while 70% of the obese adolescents in high school remained obese at age 17 (Sugimori et al., 1999).

Abrantes et al. (2002) studied the prevalence of overweight and obesity in children and adolescents in the Southeast and Northeast of Brazil. The results showed that 11.9% of children in the Southeast, and 8.2% in the Northeast region were obese. In adolescence, a smaller obesity was observed in the Southeast over the Northeast with 1.7% and 4.2% respectively. In this research, the prevalence of overweight and obesity was higher among women in both regions. Silva et al. (2002) evaluated 211

students aged 10-19 years in Recife, Brazil, and found prevalence of 6.2% overweight and 5.7% obesity among students.

Salles et al. (2000) assessed the prevalence of obesity among students aged 10-17 years in Florianópolis, Brazil, and observed a higher prevalence in public schools (13.1%) when compared in private schools (7.6%). In Fortaleza, Brazil, a survey assessed the nutritional status of adolescents from public and private schools. The results indicated that the prevalence of overweight and obesity in private schools reached 23.9% students, while in public schools this value was 19.5% (Campos et al., 2007).

4.2 Nutritional Analysis of School Meals

The results of this study showed that in relation to macronutrients, energy, and fibers, the students consumed lower amounts than recommended by the PNAE for all age groups. Regarding to micronutrients, only zinc intake for the group aged 6-10 years was adequate.

A major limitation of the study was the fact that there is no pattern in food portion sizes. PNAE recommendations are stratified by age group however meals at school are served equally for all students who receive the same menu and portion sizes. This attitude suggests a lack of guidance on the School Feeding Program, which mischaracterizes the dietary guidelines according to the nutritional needs (Ministry of Education, 2013).

In this research, the consumption of foods in out-of-school environments has not been studied to associate the nutritional status and food routine at home. However, the identification of insufficient nutrients and energy intake in school meals suggests that students may have a regular intake at home, since there is no major commitment in height of the students evaluated (2.75%).

This study showed a low intake of PNAE recommendations for all nutrients (macro and micro), but indicates a high consumption of macronutrients outside the school environment according to the nutritional profile presented by the children.

Low vitamin A ingestion, with predominance among students in the public school system, and the low consumption of vitamin C were also recorded in other research (Albuquerque e Monteiro, 2002; Maestro, 2002). These data are worrying, since hypovitaminosis A is considered a public health problem in Brazil and can cause night blindness, loss of vision and less resistance to infections (Ministry of Health, 2015). Low vitamin C intake is associated with lower iron uptake, especially in vegetable foods (Carvalho et al., 2001). The deficiencies in vitamins A and C are possibly due to the insufficient consumption of fruits and vegetables, and it is necessary to encourage the students to consume foods that are sources of these nutrients, prioritizing the regional ones, since they are low cost and high nutritional density.

Proportionally calcium was the nutrient with the lowest supply, and its intake was below the recommendations, which is also demonstrated in other studies (Albano e Souza, 2001; Albuquerque e Monteiro, 2002; Garcia et al., 2003), corroborating the results of this study. Despite the favorable daily consumption of milk, the low ingestion of calcium can be due to the intake of milk in a very diluted

form, with frequency and fractionation insufficient to reach the recommendation of this mineral in the organism. This improper diet practice may lead to low linear growth, impair the bone mass formation (Albano e Souza, 2001) and favor the early onset of osteoporosis (Carvalho et al., 2001).

5. Conclusion

The prevalence of 15% overweight (overweight, obesity, and severe obesity) among students is a warning for interventions to prevent obesity. A small group classified as underweight (0.9%) proved to be consistent with the nutritional status in the country, where malnutrition has been replaced by excess weight.

In relation to energy and macronutrients intake, there was an insufficient intake in relation to the requirements by the PNAE for all age groups of students. It is worth mentioning the low occurrence of fibers in school meals, confirmed by fiber intake of 10.2 g per day, probably due to lower consumption of fruits and vegetables.

Regarding micronutrients intake, only zinc intake was within the recommended value for the group aged 6-10 years. In general, calcium, iron, vitamin A, vitamin C, magnesium intakes were considered insufficient for all ages, and zinc for the groups aged 11-15 and 16-18 years.

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