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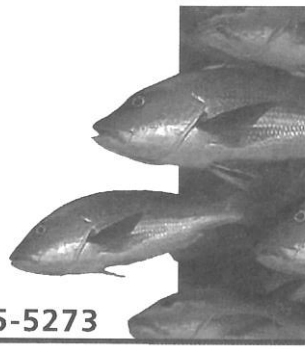

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Incidence of overweight/obesity in preschool children during a two-year follow-up[1]

Incidência de sobrepeso/obesidade em pré-escolares durante dois anos de acompanhamento

Caroline Franz Broering de MENEZES[2]
Janaina das NEVES[3]
Priscila Schramm GONSALEZ[2]
Francisco de Assis Guedes de VASCONCELOS[2,3]

ABSTRACT

Objective

To analyze the incidence of overweight/obesity and associated factors in children aged six years or less during a two-year follow-up.

Methods

This longitudinal cohort study followed 242 preschoolers from *Florianópolis, Santa Catarina*, from 2008 to 2010. The outcome was overweight/obesity (Z-score >+2) measured by accumulated incidence. The Chi-square test measured the differences between the study factors. The association between overweight/obesity and associated factors was analyzed by adjusted and crude rate ratios.

Results

Nine (4.00%) of the 222 non-overweight/obese children in 2008 were overweight/obese in 2010, indicating an accumulated incidence of overweight/obesity of 4.05% (1.4-6.7). The study accumulated incidence of overweight/obesity was 20.25/year/1000, similar to the incidence density of 20.65/year/1000.

[1] Article based on the master's thesis of CFB MENEZES, intitled *"Incidência e fatores associados ao sobrepeso/obesidade em crianças assistidas por Unidades de Educação Infantil de Florianópolis/SC"*. Universidade Federal de Santa Catarina; 2011.

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Conclusion

After adjustment, none of the study factors were associated with overweight/obesity. However, the lack of studies that investigate the incidence of overweight and obesity in preschoolers calls for longitudinal studies with larger samples that analyze not only the incidence of overweight/obesity but also other factors, such as the influence of parents' nutritional status on their offspring's nutritional status.

Indexing terms: Child, preschooler. Incidence. Obesity. Overweight.

RESUMO

Objetivo

Analisar a incidência de sobrepeso/obesidade e fatores associados em crianças com até seis anos de idade durante dois anos de acompanhamento.

Métodos

Trata-se de estudo longitudinal, de coorte de pré-escolares (n=242) de Florianópolis, Santa Catarina, acompanhados entre 2008 e 2010. O desfecho foi o sobrepeso/obesidade (escore-Z >+2) mensurado por meio da incidência acumulada. O teste Qui-quadrado foi utilizado para verificar diferenças entre os fatores avaliados. A análise de associação entre o sobrepeso/obesidade e os fatores foi feita por meio da razão de incidência, com realização de análises brutas e ajustadas.

Resultados

Entre as 222 crianças sem sobrepeso/obesidade em 2008, nove (4,00%) delas passaram a essa condição em 2010, sendo encontrada uma incidência acumulada de sobrepeso/obesidade de 4,05% (1,4-6,7). A incidência acumulada de sobrepeso/obesidade deste estudo foi de 20,25/ano/1000, semelhante à densidade de incidência que resultou em 20,65/ano/1000.

Conclusão

Nenhum dos fatores investigados associou-se significativamente ao sobrepeso/obesidade nesta população após a análise ajustada. No entanto, a carência de estudos que investiguem a incidência de sobrepeso e obesidade em pré-escolares revela a necessidade de que novos estudos longitudinais sejam realizados a fim de abranger um maior número de pré-escolares e incluir, além da incidência de sobrepeso/obesidade, outros fatores, como a influência do estado nutricional dos pais no estado nutricional dos filhos.

Termos de indexação: *Pré-escolar. Incidência. Obesidade. Sobrepeso.*

INTRODUCTION

In the last three decades, the growing prevalence of overweight/obesity in children and adolescents has been observed in many countries, including Brazil[1-5]. This phenomenon has been subject to studies and interventions by distinct scientists and institutions throughout the world, mainly of the health field, since plenty of scientific evidence show that overweight/obesity in this age group can persist through adulthood and promote other chronic noncommunicable diseases, increasing morbidity and mortality[6,7].

Nutritional status monitoring is essential to knowing the health conditions of the pediatric population[8-10]. Hence, *Unidades de Educação Infantil* (UEI, Child Education Centers) play an important role in the development of children aged six years or less because they allow the monitoring of the children's nutritional status; health promotion; and the identification of nutritional disorders and their distribution, social inequalities, and especially, the need of specific health and nutrition actions[11-18].

Thus, the use of anthropometric indices based on weight and height measurements is an important and valid strategy for analyzing nutritional status and following child growth, especially in population studies[8-10,18,19].

National and international studies confirm that overweight/obesity has become one of the main nutrition problems also in children aged six

years or less[1-5,8-22]. Despite the importance of nutritional status monitoring, most studies on early childhood obesity focus exclusively on cross-sectional assessments[8-22]. These studies are essentially prevalence studies, which calculate, estimate, or identify the frequency or number of overweight/obese cases in a given population and point in time, but they do not distinguish between new and old cases of the disease[23].

Studies that assess longitudinal changes in preschoolers' nutritional status are scarce[24]. Even scarcer are studies that assess the incidence of overweight/obesity in this age group - studies that calculate, estimate, or identify new cases[23,24]. The identification of new childhood cases of overweight/obesity can help to increase the efficacy of the health and nutritional care provided to this group, justifying the study.

The present study aims to analyze the incidence of overweight/obesity and associated factors in preschoolers attending the child education centers of *Florianópolis* (SC) over a two-year period.

METHODS

This longitudinal study included preschoolers aged four months to six years enrolled in seven public child education centers run by *Florianópolis'* Municipal Department of Education that participate in the Healthy Daycare Centers Project, a project conducted by *Santa Catarina's Centro Colaborador em Alimentação e Nutrição do Escolar* (Cecane, Schoolchildren's Food and Nutrition Collaborating Center). The said project develops health, food, and nutrition actions in health-promoting schools[25]. These child education centers were deliberately selected to participate in the study because they are located in four neighborhoods (or health territories) covered by trainees attending the class Nutrition in Public Health, of the *Universidade Federal de Santa Catarina*'s (UFSC) undergraduate nutrition program. The neighborhoods were *Agronômica, Córrego Grande, Saco Grande,* and *Rio Tavares*.

The Healthy Daycare Centers Project followed the children attending the child education centers for two years. This study cohort consists of the children anthropometrically assessed in April 2008 and April 2010. Since the project involves teaching/assistance activities developed jointly by the university and city hall, all children enrolled in the seven study centers should be included in the study. Therefore, this study involved a dynamic population and assumed that all children covered by the abovementioned project were anthropometrically assessed in 2008 (n=670). However, the cohort was defined as a fixed population, so only the children anthropometrically assessed on both occasions were included (n=242). Child education centers have a considerable child turnover. Additionally, many have to leave because these centers have an age limit (only those whose sixth birthday was after March 31, 2010, were allowed to attend the center in 2010).

To analyze incidence, all children diagnosed with overweight/obesity in 2008 were excluded from the cohort, a requirement for determining the new cases of overweight/obesity during the follow-up period.

Data collection for analyzing overweight/obesity-related factors was done in April 2010. For this purpose, a questionnaire created specifically for this study was sent to the children's parents along with the school schedule. Therefore, the study included only the children anthropometrically assessed on the two abovementioned occasions whose parents filled out the questionnaire and consented to their participation. The study variables were gender (male, female), age group (≤2 years, >2 years), program (part-time, full-time), type of institution (municipal or partner), family income per member (by income quartile), and parents' education level (≤7 years of formal education, >7 years of formal education). The parents' years of formal education was given by adding all the grades they passed, each grade considered one year of formal education, starting with the first grade of elementary school.

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Weight, length (for those aged less than two years) or height, age, and gender were collected as recommended by the World Health Organization[26] (WHO) in 1995 and Lohman[27]. Anthropometric measurements were performed by trained undergraduate students, supervised by the main researcher.

The outcome variable was overweight, which includes obesity, and is expressed herein as overweight/obesity, defined by a Z-score >+2 for Body Mass Index (BMI)-for-age and gender, according to the WHO curves[28,29]. The preschoolers were then divided into two groups: not overweight/obese (Z-score ≤+2) and overweight/obese (Z-score >+2).

Nutritional status was determined by the software Anthro Plus, and the statistical analyses were performed by the software Data Analysis and Statistical Software (Stata) version 11.0.

Outcome was measured by accumulated incidence and incidence density. Accumulated incidence was given by the number of new overweight/obese cases during the study period divided by the population exposed to the risk of overweight/obesity at the beginning of the follow-up. Incidence density was given by dividing the total number of cases in the study period by the number of children-year[23].

The Chi-square test measured the differences in the proportion of overweight/obesity at the end of two years and the changes between the categories of the study factors with a Confidence Interval of 95% (95%CI) and a significance level of 5% ($p<0.05$). The Rate Ratio (RR) measured the association between overweight/obesity and the study factors. Crude and adjusted Poisson regression analyses were performed with robust variance estimation for the RR and respective 95%CI.

This study was approved by UFSC's Human Research Ethics Committee under protocol number 090/08. Only children whose parents or guardians signed an informed consent form were included in the study.

RESULTS

Of the 670 children enrolled in 2008, 242 (36.1%) composed the study cohort. Of these, 222 (91.7%) were not overweight/obesity in 2008, thereby included in the analysis of incidence.

Table 1 compares the individual characteristics of the 670 children aged six years or less assessed in 2008 and those assessed in 2010 selected to compose the study cohort. The 95%CI and *p*-value of the initial population and cohort profiles are similar, except for age, weight, and height. In 2008, the mean ages (± standard deviation) of the population and cohort were 44.6 (±19.1) and 31.5 (±12.9) months, respectively, since children aged more than four years in 2008 were not present in 2010, so they were excluded from the cohort given that at age six years they complete child education in these centers. The same reason explains the different mean weights and heights of the population and cohort of 2008.

Although the mean age of the cohort in 2008 was smaller, the Z-scores of the BMI-for-age, weight-for-age, and height-for-age of the cohort in 2008 and 2010 were similar, reducing the likelihood of bias.

The mean family income of the cohort was 2.7 minimum salaries (R$1,377.00), and the median was 2.35 minimum salaries (R$1,198.50).

Table 2 shows other cohort characteristics, such as family income per member and parents' education level. Approximately half of the cohort had a family income per member equal to R$300.00 or less, and a little more than 60% of the parents had more than seven years of formal education.

According to BMI-for-age, the prevalence of overweight/obesity in the cohort decreased from 8.3% (95%CI: 4.5-12.1) in 2008 to 7% (95%CI: 3.5-10.5) in 2010, but the difference is not significant. Figure 1 shows the prevalence of non-overweight/obese and overweight/obese children by gender. Although in 2008 overweight/

Table 1. Characteristics of the study population in 2008 compared with the characteristics of the children selected for the study cohort in 2008 by gender, age, type of institution, program, nutritional status according to body mass index-for-age, and mean age, gender, height, and Z-score. *Florianópolis* (SC), Brazil, 2008.

Individual characteristics	Population 2008 N=670 (%)	95%CI	Cohort 2008 N=242 (%)	95%CI	*p*
Gender					
Female	333 (49.7)	(45.9-53.5)	117 (48.3)	(44.9-58.5)	0.598
Male	337 (50.3)	(46.5-54.1)	125 (51.7)	(41.5-55.1)	
Age					
≤24 months	133 (19.9)	(16.9-22.9)	80 (33.1)	(26.7-39.5)	<0.001
>24 months	537 (80.1)	(77.1-83.1)	162 (66.9)	(60.5-73.3)	
Institution					
Public	583 (87.0)	(84.5-89.5)	222 (91.7)	(87.9-95.5)	0.006
Partner	87 (13.0)	(10.5-15.5)	20 (8.3)	(4.5-12.1)	
Program[*]					
Part-time	93 (13.9)	(11.3-16.5)	30 (12.4)	(7.9-16.9)	0.213
Full-time	543 (81.0)	(78.0-84.0)	212 (87.6)	(83.1-92.1)	
Nutritional status[†]					
Overweight/obese	52 (7.8)	(4.1 - 11.5)	20 (8.3)	(4.5-12.1)	0.721
Not overweight/obese	617 (92.2)	(88.5 - 95.9)	222 (91.7)	(87.9-95.5)	
Characteristics	Mean ± SD		Mean ± SD		
Age (months)	44.60 ± 19.10		31.50 ± 12.90		<0.001
Weight (kg)	16.30 ± 4.40		13.70 ± 3.00		<0.001
Height (cm)	98.90 ± 13.10		90.40 ± 10.50		<0.001
BMI	16.40 ± 1.70		16.60 ± 1.50		0.106
BMI-for-age Z-score	0.56 ± 1.602		0.64 ± 0.97		0.290
Weight-for-age Z-score	0.24 ± 1.03		0.28 ± 0.98		0.601
Height-for-age Z-score	-0.23 ± 1.06		-0.25 ± 1.09		0.803

Note: [*]Data missing for 34 children in the population of 2008; [†]Data of a child with Z-score >+5 were removed from the nutritional status analysis. 95%CI: Confidence Interval of 95%; BMI: Body Mass Index; SD: Standard Deviation.

Table 2. Family income per member and parents' education level of the children reassessed in 2010. *Florianópolis* (SC), 2010.

Family characteristics[*]	N (%)		95%CI	
Income per member[†]				
1st and 2nd quartiles (≤R$300.00)	83 (51.5)		(40.6-62.9)	
3rd and 4th quartiles (>R$300.00)	78 (48.4)		(37.2-60.3)	
Education level[‡]	*Maternal*	*Paternal*		
≤7 years of formal education	45 (36.6)	46 (39.6)	(-0.1-3.3)	(0.0-0.0)
>7 years of formal education	78 (63.4)	70 (60.4)	(8.4-17.6)	(10.6-20.4)

Note: [*]Data collected in 2010; [†]Income data collected in 2010; information not available for 81 children; [‡]Education level data of 119 mothers and 126 fathers were missing.
95%CI: Confidence Interval of 95%.

obesity was more prevalent in males, over two years its prevalence in males decreased from 10.4 to 7.2%, and in females it increased from 6.0 to 6.8%. However, the differences were not significant.

Nine (4%) of the 222 non-overweight/obese children in 2008 were overweight/obese in 2010. On the other hand, only eight (40%) of the twenty overweight/obese children in 2008 were still overweight/obese in 2010.

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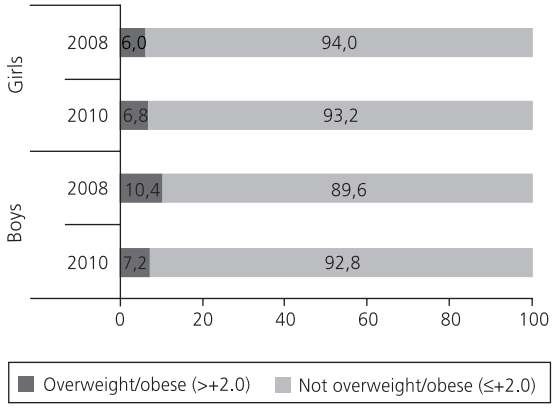

Figure 1. Prevalence of overweight/obesity in the cohort in 2008 and 2010 by gender. *Florianópolis* (SC), Brazil, 2010.

Note: *p*-values=0.790 in girls and 0.372 in boys.

Considering the number of overweight/obese children in 2008, the accumulated incidence was nine new cases in two years, which corresponds to an incidence of 4.05% (1.4-6.7) in the study cohort. The incidence density was very similar at 4.13% (1.4-6.8). Hence, the accumulated incidence of overweight/obesity in the study cohort was 20.25/year/1000, similar to the incidence density of 20.65/year/1000.

Table 3 shows the overweight/obesity rate ratios, crude and adjusted for gender, age group, family income per member, and parents' education level.

None of these factors were significantly associated with overweight/obesity in this cohort. It was not possible to analyze the effect of the program (part-time or full-time) and type of institution (municipal or partner) on outcome because none of the non-overweight/obese children attending the centers part-time or attending partner centers were overweight or obese at the end of the two-year follow-up.

DISCUSSION

In 2008 the prevalence of overweight/obesity in the study cohort (7.8%) was half of that found by the *Pesquisa Orçamento Familiares* (Family Budget Survey) of 2008-2009[2], which

Table 3. Rate ratio by gender, age group, family income per member, and parents' education level. *Florianópolis* (SC), 2010.

Characteristics*	N	Crude analysis		Adjusted analysis
		Incidence (%)	RR (95%CI)	RR (95%CI)
Gender			*p*=0.714	*p*=0.541
Male	112	3.6	1.00	1.00
Female	110	4.5	1.27 (0.35-4.63)	1.51 (0.40-5.69)
Age			*p*=0.512	*p*=0.605
≤24 months	72	2.8	1.00	1.00
>24 months	150	4.7	1.68 (0.36-7.91)	1.51 (0.32-7.18)
Income per member†			*p*=0.367	*p*=0.629
1st and 2nd quartiles	81	6.2	1.00	1.00
3rd and 4th quartiles	68	2.9	0.48 (0.10-2.39)	0.67 (0.13-3.45)
Mother's education level‡			*p*=0.079	*p*=0.079
≤7 years of formal education	41	9.8	1.00	1.00
>7 years of formal education	71	1.4	0.14 (0.02-1.25)	0.14 (0.02-1.25)
Father's education level‡			*p*=0.369	*p*=0.950
≤7 years of formal education	43	7.0	1.00	1.00
>7 years of formal education	64	3.1	0.45 (0.08-2.58)	0.95 (0.20-4.56)

Note: *Data collected in 2010; †Income data collected in 2010. This information is missing for 81 children; ‡Analysis includes only the education level data of 112 mothers and 107 fathers. This data was missing for 119 mothers and 126 fathers; *p*-value with Yates' correction.
95%CI: Confidence Interval of 95%; RR: Rate Ratio.

found a prevalence of 16.2% in five-year-old Brazilians. It was also smaller than the prevalence of 12.5% found in four-year-olds from *Feira de Santana* (BA)[30], and similar to those found by the *Pesquisa Nacional de Demografia e Saúde* (PNDS, National Survey on Demography and Health) of 2006[31] (6.6%) and by a study done in *São Leopoldo* (RS) (9.8%)[8] with children below five years of age. The four studies above assessed overweight/obesity using the reference populations of the WHO's curves[28,29] and the same cut-off points used herein.

Low family income per member may justify the prevalence of overweight/obesity even though income was not associated with overweight/obesity in the study cohort. Moreover, self-reported income requires caution because sometimes family members have informal jobs, preventing them from reporting accurate incomes, or underreport income when low income is a selection criterion of public child education centers[32].

Regarding education, 36.6% of the mothers and 39.6% of the fathers did not complete elementary school, and only 8.1% and 4.3%, respectively, had higher education. Parents' education level was not associated with overweight/obesity. Knowing the parents' education level is important because education directly influences child care, job opportunities, and salaries that promote better life conditions[32]. Food availability increases with family purchasing power and education level. Parents' education level, especially the mother's, also promotes better use of the income and access to public services[33].

Although higher maternal education levels did not affect the rate ratio significantly (RR=0.14; 95%CI=0.02-1.25) (Table 3), they tended to protect against overweight/obesity, opposing most studies conducted in Brazil[31,34-37] and other medium-income countries where higher maternal education level is usually associated with childhood overweight/obesity.

The number of children attending the study child education centers who continued to be overweight/obese after two years is concerning. However, the scarcity of studies with similar design, or the authors' inability to find them, limits interpreting the dimension of the study results, since the Brazilian literature has no parameters for such comparison. Studies on the food and nutrition of Brazilian preschoolers published from 2008 to April 2014 and indexed in the Scientific Electronic Library Online (SciELO) database are essentially cross-sectional or prevalence studies[8-22]. This scarcity reinforces the need of studies with other designs, especially observational follow-up or interventional design.

Nine children (4.05%) in the study cohort became overweight/obese in the two-year follow-up. A study done in *Pelotas* (RS) with 1,273 children aged one to four years found that 10.9% became overweight/obese over a three-year follow-up and that one-third of the overweight 12-month-old children were still overweight/obese at age four years[24]. In the study cohort, 40.0% of the children were still overweight/obese after two years. These data indicate that accumulated incidence decreases over time, reinforcing the need of long-term actions.

Gender, age group, program (part-time, full-time), type of institution (public, partner), family income per member, and parents' education level were not associated with overweight/obesity in the study cohort. Possible explanations for the absence of associations include sample size and number of new cases of overweight/obesity in the two-year study period. The limited information on family income and parents' education level should also be considered explanations. Nevertheless, children with missing family income per member and parents' education level were still included in the regression analysis to prevent the test from losing power between groups, so these results were probably unaffected. In this sense, new studies with larger samples, longer follow-ups, and better collection of socioeconomic variables are needed to overcome the study limitations.

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The fact that 60% of the overweight/obese children in 2008 were not overweight/obese in 2010 draws attention. This may be due to center attendance, where nutritional status is monitored regularly, to the health-promoting actions conducted in the study centers, and/or to specific health and nutrition actions described in the Introduction. However, this explanation should be taken with caution because of the aforementioned study design-related issues. In this sense, this also reinforces the importance of conducting intervention studies that prevent and treat preschooler overweight/obesity and allow assessment of intervention effectiveness.

The lack of studies on the incidence of preschooler overweight and obesity calls for new longitudinal studies with a larger number of preschoolers that investigate not only the incidence of overweight/obesity but also other factors, such as the influence of the parents' nutritional status on the offspring's nutritional status, food intake, breastfeeding habits, and physical activity, among others.

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COLLABORATORS

CFB MENEZES helped to collect and analyze the data, and write and review the manuscript. J NEVES helped to plan the study, collect and analyze the data, and review the manuscript. PS GONSALEZ helped to analyze the data and review the manuscript. FAG VASCONCELOS coordinated the study planning and design, supervised data collection, data analysis, and manuscript writing, and reviewed the manuscript.

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C-reactive protein and cardiometabolic risk factors in overweight or obese children and adolescents[1]

Proteína C-reativa e fatores de risco cardiometabólicos em crianças e adolescentes sobrepeso ou obesidade

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ABSTRACT

Objective

To investigate the relationship between ultrasensitive C-reactive protein and cardiometabolic risk factors in overweight or obese childrenand adolescents.

Methods

Cross-sectional study conducted at the Center for Childhood Obesity in the period from April 2009 to April 2010, involving 185 overweight children and adolescents aged 2 to 18 years. Measures of ultrasensitive C-reactive protein according to age, nutritional status, gender, race, cardiometabolic risk factors (waist circumference, lipid profile, impaired fasting glucose, high blood pressure and presence of insulin resistance) were compared through the Chi-square test and analysis of variance. All analyses were performed using the Statistical Package for the Social Sciences software version 17.0, adopting a significance level of 5%.

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Results

Altered high-density lipoprotein was the most frequent cardiometabolic risk factor, and there was a significant association between altered ultrasensitive C-reactive protein values and severe obesity (p=0.005), high waist circumference (p<0.001), hypertriglyceridemia (p=0.037) and insulin resistance (p=0.002), as well as significantly higher body mass index (p=0.000), waist circumference (p=0.001), insulin (p=0.005) and index of glucose homeostasis values(p=0.005).

Conclusion

High prevalence of altered ultrasensitive C-reactive protein and significant association with severe obesity, waist circumference, hypertriglyceridemia and insulin resistance were observed.

Indexing terms: C-reactive protein. Cardiovascular diseases. Obesity. Risk factors.

R E S U M O

Objetivo

Verificar a relação existente entre a proteína C-reativa ultrassensível e fatores de risco cardiometabólicos em crianças e adolescentes com sobrepeso e obesidade.

Métodos

Estudo transversal realizado no Centro de Obesidade Infantil, no período de abril/2009 a abril/2010, envolvendo 185 crianças e adolescentes entre 2 e 18 anos com excesso de peso. Foram comparadas as medidas de proteína C-reativa ultrassensível de acordo com a faixa etária, estado nutricional, sexo, raça, fatores de risco cardiometabólicos (circunferência abdominal, perfil lipídico, glicemia de jejum alterada, pressão arterial elevada e presença de resistência insulínica) através do teste do Qui-quadrado e da análise de variância. Todas as análises foram realizadas com a versão 17.0 do programa Statistical Package for the Social Sciences*, adotando-se o nível de significância de 5%.*

Resultados

A lipoproteína de alta densidade alterada foi o fator de risco cardiometabólico mais frequente; houve uma associação significativa entre os valores da proteína C-reativa ultrassensível alterada e obesidade acentuada (p=0,005), circunferência abdominal elevada (p<0,001), hipertrigliceridemia (p=0,037) e resistência insulínica (p=0,002), bem como com valores significativamente mais elevados do índice de massa corporal (p=0,000), circunferência abdominal (p=0,001), insulina (p=0,005) e Modelo de Avaliação da Homeostase (p=0,005).

Conclusão

Observou-se uma alta prevalência da proteína C-reativa ultrassensível alterada e uma associação significativa com obesidade acentuada, circunferência abdominal elevada, hipertrigliceridemia e resistência insulínica.

Termos de indexação: *Proteína C-reativa. Doenças cardiovasculares. Obesidade. Fatores de risco.*

I N T R O D U C T I O N

The changing epidemiological, demographic and nutritional profile characterized by reduced incidence of infectious or communicable diseases followed by increased incidence of non-communicable chronic diseases among children and adolescents has set new challenges in the fields of health care, research, and management of resources related to health in this age group[1].

The increased consumption of highly caloric foods and decreased physical activities have contributed to the increased prevalence of obesity and overweight in the population, especially in children and adolescents, causing the emergence of ever earlier complications, such as systemic hypertension, Type-2 Diabetes *Mellitus*, dyslipidemia, obstructive sleep apnea and some cancers[2,3]. Due to its negative effects on cardiovascular structure and function, obesity also has a major impact on Cardiovascular Diseases (CVD) such as atherosclerosis[4].

Once considered mere deposit of fat, the adipose tissue is now seen as an active endocrine

and paracrine organ producer of several inflammatory cytokines. In the last two decades, the remarkable development in the field of vascular biology has clarified that atherosclerotic lesions are indeed a series of highly specific and dynamic cellular and molecular responses mainly inflammatory in nature[5].

The importance of recognizing obesity as an inflammatory state is due to the possibility of inflammation being one of the links between obesity, insulin resistance, high blood pressure (hypertension) and cardiovascular disease[6].

The C-Reactive Protein (CRP) is a non-glycosylated polymer composed of five identical subunits. It is produced by the liver in order to combat invading antigens. Its synthesis by the liver is triggered by the release of some types of cytokines by inflammatory cells, particularly Interleukin-6[7].

The relationship of CRP to plasma lipoproteins has been known for over 60 years, but the first suggestion of a possible association with atherosclerosis came with the observation that the protein selectively binds to Low Density Lipoprotein (LDL)[7]. Since then, several studies have demonstrated the relationship between CRP levels and morbidity and mortality associated with CVD[8].

It has been speculated that CRP may have significant pro- inflammatory effects and, upon binding to molecules exposed on the cells (resulting from infection, inflammation, ischemia, and other disorders) and triggering the activation of the complement, it may exacerbate tissue damage[9]. Elevated CRP levels may reflect increased formation of atherosclerotic plaques, higher tendency to plaque rupture and thrombosis[3].

Based on the strong correlation between anthropometric parameters, lipid profile, CRP and cardiovascular risk widely described in the adult population, this study aims to assess the relationship between CRP and cardiometabolic risk factors in overweight children and adolescents.

METHODS

This is a cross-sectional study conducted at the Center for Childhood Obesity (COI) from April 2009 to April 2010. The COI is the reference service in obesity of *Campina Grande* (PB) with a multidisciplinary team composed of endocrinologists, nutritionists, psychologists, nurses, pharmacists, social worker and physical trainer and treatsoverweight children and adolescents referred by Basic Health Units.

This study was approved by the research ethics committee of the *Universidade Estadual da Paraíba* (UEPB) through CAAE 0040.0.133.000-08 on August 30, 2008, and all participants signed the Free and Informed Consent Form prior to their inclusion in the sample.

The sample size was calculated considering the juvenile population of the city of *Campina Grande* (PB) of 65,890 children and adolescents aged from 2 to 18 years registered in December 2008 in the *Sistema de Informação de Atenção Básica* (SIAB, Primary Care Information System). The study also considered prevalence of overweight and obesity of 25%[10] and metabolic syndrome of 42% in Brazilian children and adolescents with this condition[11], for a total of 200 children and adolescents after addition of 20% of eventual losses. Of these, two were excluded due to the use of corticosteroids and two were considered as loss for not attending blood collection. For purposes of statistical analysis, 11 were excluded for showing CRP equal or greater than 10 mg/dL, and the final sample was composed of 185 children and adolescents.

A questionnaire including socioeconomic personal and family history issues was applied and anthropometric measurements and laboratory tests were performed.

Anthropometric data (weight, height and waist circumference) were recorded in duplicate, using the mean value of the two measurements. Weight was measuredusing a platform-type Welmy® digital scale with capacity of 150 kg and precision of 0.1 kg. Height was measured using a

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Tonelli® stadiometer to the nearest 0.1 cm and Waist Circumference (WC) was measured with inelastic Cardiomed® measure tape with precision of 0.1 cm at the midpoint between the top edge of the iliac crest and the last costal margin. During the measurement, the individual should be wearing light clothing and procedures recommended by World Health Organization[10] were followed.

For classification of the nutritional status, Body Mass Index (BMI) was calculated as recommendations of the Centers of Disease Control and Prevention, and the following categories were used: overweight (85 ≤BMI <95) and obesity (≥95th percentile)[11].

Blood pressure was measured three times with rest intervals of approximately two minutes according to method established in the "VI Brazilian Guidelines on Blood Hypertension"[12], with Tycos® mercury sphygmomanometer using cuffs of appropriate sizes. The average of the last two systolic and diastolic pressure measurements was considered.

Blood collection was performed after a 12-hour fasting period at the Clinical Laboratory of the UEPB. Total Cholesterol (TC), High Density Lipoprotein-cholesterol (HDL-c), Triglycerides (TG) and blood glucose were assessed by the enzymatic colorimetric method in automatic equipment (Model BioSystems® 310), according to recommendations of the Labtest® kit manufacturer. To calculate LDL-c, the Friedewald's formula was used: LDL-c= TC-HDL-c-TG/5, which is valid for TG levels lower than 400 mg/dL. Values adopted in the "I Guideline for Prevention of Atherosclerosis in Childhood and Adolescence" were considered as reference[13].

Insulin and us-CRP values were determined by chemiluminescence on an outsourced laboratory with quality seal, the latter being measured in Immulite 1000 automated equipment (Siemens®). Us-CRP values (dependent variable) greater than 3 mg/L were considered high, and those with us-CRP values greater than or equal to 10 mg/L were excluded for suggesting acute infectious or inflammatory process[14].

As a criterion for the diagnosis of insulin resistance, the Homeostatic Model Assessment - Insulin Resistance (HOMA-IR) index described by Matthews *et al*.[15] and validated by several authors for epidemiological studies was used, which is the product of fasting insulin (μUI/mL) and fasting glucose (mmol/L) divided by 22.5[16,17]. As cutoff, HOMA-IR ≥2.5 was used[18].

The following cardiometabolic risk factors were considered: WC ≥90th percentile, with maximum limit of 88 cm for girls and 102 cm for boys[19]; Systolic and/or diastolic blood pressure ≥90th percentile; TC ≥170 mg/dL , LDL-c ≥130 mg/dL, TG ≥130 mg/dL and HDL-c <45 mg/dL; fasting glucose ≥100 mg/dL; HOMA-IR ≥2.5.

The sample was described by absolute and relative frequency of variables. The evaluation of the association between CRP with socio-demographic variables (gender, race, maternal education, age group) and cardiometabolic risk factors was performed using the Chi-square test. The comparison of the average CRP according to the presence of cardiometabolic risk factors was assessed by analysis of variance. All analyses were performed using the Statistical Package for the Social Sciences (SPSS) software version 17.0 and significance level of 5% was adopted.

RESULTS

Of the 185 children and adolescents that composed the sample, most were female (67.6%), belonged to the adolescent age group (62.6%) and had income equal to or less than 2 minimum wages (59.4%). Regarding nutritional status, prevalence of severe obesity (65.4%) was observed.

It was found that low HDL was the most common cardiometabolic risk factor (81.6%), followed by high WC (79.5%). Regarding systemic blood pressure, Diastolic Blood Pressure (DBP) showed higher levels compared with Systolic

Table 1. C-reactive protein in overweight children and adolescents according to socio-demographic, anthropometric and metabolic variables. Centre for Childhood Obesity, *Instituto Saúde Elpídeo de Almeida*, *Campina Grande* (PB), Brazil, 2008-2010.

Variables	CRP				*p*
	High		Normal		
	n	%	n	%	
Gender					0.784
Male	18	30.0	42	70.0	
Female	40	32.0	85	68.0	
Age group					0.388
Childhood (2-9 years)	19	27.5	50	72.5	
Adolescence (10-18 years)	39	33.6	77	66.4	
Nutritional status					**0.005**
Obesity	55	35.5	100	64.5	
Overweight	3	10.0	27	90.0	
Income					0.869
≤2 MW	31	30.7	70	69.3	
>2 MW	22	31.9	47	68.1	
WC					<0.001*
High	56	38.1	91	61.9	
Normal	2	5.3	36	94.7	
SBP					0.099
SBP ≥P90	27	38.6	43	61.4	
SBP <P90	31	27.0	84	73.0	
DBP					0.919
DBP ≥P90	37	31.1	82	68.9	
DBP <P90	21	38.1	45	68.2	
TG					**0.037**
High	29	40.3	43	59.7	
Normal	29	25.7	84	74.3	
HDL-c					0.277
Reduced	50	33.1	101	66.9	
Normal	8	23.5	26	76.5	
LDL-c					0.571
High	10	35.7	18	64.3	
Normal	47	30.3	108	69.7	
TC					0.659
High	22	29.3	53	70.7	
Normal	35	32.4	73	67.6	
Blood glucose					1.00*
High	1	33.3	2	66.7	
Normal	57	31.3	125	68.7	
Insulin resistance					**0.002**
Present	34	43.6	44	56.4	
Absent	23	21.9	82	78.1	

Note: *p Fischer. The highlighted numbers represent the associations between the variables (p<0.05).

CRP: C-Reactive Protein; MW: Minimum Wages; WC: Waist Circumference; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; TG: Triglycerides; HDL-C: High Density Lipoprotein-Cholesterol; LDL-C: Low Density Lipoprotein-Cholesterol; TC: Total Cholesterol.

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Blood Pressure (SBP) (64.3, 37.8%, respectively). Insulin resistance was diagnosed in 42.6% of overweight children and adolescents. Furthermore, over half of them already had 3 or more cardiometabolic risk factors.

CRP was greater than 3 mg/L in 31.4% of children and adolescents. There was a significant association between high CRP values and obesity (p=0.005), elevated WC (p<0.001), high triglyceride levels (p=0.037) and insulin resistance (p=0.002) (Table 1).

In the analysis of variance to compare the means of anthropometric and metabolic variables, significantly higher BMI (p<0.001), WC (p=0.001), TG (p=0.008), SBP (p=0.009), insulin (p=0.005), HOMA-IR values (p=0.005) and lower HDL values(p=0.008) were observed in those with elevated CRP levels (Table 2).

DISCUSSION

In the present study, a high frequency of altered CRP was observed. Norton *et al.*[20] in a study with 131 obese or overweight children and adolescents showed similar results (26.7%) of us-CRP >3 mg/dL.

Although no significant association of CRP with gender and age was observed, there was a higher prevalence of high CRP among females and adolescents,which corroborateda study conducted with 164 adolescents in two schools in England that showed no significant differences in the CRP concentrations among boys and girls[21].

Prevalence of severe obesity among children and adolescents was observed,since the health service in which this study was conducted is reference for the population of overweight children and adolescents.

Low High Density Lipoprotein-cholesterol was the most frequent cardiometabolic risk factor. Other authors[3,22] also found that low HDL values, regardless of nutritional status, questioned whether the cutoff would be ideal for this population or such outcomes would already be indicative of a serious public health problem.

The relationship of CRP with other cardiometabolic risk factors showed a significant association between elevated CRP values and

Table 2. Mean values and standard deviation of CRP according to clinical variables and cardiometabolic risk factors in 185 overweight children and adolescents. Centre for Childhood Obesity, *Instituto Saúde Elpídeo de Almeida*, Campina Grande (PB), Brazil. 2008-2010.

Variables	CRP				*p*
	High		Normal		
	Mean	SD	Mean	SD	
Age (years)	11.48	3.48	11.09	3.78	0.508
WC (cm)	90.48	12.71	83.61	12.24	0.001
BMI (kg/m²)	29.38	4.85	26.25	4.02	<0.001
TG (mg/dL)	149.88	78.69	121.53	60.27	0.008
SBP(mmHg)	111.04	11.02	106.24	11.73	0.009
DBP (mmHg)	72.94	9.39	72.02	9.80	0.551
Blood glucose (mg/dL)	82.10	8.27	80.85	7.42	0.306
Insulin (mg/dL)	14.88	9.53	11.14	7.69	0.005
HOMA-IR	3.04	1.98	2.26	1.58	0.005
TC	163.49	39.76	164.06	35.70	0.923
LDL-c	97.22	30.45	100.40	29.81	0.505
HDL-c	35.83	7.41	39.30	8.52	0.008

Note: CRP: C-Reactive Protein; WC: Waist Circumference; BMI: Body Mass Index; TG: Triglycerides; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; HOMA-IR: Index of Glucose Homeostasis; TC: Total Cholesterol; LDL-C: Low Density Lipoprotein-Cholesterol; HDL-C: High Density Lipoprotein-Cholesterol; SD: Standard Deviation.

severe obesity, WC, insulin resistance and hypertriglyceridemia.

In the Cardiovascular Health Study, CRP was also positively correlated with BMI, indicating that, although there is no single cut off for CRP, children and adolescents included in the study showed a subclinical inflammation process associated with obesity[23].

Obesity is a potent risk factor for metabolic and cardiovascular disease at population level. At individual level; however, the correlation between BMI and cardiovascular disease is not always simple due in part to differences in the fatty tissue deposits, overall rate of adipocyte dysfunction, tissue vascularity, and local level of inflammation[21].

Abdominal adipose tissue verified by high WC has been considered a predictor of elevated us-CRP concentrations due to significant expression of this protein in the deposits of abdominal, visceral and subcutaneous fat. Although the relationship between CRP and various cardiometabolic risk factors is well documented in adults but not in adolescents, Denney-Wilson *et al.*[24] recently reported that obesity and elevated WC levels in adolescents were associated with CRP.

The understanding of the relationship between inflammation process and the pathophysiology of insulin resistance in the context of cardiometabolic risk factors is based on the abdominal adipose tissue, proven in animal models submitted to surgical removal of the omentum, which showed the remission of all risk factors. The importance of removing the omentum to improve the metabolic profile was also observed in humans according to the best results found in patients with level 3 obesity undergoing gastroplasty associated with the removal of the greater omentum compared to those who underwent only gastroplasty[21].

In this sense, other studies with children and adolescents found that the accumulation of abdominal fat and hyperinsulinemia are associated with a thrombogenic and inflammatory profile. Cameron *et al.*[25] used data from three cohorts and showed that the abdominal waist circumference can predict the outbreak of four to five other cardiometabolic risk factors, indicating that visceral obesity plays a central role in the development of the metabolic syndrome and seems to precede the onset of other risk factors such as elevated CRP.

Studies have suggested the occurrence of increased cardiovascular risk from obesity (identified by either BMI or waist circumference), followed by subclinical inflammation (defined by CRP), dyslipidemia, and insulin resistance. A case-control study with children and adolescents found that obese individuals with IR have 10 times higher CRP levels than control subjects[3].

A study conducted with 209 Chilean children reported that CRP is able to predict the presence of a greater number of cardiometabolic components that lead to faster development of atherosclerosis in adulthood[26].

Children and adolescents in this study had an overall mean CRP of 2.6 mg/dL. In the analysis of variance, it was observed that the mean BMI, WC, insulin and HOMA values were significantly higher in those with altered CRP.

The significantly higher BMI values (severe obesity) during childhood and adolescence and increased inflammation can promote the activation of mechanisms related to the onset of the atherosclerotic process[26]. Serrano *et al.*[27] also found higher mean insulin and HOMA values among overweight adolescents, although no significant correlation with any of the variables (weight, height, BMI, body fat percentage, waist circumference, hip circumference and waist-hip ratio) was found.

It was observed that in addition to the mean BMI, WC and HOMA values, triglycerides also arise as a factor associated with high CRP concentrations.

The increase in the amount of adipose tissue is directly related to hypertriglyceridemia and hypercholesterolemia. Some studies have

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indicated that excess weight is the risk factor most strongly associated with dyslipidemia and this is due to multiple metabolic causes: insulin resistance, hyperinsulinemia, hyperglycemia, increased protein transferring cholesterol esters secreted by adipocytes, among others[28].

The relationship between triglyceride concentrations and CRP was also observed by Simões[29]. According to the author, this association suggests that an unfavorable lipid profile leads to increased inflammatory activity.

Although it is well established that overweight prospectively leads to chronic inflammation, it is also plausible that inflammation may precede overweight.

Thus, one limitation of this study is its cross-sectional nature, in which there is no way to determine the direction of the association between inflammatory markers and overweight; moreover, it is important to observe that among the studies conducted in Brazil, the amount of longitudinal designs with children and adolescents is still reduced.

It is known that the concept of "sum of cardiometabolic components" is more important from the predictive point of view than the absolute definition "presence-absence" of the metabolic syndrome[30].

Few studies have shown a precise relationship between obesity and inflammatory markers, especially in the age range evaluated here. Therefore, this study aims at detecting factors associated with cardiometabolic alterations, allowing early identification and intervention and the consequent reduction in morbidity and mortality rates for cardiovascular and metabolic diseases.

CONCLUSION

A high frequency of high us-CRP and a significant association with severe obesity, elevated WC, hypertriglyceridemia and insulin resistance were observed. Considering these findings and demonstratingthat CVD may have their origin in childhood and adolescence, us-CRP levels should be used in screening for the assessment of cardiometabolic risks, thereby contributing to early and possibly more effective intervention on these factors, reducing morbidity and mortalityin the near future.

CONTRIBUTORS

AS CARDOSO participation in project design, data analysis and final review of the manuscript. RO OLIVEIRA formatting and final review of the manuscript. DF CARVALHO final review of the manuscript. N COLLET final review of the manuscript. CCM MEDEIROS participation in project design, data analysis and final review of the manuscript.

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Organic foods from family farms in the National School Food Program: Perspectives of social actors from *Santa Catarina*, Brazil

Alimentos orgânicos da agricultura familiar no Programa Nacional de Alimentação Escolar: perspectivas de atores sociais em municípios de Santa Catarina

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ABSTRACT

Objective

To analyze suggestions that facilitate the use of organic foods produced by family farms made by the social actors responsible for *Santa Catarina*'s school meals.

Methods

This qualitative and exploratory study used an electronic questionnaire for surveying 293 municipalities in the state of *Santa Catarina* in 2010 and identified the percentage of organic school foods purchased from family farms. The social actors from 52 municipalities who were responsible for organic food acquisition were interviewed in person. Their suggestions were categorized and analyzed by content analysis.

Results

A total of 446 social actors made 684 suggestions categorized into four themes: *Awareness strategies for the use of organic foods* (n=286) were proposed by principals and dieticians, who emphasized the need of educating social actors and community and raising community awareness; Better *Programa Nacional de Alimentação Escolar* management (n=148) was suggested by principals and family farmers, who wanted less bureaucracy and outsourcing, fewer taxes, and more management involvement; Better coordination between the *demand and supply of organic foods* (n=130) was suggested by principals, family farmers, and cooks because of logistic

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and supply problems; and *Better management of school food production* (n=120) was suggested by principals and cooks, who reported problems with the supply of specific foods, low organic food diversity, and lack of certification.

Conclusion

For the social actors, the use of organic foods in the schools of *Santa Catarina* requires the education of those involved (technical support, educational strategies, and community awareness), government support, coordination between demand and supply, and better management of organic food production.

Indexing terms: Agriculture. Content analysis. Food, organic. School feeding.

RESUMO

Objetivo

Analisar sugestões de atores sociais da alimentação escolar em municípios de Santa Catarina para facilitar a utilização de alimentos orgânicos da agricultura familiar.

Métodos

Estudo qualitativo e exploratório. Em 2010, foi realizado censo nos 293 municípios catarinenses com questionário eletrônico, identificando-se o percentual de compras de alimentos orgânicos da agricultura familiar para a alimentação escolar. Em seguida, foram entrevistados in loco *atores sociais de 52 municípios que realizavam a compra. As sugestões foram categorizadas e analisadas com base na técnica de análise de conteúdo.*

Resultados

Foram identificadas 684 sugestões de 446 atores sociais, categorizadas em 4 temas: Estratégias de Sensibilização para a utilização dos alimentos orgânicos (n=286) foram destacadas por diretores e nutricionistas, com ênfase para formação e sensibilização de atores sociais e comunidade; Gestão Governamental do programa (n=148) foi tema de diretores e agricultores familiares que destacaram diminuição da burocracia, dos impostos, da terceirização e maior envolvimento dos gestores; Programação da Demanda e Oferta de alimentos orgânicos (n=130) foi apontada por diretores, agricultores familiares e merendeiras pelas dificuldades de logística e necessidade de organização da oferta e demanda dos alimentos orgânicos e Gestão da Produção da alimentação escolar (n=120) foi referida por diretores e merendeiras que relataram problemas com volume de um mesmo produto na safra, diversidade de alimentos orgânicos e certificação.

Conclusão

Para os atores sociais, a utilização dos alimentos orgânicos pelas escolas de Santa Catarina se dará pela formação dos atores (apoio técnico, estratégias educacionais e sensibilização comunitária), apoio governamental, organização entre demanda e oferta de alimentos orgânicos e melhoria na gestão da produção da alimentação.

Termos de indexação: *Agricultura. Análise de conteúdo. Alimentos orgânicos. Alimentação escolar.*

INTRODUCTION

The *Programa Nacional de Alimentação Escolar* (PNAE, National School Food Program) is a public policy that promotes Food and Nutrition Security, the Human Right to Adequate Food, and healthy school meals. PNAE, covering all Brazilian municipalities, aims to meet the nutritional needs of children while they are at school, promoting healthy food habits, growth and development, learning, and student performance[1].

The *Programa Nacional de Alimentação Escolar* guidelines are given by the Law nº 11.947[1] and Resolution/CD/FNDE n° 38, passed in July 2009[2]. One of the guidelines determines that at least 30% of the resources received from the *Fundo Nacional de Desenvolvimento da Educação* (FNDE, National Education Development Fund) be used for buying foods, preferably organic and/or eco-friendly foods, produced by local, regional, or domestic family farmers. According to Triches & Schneider[3] and Saraiva *et al.*[4], these guidelines fueled the local family farms that produce organic foods, increasing food supply and diversity, farmer income, and consumption of fresh foods; decreasing the amount of ultra-processed foods

consumed by schoolchildren and transportation costs; and establishing a direct link between farmers and consumers.

The policy requiring the acquisition of organic foods from family farmers may revive schoolchildren's intake of fresh foods. Studies conducted in Denmark[5-8], Finland[5,6,8], Norway[5,6,8], United States[9-14], Italy[5,6,8,15], and United Kingdom[15,16] reported difficulties of introducing organic foods in schools, and some suggested ways of facilitating their use. Despite PNAE's scope, the number of Brazilian studies on this subject is very small, especially those that investigate the perspective of social actors involved with the program.

Therefore, the present study revolves around the suggestions made by social actors that support and operate PNAE. Social control by the school community is critical not only to ensure the supply of foods associated with the broad concept of health (human, social, and environmental)[17] but also to guide future public policies and strategies that promote the local acquisition of organic foods in the study municipalities and coordinate its implementation and promotion in other municipalities[12,13,16,18,19].

In this context and in agreement with PNAE's guidelines, the objective of this study was to analyze the suggestions made by social actors to facilitate the use of organic foods in the schools of *Santa Catarina*.

METHODS

The study is part of a larger study conducted by *Santa Catarina*'s *Centro Colaborador em Alimentação e Nutrição Escolar* (Cecane/SC, Collaborating Center on Schoolchildren's Food and Nutrition), sponsored by the FNDE, called: "*Utilização de produtos provenientes da agricultura familiar e de gêneros orgânicos na alimentação de escolares e sua interface com o Programa Nacional de Alimentação Escolar em municípios do estado de Santa Catarina*" ("Use of family farm and organic products in school meals and its interface with the National School Food Program in *Santa Catarina*"). The larger study was approved by the Human Research Ethics Committee of the *Universidade Federal de Santa Catarina* under Protocol number 1005/10 and conducted in *Florianópolis*, capital of the state of *Santa Catarina*, located in the Southern Region of Brazil[20].

The *Centro Colaborador em Alimentação e Nutrição Escolar Santa Catarina* conducted the study in two stages. The first stage used an electronic questionnaire to survey all municipalities in *Santa Catarina* from May to August 2010, identifying the percentage of school foods produced by family farms and the schools buying organic foods.

Of the 63 study municipalities, nine incorrectly informed that they were buying organic foods, and another two were used in the pilot study. Hence, the study analyzed data from the 52 municipalities that met the inclusion criteria established in the first phase of the study.

The municipalities that acquired organic school foods from family farms were included in the second phase of the study, which consisted of using a semi-structured questionnaire to interview the pertinent social actors (family farmers, cooperative presidents, school food counselors, principals, dieticians, and cooks). The interviews with all social actors were scheduled in advance by the municipal dieticians.

The study used a qualitative and quantitative approach to analyze the last open question: "What would you suggest to facilitate the use of family farm and organic products in school meals?".

The questionnaires were self-administered except for the illiterate, who were helped by the interviewer. The interviewers then digitalized the answers, giving them with a four-digit code to protect the identity of the schools, social actors, and municipalities. The first digit identified the social actor; the second, the region; and the third and fourth, the school code.

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The categories were created according to the mixed model, that is, they were created before data analysis but could be modified if necessary[21]. The pre-analysis categories and respective units (suggestions) were given by the pertinent literature and organized as follows: logistics (less transportation time and improved purchasing system)[12,13,16]; quality control (better quality control and personnel training)[13,16]; menu planning (menu reformulation, taking season into account)[8,22]; government incentives (reducing prices and bureaucracy)[11,12,16]; and promotion methods (encouraging more organic food intake and providing more information to parents and students)[14].

The data were treated by content analysis, as recommended by Bardin[23]. Content analysis is a set of communication analysis techniques that use systematic and objective message content descriptions to obtain indicators, quantitative or not, that enable the inference of knowledge on the conditions in which these messages are created/received (inferred variables). It requires:

a) Pre-analysis of the interviews: Reading and organizing the information according to exhaustiveness criteria (the selected material covered all the necessary elements); representativeness (the truly representative documents were selected); homogeneity (all documents were chosen using the same technique); and pertinence (the material addressed the problem). These stages were created by Cecane/SC interviewers.

b) Material exploration: The data were codified by units (suggestions), which corresponded to the segment that would be considered a base unit. Once the units were chosen, a new categorization was performed, considering the pre-existing categories and the new findings. In this process, content elements grouped by similarity were organized into the pertinent analytic categories[21].

c) Treatment and interpretation of the results: The data were interpreted by category, consulting the pertinent literature to complement contemplation. The occurrence frequency of each unit (suggestion) was determined by the software Microsoft Excel version 2010, to determine whether the study elements differed between social actors. Suggestions made by different actors (identified by region) were used for illustrating some categories and subcategories.

Given the number of suggestions and social actors, the former was systematized by the latter; the units (suggestions) were purified, codified, and categorized one last time into themes and subthemes; and the categories were distributed by social actor.

RESULTS

The study included data from 52 municipalities located in six regions of *Santa Catarina*: Western Region (25), Mountain Region (4), *Itajaí* Valley Region (4), Northern Region (6), Southern Region (12), and Greater *Florianópolis* Region (1). A total of 713 social actors answered the questionnaire, but 212 were excluded because they made no suggestions, and 55, because they had no suggestions. Therefore, the study included 446 social actors (74 farmers, 14 cooperative presidents, 36 school food counselors, 167 principals, 46 dieticians, and 109 cooks).

Content analysis looked into the 684 suggestions made by 446 social actors to facilitate the use of organic foods in the schools of *Santa Catarina*.

The suggestions were grouped into four categories or themes and eight final subcategories (Chart 1), and listed by decreasing frequency.

The Western Region, followed by the Southern Region, had the highest number of suggestions.

The category *Awareness strategies for the use of organic foods* contained 41.8% of the suggestions (n=286), made mainly by principals (43.0%) and dieticians (17.1%). They were grouped into three subcategories: social actor education, education strategies, and raising community awareness (Table 1).

Chart 1. Suggestions for facilitating the use of organic foods made by social actors from 52 municipalities in *Santa Catarina* that purchased organic foods for the National School Food Program in 2010.

1. Strategies for raising awareness and use of organic foods		
1.1 Social actor education	*1.2 Teaching strategies*	*1.3 Raising community awareness*
- Partnerships	- Encourage healthy eating	- Advertising
- Technical assistance	- Teacher support	- Advertising forum
- Professional training/education	- Exchange experiences	- Make aware
- Training/Courses/Lectures/Explanations/Workshops	- Education proposal	- Parent involvement
- Guidance	- Environmental management	- Community inclusion
		- Student participation
		- Projects
2. National School Food Program management		
2.1 Government incentives		
- Demand compliance with the law		- Reduce bureaucracy
- Finance		- Reduce taxes
- Credit lines		- Increase manager involvement
- Increase funds/resources		- Discourage outsourcing
		- Value the farmer
3. Coordination between organic food supply and demand		
3.1 Supply management and logistics		*3.2 Coordinate supply and demand*
- Facilitate delivery		- Increases purchases
- Facilitate distribution		- Organize production
- Facilitate access to organic foods		- Organize the farmers
- Improve transportation		- Increase production
- Improve infrastructure		- Guarantee the purchase
		- Increase supply and intake
		- Organize cooperatives
		- Increase human resources
		- Reduce product price
4. Management of school food production		
4.1 Sanitary quality		*4.2 Food planning*
- Quality control		- Food variety/diversity
- Sanitary quality		- Food amount
- Sanitary surveillance		- Menu planning and adjustment
		- Better storage
		- Avoid waste
		- Seasonality/Use in-season foods
		- Food distribution times

Education of the social actors is the main item of all suggestions, and all social actors mention it as a limitation, pointing out the importance of skilled labor for the production and acquisition of organic foods for school meals: "*Train the families who live in the communities that produce organic foods, offering incentives, organization, hygiene, and environmental awareness*" (principal, Northern Region); "*Provide technical support for the production of organic foods, since we have to learn everything online; it would be nice to have an educator*" (family farmer 1, Western Region).

The second subcategory refers to education strategies for increasing organic food intake at school, such as teachers encouraging healthy eating and education proposals: "*Provide lectures accessible to everyone about organic*

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Table 1. Number of "Awareness strategies for the use of organic foods" - related suggestions to increase the use of organic foods by *Santa Catarina* region and social actor. *Florianópolis* (SC), Brazil, 2013.

Subcategories	Regions	Diet	SFC	Principal	Cook	FCP	Farmer	Total
Social actor education	West	13	13	17	3	1	12	59
	South	10	3	10	9	3	3	38
	Norte	6	3	7	1	5	1	23
	Mountain	1	3	6	1	-	1	12
	Valley	3	-	7	-	1	1	12
	GFR	-	1	4	-	1	-	6
Teaching strategies	West	-	-	3	-	-	-	3
	South	3	1	7	2	-	-	13
	Norte	-	1	4	1	1	1	8
	Mountain	-	-	2	-	-	-	2
	Valley	-	-	5	-	-	-	5
	GFR	-	-	-	-	-	-	-
	West	2	5	17	3	2	9	38
	South	5	2	25	6	2	1	41
Raising community awareness	Norte	3	3	6	4	1	-	17
	Mountain	2	-	-	-	-	2	4
	Valley	-	-	3	-	-	1	4
	GFR	1	-	-	-	-	-	1
Total	N	49	35	123	30	17	32	286
	(%)	(17.1)	(12.2)	(43.0)	(10.5)	(5.9)	(11.2)	(41.8)*

Note: *With respect to the total 684 suggestions.

Social actors: Diet: Dieticians; SFC: School Food Counselors; FCP: Farmer Cooperative President; Region: GFR: Greater *Florianópolis* Region.

products and the importance of producing and consuming them, including the associated health benefits, and their positive impact on farmers' income and the environment" (cooperative president, Western Region); *"Always have monthly meetings to exchange experiences and encourage even more"* (principal, Mountain Region).

Suggestions regarding raising community awareness show the need of educational support and strategies: *"Make people and other farmers aware, since many believe it is easier to use poisonous chemicals than to grow organic foods"* (family farmer 2, Western Region); *"Advertise through all means of communication, since we know preventing makes a difference. Education is the solution; educated people know how to take care of themselves and their health,"* (principal, Northern Region).

Another category is *PNAE management* (Table 2). Many suggestions (21.6%; n=148) emphasize the role of the government in the implementation of the policy. Principals (31.7%) and family farmers (27.7%) criticize the lack of more governmental incentives: *"Effective surveillance for public entities to follow the law"* (Cooperative president, Southern Region); *"More funds for the acquisition of organic foods from family farms"* (school food counselor, Western Region); *"The situation and associated difficulties vary across the municipality. However, the greatest difficulty is the lack of government managers' awareness of the cause"* (dietician, Western Region).

Still within the PNAE management category, outsourcing the school meals in the state schools of *Santa Catarina* was perceived as a hindrance to program quality: "*School food outsourcing in Santa Catarina decreases family farmers' sales considerably; the people who are preparing the meals are from other municipalities and the children are not familiar with the food, for example, saying that they had never eaten*

Table 2. Number of "PNAE management" - related suggestions to increase the use of organic foods by *Santa Catarina* region and social actor. *Florianópolis* (SC), Brazil, 2013.

Subcategories	Regions	Diet	SFC	Principal	Cook	FCP	Farmer	Total
Government incentives	West	12	9	13	3	3	29	69
	South	2	4	11	6	4	7	34
	Norte	-	3	14	1	2	1	21
	Mountain	1	1	5	2	-	1	10
	Valley	2	-	4	3	-	3	12
	GFR	1	-	-	1	-	-	2
Total	N	18	17	47	16	9	41	148
	(%)	(12,2)	(11,5)	(31,7)	(10,8)	(6,1)	(27,7)	(21,6)*

Note: *With respect to the total 684 suggestions.

Social actors: Diet: Dieticians; SFC: School Food Counselors; FCP: Farmer Cooperative President; Region: GFR: Greater *Florianópolis* Region.

cornmeal" (family farmer 3, Western Region); "*School meals should not be outsourced; the municipality should also provide foods for the state schools because people who live in the municipality know what the local children like. What the local children eat should not be determined by someone from São Paulo*" (family farmer 4, Western Region).

Coordination between supply and demand represented 19.0% (n=130) of the suggestions (Table 3).

Principals (28.5%), family farmers (22.3%), and cooks (16.9%) pointed out the need of better food delivery logistics and coordination between the production of organic foods and the school's demand. "*Delivery difficulty - a walk-in refrigerator was purchased and a distribution center will be built to facilitate delivery*" (principal 1, Western Region); "*Encourage the farmers to better organize themselves and encourage the creation of cooperatives*" (dietician, Western region).

Social actors pointed out that the organization of farmers, cooperatives, and organic food production can facilitate the supply of organic school foods. Organization is critical for meeting the demand and reducing prices: "*I often leave home to deliver only a few items, for example, 10 heads of lettuce and some cabbages, so the resulting cost is very high*" (family farmer 5, Western Region).

A total of 120 suggestions (17.8%) referred to the Management of school food production (Table 4).

These suggestions were made mostly by cooks (40.8%) and principals (27.5%). They emphasized the small supply of processed organic foods, and especially the lack of laws and certification: "*Inspect the products so that we can serve homemade cheese from the Mountain Region, honey, eggs, milk, meats, etc.*" (cook, Mountain Region); "*Assign people to certify organic products*" (family farmer, Southern Region).

The social actors made many suggestions related to food planning, especially the unstable supply and poor diversity of organic products, excessive amounts available around harvest time, and the benefits of this type of food: "*They need to diversify the products because sometimes we receive too much of something, which ends up spoiling and generating waste*" (principal 2, Western Region); "*A stable supply throughout the year would be better - sometimes we have too much and sometimes too little*" (principal 3, Western Region); "*The amount is small, but we notice the farmer's happiness. If they sold to grocers, they would get much less. It is nice to see the cooks peeling oranges and making juice. Before they only opened a juice box and added sugar*" (school food counselor, Western Region).

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Table 3. Number of "Coordination between supply and demand" - related suggestions to increase the use of organic foods by *Santa Catarina* region and social actor. *Florianópolis* (SC), Brazil, 2013.

Subcategories	Regions	Diet	SFC	Principal	Cook	FCP	Farmer	Total
Management of school supply logistics	West	6	1	7	7	1	5	27
	South	-	2	4	4	3	-	13
	Norte	-	-	2	-	-	2	4
	Mountain	-	-	-	2	-	-	2
	Valley	-	-	-	-	-	-	-
	GFR	-	-	-	-	-	-	-
Coordination between supply and demand	West	5	4	14	1	3	15	42
	South	3	2	4	7	1	4	21
	Norte	3	2	2	-	3	1	11
	Mountain	-	1	1	1	-	1	4
	Valley	1	-	3	-	1	1	6
	GFR	-	-	-	-	-	-	-
Total	N	18	12	37	22	12	29	130
	(%)	(13.8)	(9.2)	(28.5)	(16.9)	(9.2)	(22.3)	(19.0)*

Note: *With respect to the total 684 suggestions.

Social actors: Diet: Dieticians; SFC: School Food Counselors; FCP: Farmer Cooperative President; Region: GFR: Greater *Florianópolis* Region.

Table 4. Number of "Management of school food production" - related suggestions to increase the use of organic foods by *Santa Catarina* region and social actor. *Florianópolis* (SC), Brazil, 2013.

Subcategories	Regions	Diet	SFC	Principal	Cook	FCP	Farmer	Total
Sanitary quality	West	2	2	5	4	-	-	13
	South	3	-	-	-	-	1	4
	Norte	-	-	-	-	-	-	-
	Mountain	-	-	-	1	-	-	1
	Valley	-	-	-	-	-	-	-
	GFR	-	-	-	-	-	-	-
Menu planning	West	7	4	15	29	-	13	68
	South	2	2	7	10	1	-	22
	Norte	-	-	2	4	-	-	6
	Mountain	-	1	3	1	-	-	5
	Valley	-	-	-	-	-	-	-
	GFR	-	-	1	-	-	-	1
Total	N	14	9	33	49	1	14	120
	(%)	(11.7)	(7.5)	(27.5)	(40.8)	(0.8)	(11.7)	(17.8)*

Note: *With respect to the total 684 suggestions.

Social actors: Diet: Dieticians; SFC: School Food Counselors; FCP: Farmer Cooperative President; Region: GFR: Greater *Florianópolis* Region.

DISCUSSION

The study collected suggestions from social actors involved with school meals in the state of *Santa Catarina* in 2010 to facilitate the use of organic foods in school meals. Most suggestions were made by the Western Region, possibly because it has the highest number of organic farmers, followed by the Southern Region[24].

More acquisition of organic foods from family farms recognizably ties farmers to the land. Altmann *et al.*[25] analyzed the perspectives of representatives from the agro-industry,

cooperatives, and social organizations in *Santa Catarina* for 2008 to 2015 and found the following in all regions: youth moving to cities, increasing the age of farmer population; small and unskilled labor force; and the need to improve the state's infrastructure to improve production diversity. These findings agree with the study suggestions, where actors evidenced the need of improving the skills of those involved with school meals.

All social actors placed the greatest emphasis on "Awareness strategies for the use of organic foods". Education of social actors was considered the most important item, followed by raising awareness and teaching strategies.

Conner *et al.*[12] and Santos *et al.*[26] agree that skilled workers are critical for the acquisition of school foods.

Chaves *et al.*[27] and Juzwiak *et al.*[28] believe that PNAE-related professionals require constant refresher courses and more transdisciplinary activities to ensure knowledge and reflection, and to support and promote healthy eating-related actions in schools. The development of specific methods and multi-professional promotion of healthy eating are essential for meeting the targets mostly already established by public policies[29,30].

Suggestions on *PNAE management* include reducing bureaucracy, taxes, and outsourcing, and increasing manager involvement. Buttivant & Knai[16] analyzed school food policies in England and found that efforts made at all levels of government have a positive impact on school food. Nielsen *et al.*[5] and Nolting[6] conducted studies in Denmark, Italy, Finland, and Norway and found that government incentives through laws, promotion strategies, programs, guides, and financial control effectively increased the intake of organic foods in schools. Studies have shown the importance of government-sponsored operationalization of school food programs in these countries.

In Brazil Saraiva *et al.*[4] analyzed purchases from family farms and their compliance with new PNAE guidelines and emphasized the importance of government for local development, and therefore, for promoting school food regionalization. For this to become a reality, social actors stress that public managers must implement family farm foods as a cross-sectional action in sector policies and predict challenges, such as providing technical assistance for farmers, transportation and storage infrastructure, diagnosis and interaction with the local and regional agricultural landscape, and spaces or forums for farmers, managers, and schools to debate and plan. These aspects reinforce the demands and suggestions of social actors for government incentives and the economic impact of acquiring products from family farms.

Suggestions on *Coordination between supply and demand* consisted of the logistics and production difficulties that cooperative presidents, cooks, and family farmers face to meet schools' organic food demands. These professionals are directly involved with food distribution and storage in schools. Conner *et al.*[12], Duval & Moy[13], and Buttivant & Knai[16] reported the same difficulties: logistics- and infrastructure-related difficulties, and unorganized production and acquisition.

Nolting[6] studied school food in Italy and found that technical procedures, such as food distribution frequency, are related to logistics, and that family farmers suggested better transportation, the need of meeting demand, lowering price, and solving supply problems.

Almeida *et al.*[31] analyzed organizational problems in family farms of *Araraquara* (SP) for PNAE and found that a specific logistic structure is necessary, as follows: farmer registration; knowledge of product, production technology, amount, delivery time and location; screening upon reception; and cook training.

Suggestions related to "Management of school food production" included amount harvested, low organic food diversity, and lack of

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certification. Nielsen *et al.*[5], Conner *et al.*[12], and Duval & Moy[13] warn of the difficulties that must be overcome to create school menus, such as ways of reducing the impact of seasonality. The menu should consider food composition, nutritional balance, sustainability, flavor, and student preference.

The Brazilian Ministry for Agrarian Development proposes strategies to strengthen the dialogue between the social actors responsible for menu creation (dieticians) and food production (family farmers and organizations), to hopefully guarantee a stable supply of organic foods to schools. Two such strategies are mapping local family farm products and respecting family farm product diversity and seasonality[32]. This coordination is essential because organic food supply will suffer if farmers do not participate in menu planning and plan their production accordingly[33].

The sanitary norms for the production of homemade foods, family farm products, and community products are excessively bureaucratic for small producers, preventing certification of organic products. Souza[34] stated that certification is yet a problem in the state of *São Paulo*.

Some study limitations are the lack of regional data analysis, which could help to explain the different challenges faced by each region, and researcher database analysis instead of interviews, which limited the researcher's perception of participants' subjectivity during the interview and/or while filling out the questionnaire.

CONCLUSIONS

The perspective of PNAE - related social actors from 52 municipalities of *Santa Catarina* to facilitate the use of organic foods in schools includes the education of social actors involved with school meals, technical support for farmers, educational projects and strategies conducted at school, and raising community awareness. Challenges associated with the production of organic foods and their use in schools, such as coordination between supply and demand, good production management, and especially the lack of certification of small farmer products, are obstacles that need to be overcome. Once acquisition from preferably organic family farms is guaranteed through a compulsory minimum percentage, government managers and school food counselors, as representatives of the school community for the social control of the program, should consider this guideline a requisite for expanding PNAE's objectives. We suggest the execution of similar studies in other Brazilian states to assess the advantages of increasing the amount of organic family farm products in school meals and the compliance and effectiveness of PNAE's guidelines.

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CONTRIBUTORS

GA SILVERIO and AA SOUSA conceived and designed the study, analyzed the data, and wrote and reviewed the manuscript.

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Prevalências isoladas e combinadas de anemia, deficiência de vitamina A e deficiência de zinco em pré-escolares de 12 a 72 meses do Núcleo de Creches do Governo da Paraíba

Isolated and combined prevalence of anemia, vitamin A deficiency and zinc deficiency in preschool children 12-72 months for the government of Paraíba

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RESUMO

Objetivo

Estimar as prevalências isoladas e combinadas de anemia, deficiência de vitamina A e deficiência de zinco em crianças pré-escolares, bem como a distribuição das deficiências isoladas segundo sexo, idade e suplementação prévia com vitamina A.

Métodos

Estudo transversal com crianças pré-escolares do Estado da Paraíba. Foram realizadas análises das concentrações médias de hemoglobina, retinol sérico e zinco sérico, de acordo com o sexo, a idade e a suplementação prévia com vitamina A das crianças, bem como o risco de ocorrência simultânea de deficiências de micronutrientes na presença de uma dessas deficiências.

Resultados

As prevalências de anemia, deficiência de vitamina A e deficiência de zinco foram de 15,4%, 23,3% e 13,8%, respectivamente. A anemia mostrou-se significativamente associada à idade (p<0,01). Crianças suplementadas

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previamente com vitamina A apresentaram maiores concentrações de retinol sérico do que crianças não suplementadas, efeito não observado para as concentrações de hemoglobina e de zinco sérico. A prevalência de anemia associada à deficiência de vitamina A foi de 5,8%, sendo a chance da deficiência de vitamina A e da anemia coexistir 2,21 vezes (IC95%= 1,03-4,84) maior no caso de deficiência de vitamina A ou de anemia do que na ausência dessas condições.

Conclusão

As elevadas prevalências de deficiências de micronutrientes importantes no crescimento infantil, bem como a coexistência de carências nutricionais, evidenciam a necessidade de fortalecer as estratégias de intervenção nutricional que considerem essa problemática.

Termos de indexação: Criança. Ferro. Vitamina A. Zinco.

ABSTRACT

Objective

To estimate the isolated and combined prevalence of anemia, vitamin A deficiency and zinc deficiency in pre-school children, as well as the distribution of isolated deficiencies according to gender, age and prior supplementation with vitamin A.

Methods

Cross-sectional study with pre-school children in the state of Paraíba, Brazil. *Analysis of the average concentrations of hemoglobin, serum retinol and serum zinc, according to gender, age and previous vitamin A supplementation of children were carried out as well as the risk of simultaneous occurrence of micronutrient deficiencies in the presence of these deficiencies.*

Results

The prevalence of anemia, vitamin A deficiency and zinc deficiency were 15.4%, 23.3% and 13.8%, respectively. The anemia was significantly associated with age (p<0.01). Children previously supplemented by vitamin A had higher serum retinol concentrations than children without supplements, an effect that was not observed for concentrations of hemoglobin or serum zinc. The prevalence of anemia associated with vitamin A deficiency was 5.8%, with the chance of vitamin A deficiency and anemia coexist 2.21 times (95%CI=1.03-4.84) higher in the case of vitamin A deficiency or anemia rather than in the absence of these conditions.

Conclusion

The high prevalence of micronutrient deficiencies which are important in child growth, as well as the coexistence of nutritional deficiencies, point out the need to strengthen nutrition intervention strategies that consider this issue.

Indexing terms: *Child. Iron. Vitamin A. Zinc.*

INTRODUÇÃO

As deficiências de ferro, zinco e vitamina A constituem um problema de saúde pública em diversos países em desenvolvimento, atingindo percentuais elevados de grupos populacionais biologicamente vulneráveis, tais como as crianças[1]. Na infância, essas deficiências podem ocasionar problemas no crescimento e no desenvolvimento, assim como distúrbios imunológicos que contribuem para o aumento da morbimortalidade infantil com ênfase nas doenças infecciosas[2-4].

Evidências mostram que as deficiências de ferro, zinco e vitamina A frequentemente coexistem na população infantil[5]. Desse modo, quando uma criança apresenta deficiência de um micronutriente, pode-se inferir o risco de ocorrência simultânea de outras carências nutricionais[4]. Fatores etiológicos comuns e mecanismos subjacentes contribuem para a coexistência das deficiências de ferro, vitamina A e zinco[5]. As explicações sobre a associação entre ferro e vitamina A ainda apresentam incertezas, sendo atribuída, principalmente, à função da vitamina A na

eritropoese, na prevenção de infecções e na absorção do ferro[1,6]. No que se refere ao ferro e ao zinco, postula-se que a interação entre eles parece estar relacionada à concorrência por uma via de absorção comum. Por sua vez, a carência de zinco pode prejudicar o transporte do retinol e ocasionar aumento das reservas hepáticas, com consequências negativas nas concentrações séricas de retinol[1]. Além disso, a deficiência de zinco pode reduzir a absorção intestinal de retinol e vice-versa[7,8].

Tendo por base que a coexistência de deficiências de micronutrientes exige o desenho e a implementação de intervenções nutricionais conjuntas, o presente trabalho teve por objetivo estimar as prevalências isoladas e combinadas de anemia, deficiência de vitamina A e deficiência de zinco em crianças pré-escolares, bem como a distribuição das deficiências isoladas segundo sexo, idade e suplementação prévia com vitamina A.

MÉTODOS

Trata-se de um estudo de desenho transversal, com crianças na faixa etária dos 12 aos 72 meses, assistidas nas creches da Secretaria de Estado do Desenvolvimento Humano do Governo da Paraíba. Funcionavam, na época do estudo, 45 creches estaduais em 8 municípios: João Pessoa (30 creches, 2 317 crianças beneficiadas), Campina Grande (9 creches, 621 crianças beneficiadas), além das cidades de Areia, Bayeux, Mamanguape, Itaporanga, Soledade e Umbuzeiro (cada uma delas com uma creche, 372 crianças beneficiadas).

Os dados analisados provêm de uma pesquisa desenvolvida com o objetivo de avaliar o perfil de crescimento das crianças assistidas no Núcleo de Creches do Governo da Paraíba e a contribuição relativa das deficiências de vitamina A, ferro e zinco. No desenho da pesquisa, o tamanho da amostra foi definido para estimar o *deficit* de estatura em crianças assistidas em creches públicas do Estado da Paraíba, contextualizando, ainda, a utilidade no estado nutricional de micronutrientes condicionado ao fato de a baixa estatura constituir um indicador funcional do estado nutricional de micronutrientes associados ao crescimento. Assim, a utilização da prevalência estimada de 7% (média do déficit de estatura no Brasil) apontou a necessidade de estudar 256 crianças. Esse valor foi corrigido em 10% para compensar eventuais perdas, ficando estabelecida a amostra de 282 crianças.

Foi selecionada uma amostra probabilística de creches, por meio de um procedimento de amostragem em duas etapas. Para garantir a representatividade dos municípios, o sistema de referência para a primeira etapa de amostragem foi ordenado segundo estratos (João Pessoa, Campina Grande e outros municípios com creches estaduais), possibilitando a obtenção de um tamanho amostral apropriado para cada estrato. Considerou-se também o porte da creche (número de crianças por creche). Na segunda etapa, foram sorteadas, por sorteio simples, nas 14 creches selecionadas de forma aleatória na primeira etapa, as crianças a serem avaliadas.

A coleta de dados foi realizada nas creches selecionadas, sob a supervisão do coordenador do projeto, e contou com a participação de uma equipe treinada, composta por estudantes e profissionais da área de saúde. Foi aplicado um questionário às mães das crianças contendo perguntas referentes à saúde da criança e ao perfil materno, o qual foi pré-testado em estudo piloto com crianças com as mesmas características da população de interesse. Para este estudo, foram utilizadas as informações sobre a data de nascimento, sexo e suplementação prévia com vitamina A, obtidas da Caderneta de Saúde da Criança. A idade foi calculada pela diferença entre a data da entrevista e a data de nascimento. A suplementação prévia da criança com vitamina A baseou-se nas anotações no quadro de vacinas ou no quadro de suplementação com vitamina A da Caderneta, considerando-se suplementada aquela em conformidade com o preconizado pelo Programa Nacional de Suplementação de Vitamina A para a idade no momento do inquérito[9].

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A coleta de sangue foi realizada por técnico de laboratório com experiência na coleta de sangue de crianças. Foram coletados, no máximo, 6 mL de sangue em cada criança, obtidos de uma veia do antebraço. As coletas de sangue sempre foram feitas no período pós-prandial, padronizando e controlando, assim, o período do dia e o tempo de jejum.

As amostras utilizadas para a determinação das concentrações de retinol sérico foram envolvidas em papel alumínio. Para a determinação das concentrações de zinco sérico, foram utilizados tubos a vácuo próprios para análise de elementos traço (Vacutainer, tubos a vácuo transparentes *"trace free"*, Beckton Dickinson Inc, *Lakes New Jersey*, Estados Unidos da América).

Para avaliar a presença de anemia, foi utilizada a medida de hemoglobina por meio da realização do hemograma em contador automático (Sysmex SF - 3000, Roche Diagnóstica), conforme orientações do fabricante. Foram consideradas anêmicas as crianças com concentrações de hemoglobina <11,0 g/dL[10].

Os níveis séricos de retinol foram determinados pelo método de Cromatografia Líquida de Alta Eficiência, de acordo com a metodologia descrita por Furr *et al*.[11]. A deficiência de vitamina A foi definida por valores de retinol sérico <0,70 µmol/L[12].

Os níveis séricos de zinco foram determinados mediante Espectrofotometria de Absorção Atômica de Chama, por meio de Espectrofotômetro *Analyst* 300 (*Perkin-Elmer Norwalk*, Connecticut, Estados Unidos da América), modelo 3100, a um comprimento de onda de 213 nm e com ar acetileno[13]. Concentrações de zinco sérico <65 µg/dL foram consideradas para indicar deficiência de zinco, tal como sugerido pelo *International Zinc Nutrition Consultative Group*[14] para crianças menores de 10 anos e com coleta de sangue de manhã, sem jejum.

A presença de processos infecciosos subclínicos foi controlada através da determinação da Proteína C-Reativa (PCR), por técnica imunoturbidimétrica (*Cobas Fara analyzer, Roche Products, Welwyn*, Reino Unido), segundo orientações do fabricante. Valores de PCR >6,0 mg/L foram utilizados para a identificação de infecção subclínica, utilizada como critério de exclusão, sugestiva, inclusive, de infecção clínica.

As determinações de hemoglobina e PCR foram realizadas no Laboratório de Análises Clínicas da Universidade Estadual da Paraíba (UEPB). As determinações dos níveis séricos de retinol foram realizadas no Centro de Investigações em Micronutrientes da Universidade Federal da Paraíba. As determinações dos níveis séricos de zinco foram realizadas no Instituto Hermes Pardini.

A digitação dos dados foi realizada com dupla entrada, após a coleta da informação, em planilhas do programa Excel, de maneira a possibilitar a unificação através de uma única variável identificadora da criança. Após o término da digitação, os dois bancos de dados foram cruzados com a utilização do comando *Validate* do programa Epi Info versão. 6.04b, o que possibilitou, assim, verificar a consistência dos dados e gerar o banco final que foi usado para análise estatística. Todas as fichas foram criticadas antes da digitação.

Foi utilizado o teste *t* student para análise comparativa das concentrações médias de hemoglobina, retinol sérico e zinco sérico, segundo o sexo, a faixa etária e a suplementação prévia com vitamina A das crianças. A identificação de diferenças nas prevalências das respectivas deficiências de micronutrientes foi realizada pelo teste Qui-quadrado. Considerou-se a significância ao nível de 5%. O cálculo de *Odds Ratio* bruta e ajustada (por sexo, idade e suplementação prévia com vitamina A) foi utilizado para determinar a chance de ocorrência simultânea de deficiências de micronutrientes na presença de uma dessas deficiências. Previamente às análises, a normalidade das variáveis foi testada com o uso do teste de *Kolmogorov-Smirnov*. As análises estatísticas foram realizadas por meio do pacote estatístico *Statistical Package for the Social Sciences* (SPSS), versão 16.0.

O projeto, a partir do qual foram gerados os dados do presente trabalho, foi apreciado e aprovado pelo Comitê de Ética em Pesquisa da UEPB, protocolado sob o número 0021.0.133.000-09. A coleta de dados das crianças foi realizada após consentimento informado das mães ou responsáveis. Uma vez com os resultados, os pais foram contatados para esclarecimentos acerca do estado de saúde das crianças e correspondentes orientações nutricionais.

RESULTADOS

Do total de 282 crianças, registraram-se seis recusas e 12 perdas (problemas relacionados à coleta de sangue: sangue insuficiente ou hemólise das amostras). A presença de processos infecciosos subclínicos foi verificada em 24 crianças, excluídas das análises.

A Tabela 1 mostra as prevalências de deficiências nutricionais e a distribuição das concentrações de micronutrientes, segundo o sexo, a faixa etária e a suplementação prévia com vitamina A. Das 240 crianças avaliadas, 23,3% apresentaram deficiência de vitamina A, 15,4% estavam anêmicas e 13,8% apresentaram deficiência de zinco. As concentrações médias (Desvio-Padrão) de retinol sérico, hemoglobina e zinco sérico foram de 0,87 µmol/L (±0,29), 11,60 g/dL (±1,10) e 75,35 ug/dL (±11,23), respectivamente. A anemia mostrou-se significativamente associada com a idade (p<0,01), sendo as crianças com idade entre 12 e 36 meses as mais afetadas. Crianças suplementadas previamente com vitamina A apresentaram maiores concentrações de retinol sérico do que crianças não suplementadas (p<0,01) e menor proporção de deficiência de vitamina A (p<0,05), efeitos que não foram observados em relação ao estado nutricional relativos ao ferro e ao zinco. Quando corrigidas pela idade, as significâncias estatísticas permaneceram inalteradas.

Na Tabela 2, são apresentadas as proporções da ocorrência simultânea de deficiências de

Tabela 1. Indicadores do estado nutricional de vitamina A, ferro e zinco em crianças pré-escolares, segundo sexo, faixa etária e suplementação prévia com vitamina A. Paraíba (PB), 2009.

Indicadores	Sexo		Idade (meses)		Suplementação prévia com vitamina A		Total (n=240)
	Masculino (n=125)	Feminino (n=115)	12-36 (n=53)	32-72 (n=187)	Sim (n=175)	Não (n=65)	
Retinol sérico (µmol/L)[1]	0,85 ± 0,31	0,89 ± 0,28	0,85 ± 0,26	0,88 ± 0,30	0,96 ± 0,31*	0,86 ± 0,30	0,87 ± 0,29
Proporção <0,7 µmol/L (%)	23,8	22,8	22,6	23,5	21,7**	27,7	23,3
Hemoglobina (g/dL)[1]	11,60 ± 1,13	11,70 ± 1,01	11,30 ± 1,10*	11,70 ± 1,10	11,96 ± 0,78	11,68 ± 1,03	11,60 ± 1,10
Proporção <11,0 g/dL (%)	16,7	14,0	34,0**	10,2	14,8	16,9	15,4
Zinco sérico (ug/dL)[1]	76,70 ± 11,40	74,10 ± 11,40	75,50 ± 11,60	75,20 ± 11,10	76,68 ± 11,51	75,58 ± 11,13	75,35 ± 11,23
Proporção <65 ug/dL (%)	15,9	11,4	17,0	12,8	13,1	15,4	13,8

Nota: [1]Média ± Desvio-Padrão; *p<0,01 (teste *t* Student); **p<0,05 (teste Qui-quadrado).

Tabela 2. Ocorrência simultânea de deficiências de micronutrientes em crianças pré-escolares (n=240): prevalências e *Odds Ratio* da coexistência na presença de deficiência de um micronutriente. Paraíba (PB), 2009.

	Proporção (%)	*Odds Ratio* (IC95%)*	*Odds Ratio* (IC95%)†
Retinol sérico <0,7 µmol/L + Hemoglobina <11,0 g/dL (%)	5,8	2,12 (0,98-4,57)	2,21 (1,03-4,84)
Retinol sérico <0,7 µmol/L + Zinco sérico <65 ug/dL (%) (%)	2,6	1,62 (0,62-1,71)	1,64 (0,66-1,76)
Zinco sérico <65 ug/dL (%) + Hemoglobina <11,0 g/dL (%)	2,4	1,94 (0,73-2,64)	1,79 (0,63-2,54)

Nota: **Odds Ratio* bruta; †*Odds Ratio* ajustada para o sexo e a idade da criança, assim como para a suplementação prévia com vitamina A.
IC95%: Intervalo de Confiança de 95%.

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micronutrientes e as chances de coexistência na presença da deficiência de um micronutriente. A maior proporção relacionada à coexistência da deficiência de micronutrientes observou-se entre a vitamina A e o ferro (5,8%). A chance de a deficiência de vitamina A e a anemia coexistirem foi 2,21 vezes (Intervalo de Coeficiência de 95% - IC95%= 1,03-4,84) maior no caso de deficiência de vitamina A ou de anemia do que na ausência dessas condições.

DISCUSSÃO

Nos últimos anos, a deficiência de micronutrientes vem ganhando importância como problema de saúde pública em virtude das altas prevalências comparadas com as de macronutrientes, sendo considerada fator de risco à saúde e sobrevivência de grupos vulneráveis, em especial à população infantil[7,15].

Neste estudo, a prevalência de anemia de 15,4% pode ser considerada um problema de saúde pública leve, segundo os critérios adotados pela Organização Mundial da Saúde (entre 5,0 e 19,9%)[16]. Esses achados estão em consonância com os resultados de estudos desenvolvidos com crianças no Rio de Janeiro (13,0%)[17] e Minas Gerais (16,1%)[18]. Os dados da Pesquisa Nacional de Demografia e Saúde da Mulher e da Criança (PNDS)[19], desenvolvida com crianças menores de cinco anos, revelaram índices de prevalência de anemia superiores aos do presente estudo no que se refere à média nacional (20,9%) e às estimativas para a região Nordeste (25,5%).

A prevalência de deficiência de vitamina A (23,3%) situou-se em patamares semelhantes àqueles descritos para crianças brasileiras menores de cinco anos (17,4%) e da região Nordeste (19,0%), segundo a PNDS[19]. De acordo com os critérios adotados pela Organização Mundial da Saúde[12] de categorização da deficiência de vitamina A como problema de saúde pública severo (≥20%), os resultados deste estudo são compatíveis com os descritos anteriormente na Paraíba (21,8%)[20], em Sergipe (32,1%)[21] e em Alagoas (44,8%)[22].

Em relação à deficiência de zinco, estudos realizados no Brasil apontam baixos níveis de zinco na população infantil[23-25], assim como encontrado nesta pesquisa (13,8%). Ressalta-se que os dados de prevalência de deficiência de zinco no Brasil e no mundo ainda são escassos, devido, provavelmente, às dificuldades técnicas para obtenção de um marcador biológico confiável[1].

Pesquisas realizadas com crianças menores de cinco anos em Alagoas[26], em Pernambuco[27], na Paraíba[6] e em municípios de Baixo Índice de Desenvolvimento Humano da região Nordeste[28] constataram uma tendência crescente nas concentrações médias de hemoglobina com o aumento da idade. Em adição, um estudo de revisão sistemática indicou a idade da criança entre os fatores estatisticamente associados à anemia ou à diminuição da concentração de hemoglobina, com maior risco nas menores faixas etárias[29]. Neste estudo, de maneira similar, os níveis médios de hemoglobina diferiram estatisticamente de acordo com a idade, sendo observada uma menor média entre as crianças de 12 a 36 meses, em comparação ao grupo de pré-escolares com idade mais avançada. Considera-se que a maior ocorrência de anemia em crianças menores de 36 meses pode estar relacionada ao rápido ritmo de crescimento, à introdução da alimentação complementar, que, em geral, é composta por alimentos com baixa biodisponibilidade de ferro, e a maior prevalência de doenças, como diarreia e infecções respiratórias[18].

Por sua vez, não foi confirmada a tendência observada em certos estudos de que as crianças de menor idade são mais vulneráveis à deficiência de vitamina A[30] e à deficiência de zinco[31]. Em conformidade com os dados desta pesquisa, em estudo realizado no Ceará[32], com indivíduos na faixa etária dos dois aos 97 meses, os níveis séricos de retinol e de zinco não apresentaram diferenças estatísticas considerando a faixa etária das crianças. Na Paraíba, em pesquisas realizadas com pré-escolares, a idade não apresentou

associação estatisticamente significante com a deficiência de vitamina A[20] e com as concentrações médias de zinco no soro[25].

Em relação à suplementação com vitamina A, em consonância com os resultados desta pesquisa, um estudo realizado no Piauí com crianças de 36 a 83 meses mostrou uma associação positiva entre os níveis de retinol sérico e a suplementação prévia com vitamina A[30]. No entanto, embora alguns autores mostrem que a vitamina A beneficia o estado nutricional de ferro[16] e zinco[33], não foram observadas associações estatísticas significativas entre a suplementação com vitamina A e os indicadores do estado nutricional desses micronutrientes nas crianças deste estudo.

No tocante à coexistência de carências nutricionais, assim como observado para a população deste estudo, diferentes autores constataram a ocorrência simultânea de deficiências de vitamina A e ferro e/ou zinco na população infantil, em pesquisas realizadas no Brasil[4,16] e em outros países como Estados Unidos[3], Indonésia[15], Honduras[34], Colômbia[35], África do Sul[36], China[37], Mongólia[38] e Burkina Faso[39], incluindo a coexistência da deficiência de vitamina A e anemia, que foi a de maior proporção no presente trabalho. As proporções das coexistências reportadas nos estudos anteriores diferem de um estudo para outro. Em geral, as proporções inferiores encontradas neste trabalho quando comparadas aos dos outros estudos podem estar relacionadas às características do processo amostral, porém sinalizam a problemática independente dessa limitação.

No presente estudo, a chance da coexistência de deficiência de micronutrientes foi maior entre a deficiência de vitamina A e a anemia. Ao investigarem a coexistência de carências nutricionais em crianças na Indonésia, pesquisadores constataram que as crianças com deficiência de vitamina A apresentaram 2,9 vezes mais chance de desenvolver deficiência de zinco e um risco 2,5 maior de anemia, quando comparadas às crianças sem deficiência vitamínica[15]. Na África do Sul, a coexistência das deficiências de zinco e de ferro foi maior do que a coexistência da deficiência de vitamina A com a deficiência de zinco[36]. Outro estudo, com crianças afro-americanas e hispânicas da cidade de Atlanta, Estados Unidos, apontou associação entre deficiência de zinco e anemia ao indicar o maior risco de deficiência de zinco entre as crianças anêmicas[3]. A correlação entre indicadores do estado nutricional de vitamina A e das concentrações de hemoglobina tem sido observada na literatura, como em estudo conduzido com crianças da Jordânia[40].

A ocorrência simultânea dessas carências nutricionais, mais frequentemente verificadas em crianças de países em desenvolvimento, pode ser atribuída à presença de fatores etiológicos comuns. As carências nutricionais compartilham um contexto de pobreza, baixos níveis de educação e outros fatores sociais desfavoráveis, os quais estão associados à insegurança alimentar nas famílias, cuidados maternos e infantis inadequados, insuficiência dos serviços de saúde e um meio ambiente insalubre[41]. O aumento das necessidades orgânicas de micronutrientes decorrente do acelerado crescimento infantil também pode contribuir para a ocorrência de *deficit* nutricional[25,42]. Considera-se ainda que as interações metabólicas entre o ferro, a vitamina A e o zinco podem contribuir para a ocorrência de carências nutricionais múltiplas na população na medida em que a deficiência de um desses nutrientes pode prejudicar a utilização dos demais pelo organismo humano[5].

Cabe informar que o presente trabalho apresenta limitações, duas das quais são destacadas: (a) não se tratou de uma pesquisa desenhada especificamente para os objetivos aqui explicitados, definindo-se para o tamanho da amostra o *deficit* de estatura como a variável dependente de estudo, não comportando, portanto, a amostra que teoricamente seria desejável; (b) o segundo aspecto deriva da condição de que a obtenção da informação sobre a suplementação prévia com vitamina A foi obtida da Caderneta de Saúde da Criança, sem ponderar questões temporais como o tempo transcorrido desde a suplementação até o momento da avaliação bioquímica.

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De modo geral, os resultados desta pesquisa apontam elevadas prevalências de deficiências de micronutrientes em crianças pré-escolares. A contribuição desses micronutrientes no crescimento, desenvolvimento e na condição de saúde é unânime. Destaca-se que a deficiência de vitamina A e a anemia continuam sendo importantes problemas de saúde pública no Brasil, apesar de serem prioridades na agenda de pesquisa na área de nutrição por longas décadas, além de alvo de programas específicos de prevenção e controle. A ocorrência de fatores socioeconômicos desfavoráveis que dificultam o acesso da população a práticas alimentares adequadas, capazes de suprir as necessidades orgânicas de nutrientes específicos, soma-se à vulnerabilidade biológica no desencadeamento de complicações oriundas da fome oculta com prejuízos físicos, mentais, cognitivos e substanciais custos financeiros e sociais.

As elevadas prevalências de deficiência nutricional e a coexistência de carências nutricionais na população infantil evidenciam a necessidade de fortalecer estratégias de intervenção que visem à qualidade da dieta e à modificação das práticas alimentares. Nesse contexto, adverte-se a importância da suplementação alimentar, da fortificação dos alimentos e de ações educativas. Contudo, o êxito de quaisquer medidas interventivas depende de uma melhor compreensão acerca da distribuição e da magnitude das carências nutricionais, inclusive em relação à ocorrência simultânea de carências nutricionais. O conhecimento dos fatores determinantes é indispensável ao adequado planejamento e alocação de recursos humanos e materiais destinados à prevenção e ao combate da desnutrição infantil. Devido à carência de estudos no Brasil que abordem a coexistência de deficiências de micronutrientes, sugere-se a necessidade de maior quantidade de estudos que possibilitem um melhor entendimento da problemática e, portanto, as decisões de saúde pública.

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Are inappropriate eating behaviors and anxiety related with track and field in adolescent athletes?

Comportamentos alimentares inadequados e ansiedade estão relacionados com atletismo em atletas adolescentes?

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ABSTRACT

Objective

The study analyzed the relationship between anxiety and inappropriate eating behaviors in adolescent female athletes.

Methods

Eighty-eight track and field athletes aged 12 to 17 years participated in the study. We used the Eating Attitudes Test-26 subscales to assess inappropriate eating behaviors and the Brazilian State - Trait Anxiety Inventory subscales to assess State and Trait anxiety.

Results

State - Trait Anxiety Inventory - State (p=0.18) or State - Trait Anxiety Inventory - Trait (p=0.14) had no significant influence on the Dieting subscale score. The Bulimia and Food Preoccupation subscale score was also not influenced by State - Trait Anxiety Inventory - State (p=0.25) or State - Trait Anxiety Inventory - Trait (p=0.21). However, State - Trait Anxiety Inventory - Trait (p=0.048) had a significant impact on the Oral Control subscale score, but State - Trait Anxiety Inventory - State (p=0.19) did not explain its variance.

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Conclusion

Only State - Trait Anxiety Inventory - Trait was related to oral control and the environmental and social forces that encourage food intake in female athletes.

Indexing terms: Anxiety. Athletes. Eating disorders. Track and field.

RESUMO

Objetivo

O objetivo deste estudo foi analisar a relação da ansiedade com os comportamentos alimentares inadequados em atletas adolescentes do sexo feminino.

Métodos

Participaram 88 atletas de atletismo com idade entre 12 e 17 anos. Utilizaram-se as subescalas do Eating Attitudes Test para avaliar o comportamento alimentar. As subescalas de Avaliação do Inventário de Ansiedade Traço-Estado foram utilizadas para avaliar a ansiedade estado e traço.

Resultados

Os achados não apresentam influência estatisticamente significativa da Avaliação do Inventário de Ansiedade Traço - Estado (p=0,18), nem da Avaliação do Inventário de Ansiedade Traço - Traço (p=0,14) sobre os escores da subescala Dieta. A respeito da subescala Bulimia e Preocupação com Alimento, os resultados não apontaram influência estatisticamente significativa da Avaliação do Inventário de Ansiedade Traço - Estado (p=0,25) e da Avaliação do Inventário de Ansiedade Traço - Traço (p=0,21). Em relação à subescala Autocontrole Oral, a Avaliação do Inventário de Ansiedade Traço - Traço demonstrou impacto significante (p=0,048), enquanto a Avaliação do Inventário de Ansiedade Traço - Estado (p=0,19) não explicou sua variância.

Conclusão

Concluiu-se que apenas a Avaliação do Inventário de Ansiedade Traço - Traço esteve relacionada ao autocontrole em relação à comida e às forças ambientais e sociais estimulantes à ingestão alimentar nessas atletas.

Termos de indexação: *Ansiedade. Atletas. Transtornos alimentares. Atletismo.*

INTRODUCTION

Inappropriate Eating Behaviors (IEB) are classified as health-damaging behaviors[1,2]. Long-term food restriction, the use of laxatives and diuretics, self-induced vomiting, binge eating, and the use of anabolic-androgenic steroids are some examples of IEB[3,4]. Schaal *et al.*[5] consider IEB the main symptoms of eating disorders, such as anorexia nervosa and bulimia nervosa. The prevalence of IEB in Brazil varies from 10 to 20%[6,7]. It is higher in adolescents[8,9], especially female adolescents[10], and even higher in athletes[5,11-13], affecting approximately 50% of this population[3,14].

Competition sports have many requirements to optimize performance[2,4], which may somehow encourage athletes to adopt IEB. Fortes *et al.*[15] point out that coaches are the main promoters of vulnerability to IEB. These same authors claim that coaches' demands for better performance are excessive. However, food restriction and self-induced vomiting may reduce athletes' anaerobic power[16]. In this sense, some track and field athletes (100 meters, 200 meters, 100-meter hurdles, pole vault, long jump) whose performance is determined by anaerobic power can damage their careers by engaging in IEB daily.

Moreover, competition sports generate psychological stress in athletes[17] and psychological stress may increase anxiety[18]. Anxiety, an emotional state, is divided into state anxiety and trait anxiety[4]. State anxiety refers to a transitory emotional state characterized by subjective feelings or tension of varying intensity and duration. Trait anxiety regards the stable relation of responding to stress and a tendency to perceive stress- or tension-generating situations.

Anxiety has been related to IEB in athletes. Gomes *et al.*[19] studied male and female Portuguese Karate, Taekwondo, swimming, basketball, handball, and volleyball athletes and found that IEB frequency increased with anxiety. Vargar *et al.*[20], who studied male and female Turk basketball, volleyball, swimming, track and field, wrestling, handball, rhythmic gymnastics, tennis, Taekwondo, and dance athletes, and Silva *et al.*[12], who studied male and female Portuguese handball, basketball, volleyball, swimming, track and field, Taekwondo, and karate athletes, found that athletes at risk of developing eating disorders experienced more anxiety than those not at risk. On the other hand, Rouveix *et al.*[4] did not find a relationship between anxiety and IEB in male French judo athletes. However, all these studies regarded European athletes. The Medical Literature Analysis and Retrieval System Online (Medline), Web of Science, Scientific Eletronic Library Online (SciELO), and Scopus databases were searched using the keywords eating disorders, eating behaviors, anxiety, and sport. Except for the study by Fortes *et al.*[21] with artistic gymnastics athletes, no other study Brazilian study analyzed the relationship between IEB and anxiety in Brazilian athletes.

This type of study is critical for track and field coaches. If anxiety is related to IEB in female Brazilian athletes, coaches will be able to identify those susceptible to eating disorders by investigating their competition anxiety. Thence, the objective of this study was to analyze the relationship between anxiety and IEB in adolescent female track and field athletes.

METHODS

This study was approved by the Human Research Ethics Committee of the School of Philosophy, Sciences, and Letters of *Universidade de São Paulo* (USP) under protocol number 119/2012 (CAE - 05166712.8.0000.5407). The athletes and their guardians signed an informed consent form that explained the study objectives and procedures. Anonymity and complete data confidentiality were guaranteed to the participants.

Participants

According to the State of *Rio de Janeiro's* Track and Field Federation, the adolescent female track and field population in 2013 numbered roughly 445 athletes. The participants were recruited by simple random sampling a convenience sample. A total of 99 adolescent female track and field (sprints, jumps, and throws) athletes aged 12 to 17 years from sports clubs in the city of *Rio de Janeiro* (RJ) participated in the study. Although adolescence encompasses ages 10 to 19 years[8,15], the literature emphasizes that adolescents below 12 years of age normally have difficulty filling out psychometric questionnaires[5,19]. Hence, athletes aged less than 12 years were not included in the study. Additionally, athletes aged more than 17 years were not recruited because the participating sports clubs included only athletes aged less than 18 years.

The inclusion criteria were: having signed the Informed Consent Form; training at least two hours a day, five days a week; having participated in a regional competition in 2013; having answered the questionnaires; and having undergone anthropometric assessment. The exclusion criteria were: having physical and/or intellectual disabilities; and taking psychoactive medication periodically. Eleven athletes were excluded from the study because they did not answer the questionnaires fully. Thus, the final sample consisted of 88 athletes [100 meters (n=24), 200 meters (n=15), 100-meter hurdles (n=11), 400-meter hurdles (n=9), pole vault (n=7), long jump (n=10), high jump (n=6), and javelin throw (n=6)] with a mean age of 15.03 (±1.74) years and mean percentage of body fat of 17.44 (±2.37), training 3.22 (±0.84) hours a day. According to sexual maturation classification, 20% were prepubertal, 35% were pubertal, and 45% were postpubertal.

Instruments

The female version of the Eating Attitudes Test-26 (EAT-26) validated by Bighetti *et al.*[1], with

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an internal consistency of 0.82, investigated IEB. This questionnaire consists of 26 questions distributed into three factors: 1) Dieting: Investigates the pathological refusal of high-calorie foods and preoccupation with physical appearance; 2) Bulimia and Food Preoccupation: Investigates binge eating followed by self-induced vomiting to lose/control body weight; and 3) Oral Control: Investigates self-control with food and assess environmental and social promoters of food intake. The final EAT-26 score is given by adding the item scores, and the cut-off score that indicates risk of eating disorders is 21. The study sample has an internal consistency (Cronbach's alpha) of 0.83.

The short version of the Brazilian State-Trait Anxiety Inventory (STAI) validated for the Brazilian population by Fioravanti-Bastos *et al.*[18] assessed anxiety. STAI has twelve 4-point Likert-scale items (absolutely not = 1; a little = 2; some = 3; and very much = 4) divided into two subscales: a) State anxiety (STAI-S), which regards how the interviewee feels at that moment; and b) Trait anxiety (STAI-T), which regards how the interviewee generally feels. The STAI validation study[18] found internal consistencies of 0.90 and 0.89 for STAI-S and STAI-T, respectively. Cronbach's alphas for the present sample were 0.85 for STAI-S and 0.87 for STAI-T, indicating good internal consistency.

The Body Shape Questionnaire (BSQ) validated for Brazilian adolescents assessed body dissatisfaction[22]. The instrument has good internal consistency, with a Cronbach's alpha (α) of 0.96 and a significant correlation coefficient between the test and retest scores (0.89 for girls). The study sample had α=0.91, demonstrating good instrument consistency. The self-assessment questionnaire consists of 34 Likert-scale questions on the adolescent's preoccupation with her body weight and physical appearance. The BSQ results are classified into four levels of body dissatisfaction as follows: no dissatisfaction when the score is below 80; mild dissatisfaction when the score is between 80 and 110; moderate dissatisfaction when the score is between 110 and 140; and severe dissatisfaction when the score is 140 or more. Since body dissatisfaction promotes eating behaviors associated with risk of eating disorders[11,23], the BSQ scores were controlled in some statistical analyses.

Percentage of body fat was calculated as recommended by Slaughter *et al.*[24] for adolescents. The triceps and subscapular skinfold thicknesses were measured as recommended by the International Society for Advancement for Kineanthropometry[25], using the skinfold caliper (adipometer) LANGE® (Cambridge Scientific Industries Inc.) with accuracy of 1 mm. The measurements were taken rotationally three times, using the mean in the analyses. The authors created a sociodemographic questionnaire for the athletes to report their race (white, black, yellow, brown) as required by the protocol proposed by Slaughter *et al.*[24]. Sexual maturation was determined by Tanner's criteria[26], validated for Brazilians by Matsudo & Matsudo[27]. Since body fat influences IEB[11,15], the percentage of body fat was used as covariate in some statistical analyses.

Procedures

First, the researchers contacted the track and field coaches of sports clubs in the city of *Rio de Janeiro* (RJ). After the study procedures and objectives were properly explained, the researchers asked the coaches' permission for the athletes to participate in the study.

After the coaches authorized the study, the researchers held a meeting with each team to inform the athletes about all the study procedures and hand them the informed consent form for their guardians to sign, thereby giving their authorization in writing for the athletes to participate in the study.

Data were collected in two different occasions in appropriate rooms at the sports clubs.

In the first meeting, the athletes answered the EAT-26, STAI, and BSQ questionnaires, and in the second meeting, the skinfold thicknesses were measured. The athletes were instructed verbally on how to fill out the questionnaires, and their doubts were clarified. The questionnaires also contained filling instructions. The questionnaires were administered in a group setting but answered individually, which took roughly 30 minutes.

Data analysis

The Kolmogorov Smirnov test checked data normality. Since the data had a normal distribution, the variables were expressed as central tendency (mean) and dispersion (minimum, maximum, and standard deviation). The mean STAI (26.53) was used as the cut-off point to classify athletes by level of anxiety: high anxiety ≥26.53 and low anxiety <26.53. Three simple linear regression models were constructed to verify the influence of: 1) STAI-S and STAI-T on EAT-26's Dieting subscale score; 2) STAI-S and STAI-T on EAT-26's Bulimia and Food Preoccupation subscale score; and 3) STAI-S and STAI-T on EAT-26's Oral Control subscale score. Multivariate Analysis of Variance (Manova) compared the EAT-26 subscale scores by anxiety (STAI score) group. Then Bonferroni *post hoc* correction identified the statistical differences. BSQ and percentage of body fat were controlled in all analyses. The software Statistical Package for the Social Sciences (SPSS) 17.0 treated the data with a significance level of 5%.

RESULTS

The Eating Attitudes test-26 results showed that 16% of the athletes were at risk of eating disorders. Furthermore, 46.7% of the sample experienced high anxiety (STAI >26.53). Table 1 shows the descriptive data of all study variables.

The regression model in Table 2 shows that neither STAI-S ($F(1, 87)=2.99$; $p=0.18$) nor STAI-T ($F(1, 87)=3.24$; $p=0.14$) influenced EAT-26 Dieting subscale scores significantly.

Table 3 shows the regression model that used Bulimia and Food Preoccupation subscale

Table 1. Descriptive values (minimum, maximum, mean, and standard deviation) of the EAT-26, STAI, BSQ, age, and percentage of body fat of female track and field athletes. *Rio de Janeiro* (RJ), Brazil. 2013.

Variables	Minimum	Maximum	Mean	SD
EAT-26	0	29	10.60	8.29
STAI	19	37	26.53	4.98
BSQ	38	125	69.94	19.87
Age (years)	12	17	15.03	1.74
%BF	12	23	17.44	2.37

Note: SD: Standard Deviation; EAT-26: Eating Attitudes Test-26; STAI: Brazilian State-Trait Anxiety Inventory; BSQ: Body Shape Questionnaire; %BF: Percentage of Body Fat.

Table 2. Multiple linear regression using STAI-S and STAI-T as explanatory variables of the variance in EAT-26's Dieting subscale scores of adolescent female track and field athletes. *Rio de Janeiro* (RJ), Brazil. 2013.

Variables	Block	B	R	R^2	R^{2*}	p-value
STAI-S	1	0.08	0.25	0.06	0.04	≤0.18
STAI-T	2	0.09	0.18	0.04	0.03	≤0.14

Note: EAT-26: Eating Attitudes Test; R^{2*}: *Ratio*^{2} adjusted; STAI-S: State-Trait Anxiety Inventory-State; STAI-T: State-Trait Anxiety Inventory-Trait.

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Table 3. Multiple linear regression using STAI-S and STAI-T as explanatory variables of the variance in EAT-26's Bulimia and Food Preoccupation subscale scores of adolescent female track and field athletes. *Rio de Janeiro* (RJ), Brazil. 2013.

Variables	Block	B	*R*	R^2	R^{2*}	*p*-value
STAI-S	1	0.05	0.10	0.01	0.01	≤0.25
STAI-T	2	0.07	0.12	0.03	0.02	≤0.21

Note: EAT-26: Eating Attitudes Test; R^{2*}: *Ratio*^{2} adjusted; STAI-S: State-Trait Anxiety Inventory-State; STAI-T: State-Trait Anxiety Inventory-Trait.

Table 4. Multiple linear regression using STAI-S and STAI-T as explanatory variables of the variance in EAT-26's Oral Control subscale scores of adolescent female track and field athletes. *Rio de Janeiro* (RJ), Brazil. 2013.

Variables	Block	B	*R*	R^2	R^{2*}	*p*-value
STAI-S	1	0.08	0.04	0.02	0.01	≤0.19
STAI-T	2	0.12	0.23	0.05	0.03	≤0.05

Note: EAT-26: Eating Attitudes Test; R^{2*}: *Ratio*^{2} adjusted; STAI-S: State-Trait Anxiety Inventory-State; STAI-T: State-Trait Anxiety Inventory-Trait.

Table 5. Comparison between the EAT-26 subscale scores of the high- and low-anxiety groups of adolescent female track and field athletes. *Rio de Janeiro* (RJ), Brazil. 2013.

Variables	Group						*p*-value
	Low anxiety (STAI <15.26)			High anxiety (STAI ≥15.26)			
	Mean	±	Standard Error	Mean	±	Standard Error	
Dieting	6.09	±	1.04	5.46	±	1.14	≤0.27
B and FP	3.63	±	0.56[a]	0.98	±	0.62	≤0.02
OC	3.91	±	1.39	2.66	±	1.51	≤0.15

Note: [a]p<0.05 in relation to the high-anxiety group.
B: Bulimia; FP: Food Preoccupation; OC: Oral Control; STAI: Brazilian State-Trait Anxiety Inventory; SE: Standard Error; EAT-26: Eating Attitudes Test-26.

score as the criterion variable. Again, STAI-S (F(1, 87)=1.95; p=0.25) and STAI-T (F(1, 87)=2.36; p=0.21) had no significant influence on this score.

The last regression model used the Oral Control subscale score as the dependent variable (Table 4). Only STAI-T (F(1, 87)=6.61; p=0.048) had a significant impact on this score at the 5% level. STAI-S (F(1, 87)=3.07; p=0.19) did not explain the oral control variance in young track and field athletes.

Some findings regarding the comparison of EAT-26 subscales by anxiety group deserve emphasis (Table 5): 1) The Dieting subscale scores of high- and low-anxiety athletes did not differ significantly (F(1, 86)=2.16; p=0.27); 2) Low-anxiety athletes had higher Bulimia and Food Preoccupation subscale scores than high-anxiety athletes (F(1, 86)=17.02; p=0.018); and 3) The Oral Control subscale scores of high- and low-anxiety athletes did not differ significantly (F(1, 86)=4.64; p=0.15).

DISCUSSION

The objective of the present study was to analyze the relationship between anxiety and IEB in adolescent female track and field athletes. Some authors have recommended studies to determine whether anxiety can predispose athletes to IEB. So far, such studies have found a relationship between anxiety and IEB[12,19,20]. However, these studies regarded European athletes. The only study that investigated the relationship between anxiety and IEB in Brazilian

athletes confirmed the positive relationship between these variables, but this study was performed on gymnasts[21]. Thus, there are no studies analyzing the relationship between anxiety and IEB in female Brazilian track and field athletes.

The study results show a prevalence of IEB of 16% (EAT+). This finding is corroborated by other studies on female Brazilian athletes[11,28]. IEB prevalence in athletes of competitive team sports or those that require anaerobic power (track and field, basketball, and soccer) is usually lower than that in athletes of aesthetic sports (synchronized swimming, diving, and artistic gymnastics)[28]. Scoffier *et al.*[17] argued that the main trigger of abnormal eating behaviors is the coaches' insistence for the athletes to lose weight to optimize performance. Indeed, according to the scientific literature, track and field athletes are not considered a group at risk of eating disorders[3].

The mean percentage of body fat was 17.44 (±2.37), which may be considered low for females[11,16]. However, athletes require a percentage of body fat close to this number for good performance in most sports[14,23]. Athletes with a percentage of body fat below 15% may have menstrual disorders[3] and malnutrition[11], which may hinder both their performance and health[16]. Moreover, researchers have suggested that a low percentage of body fat may be closely associated with higher anxiety[20], which may explain the 46.7% prevalence of high anxiety in athletes.

The results of the first regression model (Dieting subscale) show that state and trait anxiety were not associated with long fasting periods in female athletes, which is corroborated by Vargar *et al.*[20]. These authors have also not evidenced a relationship between food restriction and anxiety in Turk athletes of various sports. Hence, an anxious athlete does not seem to restrict food intake. Rouveix *et al.*[4] claims that anxious athletes are probably more prone to binge eating than to food restriction.

The regression model using the Bulimia subscale score as the criterion variable showed that anxiety was not related to self-induced vomiting and binge eating in female athletes, contrary to what some studies have indicated[19,20]. The present results may be explained by the fact that physical training reduces anxiety[20], and training is a daily habit for athletes. Therefore, young athletes probably have low anxiety levels, which would indicate low susceptibility to binge eating. Physically active individuals experience less anxiety than inactive individuals[12]. This relationship may stem from the fact that physical activity increases the release of the neurotransmitters serotonin and dopamine, associated with happiness and psychological wellbeing, attenuating negative emotional states such as anxiety[20]. Given that track and field athletes train systematically, they may have low anxiety levels. Corroborating this idea, Rouveix *et al.*[4] found lower anxiety levels in athletes than in non-athletes. On the other hand, some authors emphasize that athletes with anxiety disorder may binge eat high-carbohydrate foods because these foods promote the release of neurotransmitters, such as serotonin[12,29].

The last regression model showed that trait anxiety influences the type and amount of foods consumed by the athletes. Silva *et al.*[12] asserted that anxious adolescents may learn about healthy and not-so-healthy foods from their coaches and family members more easily than adolescents with low anxiety levels.

Comparison of the EAT-26 subscales by anxiety group based on the mean STAI score showed that food restriction frequency and environmental pressure to control food intake were similar in both groups (high- versus low-anxiety levels), contrary to Gomes *et al.*[19]. On the other hand, athletes who experience high anxiety binge eat and self-induce vomiting more often than those who experience low anxiety, corroborating Vargar *et al.*[20].

Although the present results are original, the study has some limitations. One is the cross-sectional study design, preventing the inference of causality. This means that it is not possible to

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assess the intensity and direction of the associations found between the outcome variable and the independent variables. Another limitation may be the non-assessment of the athletes' menstrual cycle phase since the menstrual cycle may affect anxiety.

CONCLUSION

The study results indicate that only trait anxiety is related to oral control and the environmental and social forces that encourage food intake in female athletes. Trait anxiety in track and field athletes may make them vulnerable to poor oral control and environmental food intake promoters. Finally, low-anxiety athletes are more vulnerable to bulimic symptoms (binge eating and compensatory behaviors).

More specifically, coaches should pay attention to anxiety symptoms in their young athletes. Additionally, athletes' anxiety level should be assessed by STAI. Coaches should watch high-anxiety athletes for binge eating and self-induced vomiting, and keep track of the types and amounts of foods they consume. Athletes with abnormal eating behaviors should be referred to a psychologist, psychiatrist, and/or dietician.

CONTRIBUTORS

LS FORTES developed the research project, collected data, and wrote the article. SS ALMEIDA analyzed the data and reviewed the article. MEC FERREIRA supervised the entire study and reviewed the article.

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Folate inadequacy in the diet of pregnant women[1]

Inadequação de folato na dieta de gestantes

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ABSTRACT

Objective

To estimate food and dietary folate inadequacies in the diets of adult pregnant women.

Methods

A prospective study was conducted with 103 healthy pregnant adult users of the Public Health Care System of *Ribeirão Preto*, *São Paulo,* Brazil. The present study included the 82 women with complete food intake data during pregnancy, which were collected by three 24-hour dietary recalls. Food folate (folate naturally present in foods) and dietary folate (food folate plus folate from fortified wheat flour and cornmeal) inadequacies were determined, using the Estimated Average Requirement as cutoff.

Results

The diets of 100% and 94% of the pregnant women were inadequate in food folate and dietary folate, respectively. However, fortified foods increased the medium availability of the nutrient by 87%.

Conclusion

The large number of pregnant women consuming low-folate diets was alarming. Nationwide population studies are needed to confirm the hypothesized high prevalence of low-folate diets among pregnant women.

Indexing terms: Folic acid. Food consumption. Pregnancy.

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RESUMO

Objetivo

Estimar a inadequação de folato alimentar e folato dietético na dieta de gestantes adultas.

Métodos

Um estudo prospectivo foi conduzido entre 103 gestantes adultas e saudáveis, usuárias do Sistema Único de Saúde do município de Ribeirão Preto, São Paulo, Brasil. Foram incluídas no presente estudo 82 mulheres com dados de consumo alimentar ao longo da gestação. Os dados dietéticos foram obtidos por meio de três inquéritos recordatórios de 24 horas, durante a gravidez. Para estimar a inadequação do folato alimentar (naturalmente presente nos alimentos) e do folato dietético (folato dos alimentos adicionado ao proveniente da fortificação das farinhas), empregou-se o método do requerimento médio estimado - Estimated Average Requirement *como ponto de corte.*

Resultados

Verificou-se que 100% das gestantes apresentaram dietas com ingestão inadequada de folato alimentar. Considerando-se o folato dietético, 94% das gestantes reportaram dietas com ingestão inadequada do nutriente. Entretanto, houve um aumento de 87% na disponibilidade do valor mediano do nutriente após se considerar o ácido fólico proveniente da fortificação das farinhas.

Conclusão

A inadequação de folato na dieta das gestantes avaliadas foi alarmante. Estudos populacionais de abrangência nacional são necessários para a confirmação da hipótese de uma elevada inadequação de folato na dieta de gestantes.

Termos de indexação: *Ácido fólico. Consumo alimentar. Gravidez.*

INTRODUCTION

Folate is one of the micronutrients with important roles during pregnancy. Low dietary intake of this vitamin may compromise the mother's and child's health, making them more susceptible to preeclampsia, megaloblastic anemia, low birth weight, preterm birth, chromosomal changes, and fetal malformations due to Neural Tube Defects (NTD)[1-4].

High prevalences of folate inadequacy in pregnant women have been found in developing and developed countries. In rural China[5] and India[6], the prevalences of folate inadequacy were 97% and 99%, respectively. In Portugal, a prospective study found that 91% of the pregnant women had low dietary folate intake[7]. In southern Spain, the prevalence of folate inadequacy in pregnant women was 98%[8].

In the Brazilian context, studies that estimated folate adequacy in the diet of pregnant women are scarce[9-11]. Additionally, these studies were conducted before the Institute of Medicine (IoM) published recommendations for specific populations, namely the Estimated Average Requirement (EAR), established to assess nutrient adequacy[12].

The recommended folate intake during pregnancy is challenging to meet through diet alone[13]. Some strategies have been implemented to increase access to this nutrient, such as folic acid supplementation and fortification of wheat flour and cornmeal[14].

Like other countries, the *Agência Nacional de Vigilância Sanitária* (Anvisa, National Sanitary Surveillance Agency) in Brazil regulated the compulsory fortification of wheat flour and cornmeal, and their derivatives, with iron and folic acid. The legislation requires the addition of 150 µg of folic acid per 100 g of wheat flour or cornmeal[15].

A cross-sectional population study conducted in the municipal urban area of *São Paulo* analyzed folate intake before and after food fortification and found a significant decrease in the prevalence of folate inadequacy in all study

strata/groups (adolescents, adults, and older adults). However, the prevalence of folate inadequacy in adult women remained high (38%)[16].

The *Pesquisa Orçamento Familiares* (Family Budget Survey)[17] analyzed Brazilian food intake and found that folate inadequacy in adult women remains high (38.1%) regardless of added folate. However, information about the prevalence of folate inadequacy in pregnant women was not available.

Brazilian studies that estimate folate inadequacy in the diet of pregnant women according to the current recommendations have not been found[12]. Given the importance of adequate dietary folate intake during pregnancy, the present study aimed to estimate food and dietary folate inadequacies in the diet of pregnant women.

METHODS

The present study consisted of the secondary analysis of data from a prospective study on pregnant users of the municipal Public Health Care System of *Ribeirão Preto* (SP), Brazil.

Data from a convenience sample were collected at four primary care units located in the southern, eastern, and western regions of the municipality. The inclusion criteria were: age between 18 and 35 years; normal weight before pregnancy (18.5 kg/m² <BMI <24.9 kg/m²)[18]; and no reported conditions that impacted habitual food intake. An on-call scheme was implemented on the prenatal follow-up days in the selected health care units. All women who visited these units for prenatal care and met the study inclusion criteria were invited to join the study.

The study consisted of three assessments, one on each trimester of pregnancy, and collection of sociodemographic, asset, lifestyle, and food intake data. The first assessment was performed during the user's first prenatal care visit, from September 2009 to May 2010. The other two assessments were done during other prenatal care visits or at the patient's home.

In all, 247 women were approached; 103 met the inclusion criteria and accepted to enter the study. Eighty-two of the 103 participants provided complete food intake data during pregnancy, so they were included in the present study.

The present study included all pregnant women with complete food intake data during pregnancy, totaling 82 women.

A structured questionnaire collected age, marital status, skin color, education level of the family head, education level of the pregnant woman, and asset data. The *Associação Brasileira de Estudos Populacionais* (Brazilian Association of Market Research Companies')[19] questionnaire determined the socioeconomic classes of the pregnant women.

Estimate of dietary folate intake by the pregnant women was three 24-Hour Recalls (24HR), one on each assessment, collected dietary data of nonconsecutive days. A 24HR was administered by telephone to a subsample of pregnant women seven to fifteen days after the in-person interviews.

The 24-hour were filled using the multiple-pass method[20], and the standard weights of the cooking units in grams were provided by the "Brazilian Manual of Home Cooking Recipes and Cooking Units"[21,22].

The United States Department of Agriculture food composition table served as reference for estimating dietary folate intake. This table lists Dietary Folate Equivalents (DFE), which differentiates between the bioavailability of food folate and the folic acid in fortified foods[23]. The amount of DFE was given by the formula: DFE= folate + 1.7x folic acid[24].

The folic acid values were also corrected from 140 µg/100 g of wheat flour or cornmeal, the amount added in the United States of America[25], to 150 µg/100 g of wheat flour or cornmeal, the amount added compulsorily in Brazil[15].

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The contribution of a particular food to the dietary folate ingested by the pregnant women was given by multiplying the total amount of folate present in the food (naturally and added) by 100 and dividing by total dietary folate[26]. The foods were then ordered in decreasing percent contribution.

The mean and standard deviation of continuous variables and frequency of categorical values were calculated.

Folate inadequacy was estimated in two stages using the same method: the first considered only the folate naturally present in foods (food folate); the second considered food folate plus the folate added to flour wheat and cornmeal (dietary folate).

Once Analysis of Variance (Anova) adjusted the distribution of dietary folate intake, the proportion of pregnant women with inadequate folate intakes was calculated, using the EAR as cutoff, as recommended by the IoM[12].

All statistical analyses were performed by the software Statistical Package for the Social Sciences (SPSS) (version 17.0)

The study was approved the by Research Ethics Committee of the Health Center of the School of Medicine of *Ribeirão Preto* under protocol number CEP/CSE-FMRP-USP-150/2012. The pregnant women who met the inclusion criteria were informed of the study objectives in writing and filled out an Informed Consent Form.

RESULTS

Being married, socioeconomic class C, and at least eight years of formal education prevailed among the study women (Table 1).

The pregnant women had a mean (Standard Deviation) food folate intake of 183 (54) DFE/day and a median of 179 DFE/day, varying from 61 to 350 DFE/day. The mean dietary folate intake was 342 (109) DFE/day, and the median was 335 DFE/day, varying from 116 to 752 DFE/day. Therefore, food fortification increased folate availability by 87%.

Table 1. Sociodemographic characteristics of the 82 pregnant women. *Ribeirão Preto* (SP), Brazil, 2009.

Characteristics		
Age (years)	M=25	SD=5
	n	%
Marital status		
Married/lives with partner	57	69.5
Single	22	26.8
Separated	3	3.7
Skin color		
White	43	53.0
Brown/Red	28	34.6
Black	8	9.9
Yellow	2	2.5
Education level (formal education)		
<4 years	2	2.4
4 a 8 years	25	30.5
>8 years	55	67.1
*Socioeconomic class**		
A + B	7	8.5
C	59	72.0
D + E	16	19.5

Note: **Critério de Classicação Econômica Brasil*[19].

M: Mean; SD: Standard Deviation.

A total of 346 foods were listed in the 24HR. The foods that contributed most to food folate intake were: cooked beans, bread rolls, whole milk, orange juice, and loose-leaf lettuce. The greatest contributors to dietary folate intake were bread rolls, cooked beans, crackers, and whole milk (Table 2).

Figure 1 shows that the food folate intake of 100% of the study women fell short of the amount recommended by the EAR (520 µg DFE/day), and 94% of the women had inadequate dietary folate intake (Figure 2).

DISCUSSION

This is the first Brazilian study to estimate the food and dietary folate inadequacies in the diet of pregnant women according to the current recommended intake[12].

Although food fortification increased the nutrient's availability, the proportion of women with inadequate dietary folate intake according

Table 2. Contribution of different foods to the food and dietary folate intakes of pregnant women. *Ribeirão Preto* (SP), Brazil, 2009.

Classification	Foods	Contribution* (%)	Folate in 100 g of food**
	Dietary folate		
1	Bread roll	21.7	243.8
2	Cooked beans	9.9	48.6
3	Crackers	4.6	199.3
4	Whole milk	2.5	5.0
5	Hamburger bun	2.5	156.4
6	Natural orange juice	2.2	30.0
7	Breakfast cereal	2.1	845.3
8	Pasta	1.9	47.0
9	Cake	1.9	156.5
10	Cornmeal couscous	1.9	286.7
	Food folate		
1	Cooked beans	18.7	48.6
2	Bread roll	5.2	31.0
3	Whole milk	4.8	5.0
4	Natural orange juice	4.3	30.0
5	Loose-leaf lettuce	3.4	38.0
6	*Feijoada*	2.9	100.2
7	Papaya	2.6	38.0
8	Banana	2.2	20.0
9	Liver	2.2	260.0
10	Rice	2.1	2.00

Note: *Percent folate contribution of the food to the total dietary folate intake; **Shown as Dietary Folate Equivalent (DFE).
1 DFE = 1 µg of naturally occurring folate = 0.6 µg of synthetic folic acid present in fortified foods and vitamin supplements.

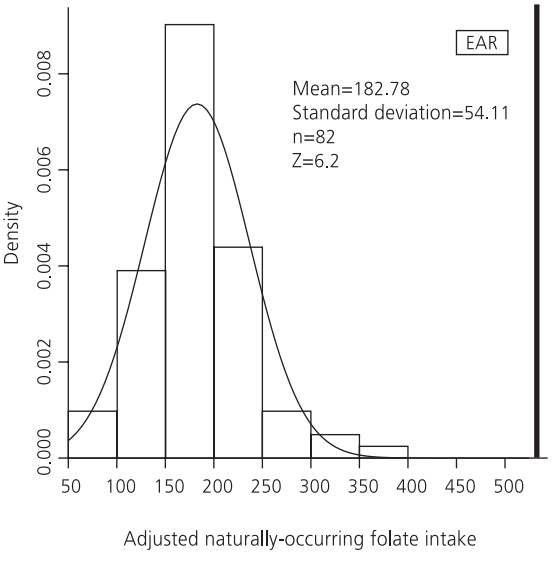

Figure 1. Distribution of the adjusted food folate intake Dietary Folate Equivalent of the 82 pregnant women. *Ribeirão Preto* (SP) Brazil, 2009.

Note: EAR: Estimated Average Requirement.

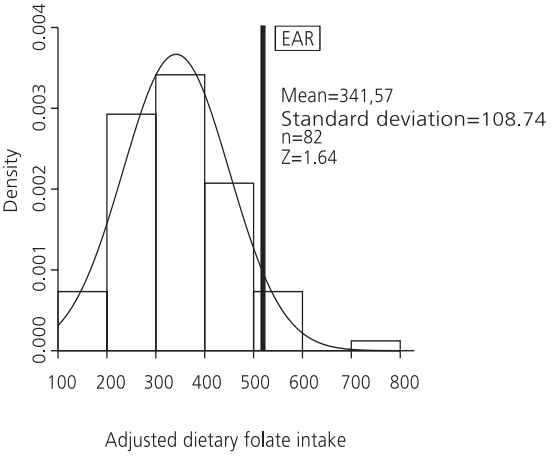

Figure 2. Distribution of the adjusted dietary folate intake Dietary Folate Equivalent of the 82 pregnant women. *Ribeirão Preto* (SP), Brazil, 2009.

Note: EAR: Estimated Average Requirement.

to the EAR was very high at 94%. This finding suggests a serious public health problem since folate deficiency during pregnancy may have some negative effects on the mother's and child's health[1,2,8].

Studies from other countries have also found high proportions of women with inadequate dietary folate intake, corroborating the present findings. A study in the state of Ohio, United States of America, with pregnant adolescents and adults found that less than 10% of the sample had adequate folate intake according to the reference standard[27]. In Spain a study found that folate was the second most prevalent dietary micronutrient inadequacy in pregnant women, affecting 99.6% of the study sample[28].

The foods that contributed most to dietary folate intake were bread rolls and beans. However, these were not the foods with the highest folate levels. Steluti *et al.*[29] reported a similar finding for Brazilian adolescents. A plausible explanation for this fact is that the foods preferred by the two groups are not the best sources of the nutrient.

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Another Brazilian study with adolescents, adults, and older adults found that breads and beans contribute most to dietary folate, and breads provided the highest contribution regardless of the subject's age[16]. The established folate requirement of pregnant women exceeds that of nonpregnant women, and it is challenging to meet the requirement without fortified foods and/or supplementation[30].

One limitation of the present study is the use of a convenience sample, which prevents extrapolation of the results. Additionally, biochemical tests were not performed. However, this original study in Brazil points out the high proportion of pregnant women with inadequate dietary folate intake.

CONCLUSION

The proportion of pregnant women with inadequate dietary folate intake was alarming. The food folate in the diets of all study pregnant women was short of the EAR, and 94% of the women still presented inadequate dietary folate intake, which included the folate added to wheat flour and cornmeal. Brazilian population studies are recommended to confirm the hypothesis that inadequate dietary folate intake by pregnant women is a serious public health problem.

CONTRIBUTORS

LC CRIVELLENTI participated to the collected data, analyzed and interpreted the data, and wrote the manuscript. P BARBIERI participated to the designed the prospective study, supervised data collection, and reviewed and approved the final version of the manuscript. DS SARTORELLI performed the general coordination of the study and reviewed and approved the final version of the manuscript.

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Reference serving sizes for the Brazilian population: An analysis of processed food labels[1]

Porção de referência para a população brasileira: uma análise considerando rótulos de alimentos industrializados

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ABSTRACT

Objective

To compare serving sizes reported on processed food labels with reference serving sizes according to nutrition labeling legislation and the "Food Guide for the Brazilian Population".

Methods

This cross-sectional study analyzed the labels of 2,072 processed foods in a supermarket of *Florianópolis, Santa Caratina,* Brazil. The foods were classified according to the Brazilian food labeling legislation. Central tendency and variability values were calculated for the serving sizes and energy values reported on the labels, as well as the ratio between the reported and reference energy value. The Spearman correlation test was performed between the reference serving size and the reference energy density, and also between the reference serving size and energy density of each study food.

Results

Nutrition labeling and the Food Guide presented reference servings with different sizes and energy values. The serving sizes reported on the labels did not follow either of the references and presented heterogeneous values, with a maximum range of 55-240 g among ready and semi-ready pre-prepared dishes. The reported energy values were between 0.1 times smaller and 2.4 times larger than the reference values. The reference

[1] Article based on the master's thesis of N KLIEMANN intitled "*Análise das porções e medidas caseiras em rótulos de alimentos industrializados ultraprocessados*". Universidade Federal de Santa Catarina; 2012.

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serving sizes presented a highly inverse correlation with the reference energy density (Spearman coefficient= 0.9) and a very low inverse correlation with the energy density of the foods analyzed (Spearman coefficient= 0.2).

Conclusion

This study showed the need for standardizing reference serving size information for the Brazilian population as well as reviewing nutrition labeling legislation in order to standardize the serving sizes reported on labels and to update the reference energy density used to calculate serving sizes.

Indexing terms: Food nutrition education. Food labeling. Industrialized foods. Nutrition policy. Nutritional facts.

RESUMO

Objetivo

Comparar as porções declaradas nos rótulos de alimentos industrializados com as porções de referência da legislação de rotulagem nutricional e do "Guia Alimentar para a População Brasileira".

Métodos

Estudo transversal que analisou os rótulos de 2 072 alimentos industrializados em um supermercado de Florianópolis, Santa Catarina. Os alimentos foram classificados de acordo com a legislação brasileira de rotulagem nutricional. Foram calculados valores de tendência central e de variabilidade para porção e valor energético declarados nos rótulos, além da razão entre o valor energético declarado e de referência. Teste de Correlação de Spearman foi realizado entre porção e densidade energética de referência e entre porção de referência e densidade energética de cada alimento analisado.

Resultados

A rotulagem nutricional e o Guia Alimentar apresentaram porções de referência com tamanhos e valores energéticos diferentes. As porções declaradas nos rótulos não seguiram nenhuma das referências e apresentaram valores heterogêneos, com amplitude máxima de 55-420 g entre pratos preparados prontos e semiprontos. Os valores energéticos declarados foram de 0,1 vez menor a 2,4 vezes maiores do que os valores de referência. As porções de referência da rotulagem apresentaram correlação inversa alta com a densidade energética de referência (Coeficiente de Spearman=-0,9), e muito baixa com a densidade energética dos alimentos analisados (Coeficiente de Spearman=-0,2).

Conclusão

Evidenciou-se a necessidade de padronização das informações sobre porção de referência para a população brasileira, assim como de fiscalização e revisão da legislação de rotulagem nutricional a fim de uniformizar as porções declaradas nos rótulos e atualizar a densidade energética de referência usada para o cálculo das porções.

Termos de indexação: *Educação alimentar nutricional. Rotulagem de alimentos. Alimentos industrializados. Política nutricional. Informação nutricional.*

INTRODUCTION

Obesity is currently considered a major public health problem and affects large parts of the world[1]. The main causes of obesity include changes in dietary and physical activity patterns, especially an increase in the consumption of processed foods as well as the size of the portions consumed[2-5].

Studies have indicated that obesity and various other chronic diseases can be prevented through public policies and actions in the food environment[1,6]. A healthy environment should promote and facilitate healthier food and serving size choices[2-5]. Examples of population-based strategies include food guides for the public and nutrition labeling of foods. Such measures have been promoted by the World Health Organization

(WHO) in the 2004 "Global Strategy on Diet, Physical Activity and Health"[3]. The WHO has kept this recommendation in its "Global Action Plan for the Prevention and Control of Non-communicable Diseases 2013-2020"[7].

In Brazil, nutrition labeling and the "Food Guide for the Brazilian Population" have emerged with the aim of promoting healthy food choices and appropriate serving sizes. The Brazilian nutrition labeling legislation[8,9] has been drafted and harmonized with other Mercosul countries[10,11] and reference food serving sizes have been defined to be reported on food labels. Along the same lines, the "Food Guide for the Brazilian Population" also defines reference serving sizes for the public in order to guide people in making healthier food choices[12].

In both policies, the reference serving sizes are defined based on a diet of 2,000 kcal. In this way, food groups have been defined and the number of servings per day and the reference energy value of each serving have been set for each group[8,12]. In addition, serving sizes in grams or millimeters (g or mL) have been defined for most foods[8,12]. However, the nutrition labeling legislation allows the serving sizes reported on labels to be up to 30% larger or smaller than the reference serving size[8-9].

Studies have suggested that the lack of serving size standardization on food labels among similar kinds of food products can complicate comparison and, as a result, food choices[2,13-14]. Furthermore, according to Monteiro & Cannon[15], an increase has been observed in the production and consumption of high-energy ultra-processed foods in Brazil as well as a trend towards reformulating these foods in order to reduce their sodium, trans fat, and energy content so that they can be advertised as healthy. However, considering the change in the energy standards of processed foods[15], it is assumed that the reference serving sizes (g or mL), when reported on nutrition labels of the processed foods currently available on the Brazilian market, may not match the reference energy values. Furthermore, it is suggested that such issues can compromise the use of this information as a reference for consumption by the public.

Thus, in light of the importance of coherent educational strategies to control the serving sizes consumed by the population[2], this study analyzed the compliance (in grams/millimeters and energy value) of the servings reported on processed food labels with the reference serving sizes according to Brazilian nutrition labeling legislation and the "Food Guide for the Brazilian Population".

METHODS

This was a descriptive and analytical cross-sectional study. The data was collected in a large supermarket in *Florianópolis* (SC), Brazil. The selection of the study's location was intentional. We chose a supermarket that sells a national range of processed foods and belongs to one of the ten largest supermarket chains in Brazil, according to a survey by the Brazilian Supermarket Association in 2013[16]. To participate in the study, the free and clear consent of the supermarket managers was obtained.

The sample consisted of 2,072 processed foods that were available for sale during the data collection period and that met the selection criteria explained below.

The inclusion criteria were all the processed foods included in the food list created by Silveira[17] classified as processed or ultra-processed[15]. Processed foods are considered to be those that are derived directly from natural foods and converted into less perishable and more palatable and attractive food products through the addition of salt, sugar and/or fat and the use of techniques such as roasting and smoking. Ultra-processed foods are those that are ready- or semi-ready-to-eat and consist partially or entirely of industrial ingredients. These foods have low nutritional value and high amounts of energy, simple carbohydrates, sodium and trans and/or saturated fats[15]. We chose this classification

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because it includes foods that are forming a growing part of the Brazilian diet[18-20].

Exclusion criteria: all concentrated, powdered, dehydrated and/or mixed foods that require reconstitution by adding other ingredients. Processed foods in which the reference serving size according to the Brazilian legislation[8] was defined based on household measurements or according to the food's nutritional profile. Bakery products prepared and packaged by the supermarket itself, as the nutrition labeling of products sold without packaging or with protective packaging is not mandatory.

Data collection was done by dietitians and trained nutrition students during two consecutive weeks in August 2011. The instrument used for data collection had been previously tested in a pilot study. The instrument included the following information: type of processed food, flavor, total weight (g or mL), brand, origin (location where the food was produced), serving size (g or mL), household measurement and energy value per serving. Magnifying glasses were available during the data collection to better view the nutritional information and plastic gloves were provided to handle chilled and/or frozen processed foods.

Variations of the same processed food available in packages of different sizes were recorded as new products, as not all of them had identical serving sizes.

Information was collected on reference serving size in energy value and in grams or milliliters according to Brazilian nutritional labeling legislation[8] and the "Food Guide for the Brazilian Population"[12].

The collected data were entered into two separate databases and were subsequently checked for errors and validated in EpiData® version 3·1.

The processed foods analyzed were divided into six groups and 38 subgroups with the same reference serving size, according to *Resolução da Diretoria Colegiada* (RDC) nº 359/2003[8].

Group A: Composed of bakery products, cereals, legumes, roots, tubers, and their derivatives, including the following subgroups: dry pasta (instant noodles); fresh pasta (with or without filling); fresh dough for pastries and wraps; pizza dough; chilled or frozen dough without filling (e.g. cheese bread); salty crackers with or without filling; pre-fried and/or frozen tubers and cereals (e.g. fried potatoes, polenta and cassava); breakfast cereals 1 (≤45 g *per* cup); breakfast cereals 2 (>45 g *per* cup); cereal- and flour-based snacks (e.g. potato chips, potato sticks, shoestring potatoes and ice cream cones); ready-made flour; packaged processed breads; toast; popcorn; chilled and frozen foods with filling; and cakes and similar products with or without filling.

Group B: Composed of milk and dairy products, including the following subgroups: dairy drinks, yogurt and fermented milk; cottage, nonfat ricotta, minas, nonfat soft and *petit-Suisse* cheese; grated cheese; ricotta, semi-hard, white, soft and cream cheese; and dairy desserts.

Group C: Composed of meats and eggs, including the following subgroups: meatballs and hamburger; *patés*; and meat pastries.

Group D: Composed of oils, fats and oilseeds, including the following subgroups: oilseeds (sweet and salty) and whipped cream.

Group E: Composed of sugars and products that provide energy from carbohydrates and fats, including the following subgroups: chocolates and similar sweets; chocolate confections (e.g. granulated chocolate); soft and peanut sweets (e.g. creamy sweets); sweet preparation mixtures, cake and pie frosting and ice cream syrup; cookies with or without filling; mass or individual ice creams (e.g. ice cream bars and popsickles); and candies, lollipops and lozenges.

Group F: Composed of pre-prepared dishes, including only one subgroup: ready and semi-ready pre-prepared dishes (e.g. refrigerated and frozen dishes; pizza; frozen sandwiches and pies; and non-refrigerated and *vacuum*-sealed ready-made dishes).

In the descriptive analysis of the data, we initially compared the reference serving sizes of the nutrition labeling legislation[8] with those of the "Food Guide for the Brazilian Population"[12]. In addition, we calculated the median and range of the serving sizes reported on the labels by food subgroup in order to assess the variability of their sizes. In each food subgroup, we also calculated the median and interquartile range for the reported energy values per serving.

Considering that both Brazilian nutrition labeling legislation[8] and the "Food Guide for the Brazilian Population"[12] have reference energy values per serving for each food group, we calculated the ratio between the energy value reported on the labels and the reference values for each subgroup. Thus, it was possible to assess the agreement between these two parameters (reported energy value and reference values).

The non-parametric Spearman correlation test was performed between reference serving size and energy density, both per 100 g of each food analyzed and per 100 g of the reference value in the nutrition labeling legislation. This analysis made comparison possible between the theoretical energy density used by the legislation to calculate serving size and the energy density of the foods analyzed in this study. This study included only products with serving sizes defined by law in grams or milliliters.

To analyze the serving sizes (g or mL) reported on labels in relation to the reference values, the foods were classified into five groups. This classification was done according to the reference serving size under Brazilian law, following the criteria presented in Table 1. However, we have not included the foods in Group F because these foods do not have a reference serving size in grams or milliliters.

RESULTS

Information was collected from the nutrition labels on 2,072 processed foods. In the comparative analysis between the reference serving sizes under Brazilian law and those of the "Food Guide for the Brazilian Population", we observed that although both use a 2,000 kcal diet as a basis, there were differences between these documents. There were disagreements in the classification of foods into groups as well as in the energy value of the serving sizes, as can be seen in Table 2. Agreement was observed only in the serving sizes of the 'cereals, tubers, roots and derivatives' and 'fruits and natural fruit juices' groups. Beans were considered to be a separate group only in the "Food Guide for the Brazilian Population"[12], as the nutrition labeling legislation[8] included beans in the cereals group. Reference value for ready- and semi-ready-to-consume dishes were not defined in either of the two documents analyzed[8,12].

In regard to serving sizes in grams or milliliters, we found that the Food Guide[12] defined serving sizes by food type and not by food group, as the nutrition labeling legislation did[8]. For example, cakes with different flavors had different serving sizes in the Food Guide - e.g. the serving

Table 1. Classification of serving sizes (g or mL) reported on labels in relation to reference serving sizes under Brazilian food labeling law.

Classification[1]	Meaning	Compliance with law[2]
<70%	Serving size smaller than 70% of recommended serving size (g or mL)	Inadequate
70-99%	Serving size up to 30% smaller than recommended serving size (g or mL)	Adequate
100%	Serving size equal to recommended serving size (g or mL)	Adequate
101-130%	Serving size up to 30% larger than recommended serving size (g or mL)	Adequate
>130%	Serving size larger than 130% of the recommended serving size (g or mL)	Inadequate

Note: [1]Classification of serving size in g or mL reported on the label in relation to the legislated reference serving size. [2]*Resolução da Diretoria Colegiada* nº 359/2003[8].

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Table 2. Comparison between reference serving sizes, in energy value, under Brazilian nutritional labeling law and according to the "Food Guide for the Brazilian Population".

Food group	Reference energy value per serving (number of servings per day)[#]	
	RDC nº 359/2003	Food Guide for the Brazilian Population
Cereals, tubers, roots, and derivatives	150 kcal (6)	150 kcal (6)
Vegetables	30 kcal (3)	15 kcal (3)
Fruits and natural fruit juices	70 kcal (3)	70 kcal (3)
Milk and derivatives	125 kcal (2)	120 kcal (3)
Meats and eggs	125 kcal (2)	190 kcal (1)
Oils, fats, and oilseeds	100 kcal (2)	73 kcal (1)
Sugar and sweets	100 kcal (1)	110 kcal (1)
Beans	Assigned to the cereals group	55 kcal (1)
Sauces, pre-prepared seasonings, broths, soups and pre-prepared meals	No recommendation	No recommendation

Note: [#]Based on a diet of 2,000 kcal.
RDC: *Resolução da Diretoria Colegiada* nº 359/2003[8].

size was 30 g for carrot cake and 50 g for banana cake. However, under the nutrition labeling legislation, all cake types and flavors had the same reference serving size (60 g).

Table 3 shows the variability of serving size and energetic value per serving reported on the food labels analyzed. It also presents the ratios between the reported energy values and the reference values. The serving size analysis found that the median serving sizes of 28 subgroups (83.3%) were equal to the legislated reference values. However, serving size standardization (in which all food products have declared serving sizes equal to those recommended by law) was found in only six food subgroups (17.6%), five of which (14.7%) belong to Group A. The 28 remaining subgroups varied in reported serving sizes, with a minimum range of 21-30 g among salty crackers and a maximum range of 55-420 g among ready- and semi-ready-to-consume dishes. The greatest variations were found in the following subgroups: ready- and semi-ready-to-consume dishes; meatballs and hamburgers; meat preparations with flour and bread; and dairy drinks, yogurt and fermented milk.

Regarding energy value per serving, we observed that five food subgroups had median values (r=1.0) that agreed with the reference values defined by the legislation[8] and/or the Food Guide for the Brazilian Population[12]. However, only three of these subgroups (r=1.0) agreed with both references. Table 3 also shows that the reported energy value per serving was less than the reference value (r<1.0) in the legislation[8] and Food Guide[12] in 58% and 62% of the assessed subgroups, respectively. It should be noted that the patés and grated cheese subgroups had reported energy values that were 0.1 and 0.4 times smaller than the reference values, respectively. Reported energy value per serving was greater than the reference value (r>1.0) in 28% and 22% of the subgroups in relation to the legislation[8] and the Food Guide[12], respectively. The fresh pasta and dry pasta groups stand out as their reported energy values were 1.8 and 2.4 times greater than the reference values, respectively.

A high inverse correlation was found between the reference energy density (*per* 100 g) and the reference serving size established under Brazilian nutrition labeling legislation, as shown in Figure 1.

However, a low inverse correlation was found between legislated reference serving size and energy density (*per* 100 g) of the foods analyzed, as shown in Figure 2. In Figure 2, it can be seen that above the curve, there are processed foods that have large serving sizes defined by law,

Table 3. Description of serving size (g or mL) and energy value per serving reported on labels and the ratio between reported energy values and the reference values under Brazilian law and according to the "Food Guide for the Brazilian Population". *Florianópolis* (SC), Brazil, 2011.

Group	Food subgroup	n	Reference serv. size (g or mL)	Reported serv. size (g ou mL)		Reported energy value per serving (kcal)		Ratio between median energy value and reference values	
				Median	Range	Median	IQR	Law[1]	FGBP
A	Dry pasta	67	80	85	(30.0;109.0)	364	(271; 392)	2.4	2.4
	Fresh pasta with or without filling	48	100	100	(50.0; 160.0)	275	(241; 293)	1.8	1.8
	Fresh dough for pastries and wraps	23	30	30	(30.0; 60.0)	90	(86; 95)	0.6	0.6
	Pizza dough	10	40	40	(25.5; 40.0)	113	(112; 117)	0.8	0.8
	Chilled or frozen without filling	7	50	50	(-)	145	(139; 152)	1.0	1.0
	Crackers	92	30	30	(21.0; 30.0)	124	(111; 135)	0.8	0.8
	Pre-fried and/or frozen tubers and cereals	11	85	85	(70.0; 100.0)	123	(106; 155)	0.8	0.8
	Breakfast cereals 1 (≤45 g *per* cup)	22	30	30	(20.0; 30.0)	110	(109; 113)	0.7	0.7
	Breakfast cereals 2 (>45 g *per* cup)	39	40	40	(-)	158	(138; 163)	1.1	1.1
	Cereal- and flour-based snacks	107	25	25	(10.0; 40.0)	127	(116; 141)	0.8	0.8
	Pre-prepared flour	6	35	35	(-)	142.5	(134; 150)	1.0	1.0
	Packaged bread, sliced and unsliced	101	50	50	(40.0; 75.0)	122	(115; 138)	0.8	0.8
	Toast	26	30	30	(-)	112	(105; 119)	0.7	0.7
	Popcorn	31	25	25	(-)	98	(94; 102)	0.7	0.7
	Chilled or frozen with filling	12	40	45	(30.0; 120.0)	134.5	(121; 204)	0.9	0.9
	Cakes and similar foods	55	60	60	(30.0; 60.0)	219	(161; 247)	1.5	1.5
B	Dairy drinks†, yogurt and fermented milk†	186	200	180	(75.0; 300.0)	112.5	(63; 157)	0.9	0.9
	Cheese: cottage, ricotta, non-fat, minas, non-fat soft, and *petit-Suisse*	45	50	40	(30.0; 60.0)	64	(50; 80)	0.5	0.5
	Grated cheese	16	10	10	(10.0; 30.0)	46	(42.5; 100)	0.4	0.4
	Cheese: ricotta, semi-hard, white, soft, cream cheese	184	30	30	(20.0; 120.0)	99,5	(80,5; 110)	0.8	0.8
	Dairy desserts	20	120	105	(40.0; 200.0)	128	(101; 152)	1.0	1.1
C	Meatballs and hamburger patty	25	80	80	(56.0; 420.0)	149	(101; 178)	1.2	0.8
	Patês	24	10	10	(10.0; 100.0)	24.5	(19; 220)	0.2	0.1
	Breaded meat preparations	49	130	130	(30.0; 275.0)	245	(165; 305)	2.0	*
D	Oilseeds	31	15	15	(15.0; 25.0)	87	(75; 92)	0.9	1.2
	Whipped cream	5	20	20	(7.0; 20.0)	59	(50; 60)	0.6	0.8
E	Chocolates and similar products	159	25	25	(10.4; 41.0)	133	(123; 138)	1.3	1.2
	Chocolate confections	23	25	25	(10.0; 25.0)	97	(40; 117)	1.0	0.9
	Dough and peanut sweets	26	20	20	(15.0; 40.0)	104.5	(95; 115)	1.0	1.0
	Frosting and syrup for cakes, pies, and ice cream	15	20	20	(-)	56	(56; 63)	0.6	0.5
	Cookies with or without filling	275	30	30	(14.0; 100.0)	143	(131; 152)	1.4	1.0
	Soft and individual ice creams	157	60	60	(40.0; 90.0)	114	(103; 135)	1.1	1.0
	Candies, lollipops and lozenges	60	20	20	(2.0; 20.0)	79	(75; 80)	0.8	0.7
F	Ready and semi-ready prepared dishes	115	-	145	(55; 420)	335	(175; 401)	*	*

Note: †Serving size in mL. [1]*Resolução da Diretoria Colegiada* nº 359/2003[8]. Dietary Guide for the Brazilian Population[12]. *There is no reference value. Group A: Bread products, cereals, legumes, roots, tubers and their derivatives. Group B: Milk and derivatives. Group C: Meats and eggs. Group D: Oils, fats and oilseeds. Group E: Sugars and products that provide energy from carbohydrates and fats.

IQR: Interquartile Range; FGBP: Food Guide for the Brazilian Population.

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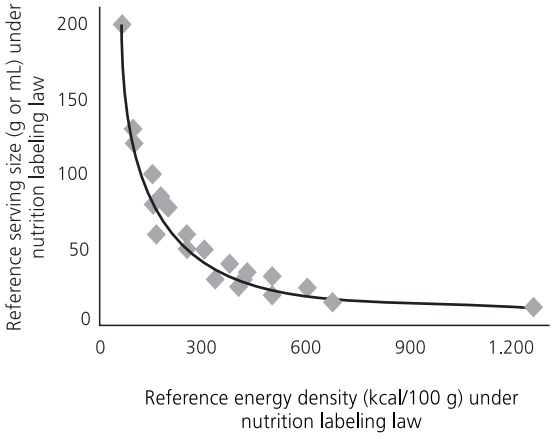

Figure 1. Relation between reference serving size (g or mL) and reference energy density (kcal/100 g) established by Brazilian nutrition labeling law. *Florianópolis* (SC), Brazil, 2011.

Note: Spearman correlation; Coefficient=-0.9; N=1,957.

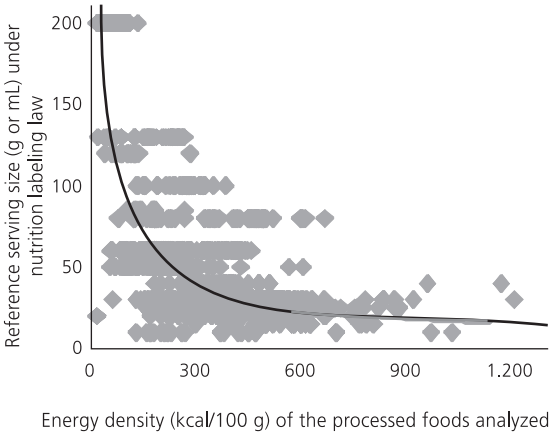

Figure 2. Relation between reference serving size (g or mL) under Brazilian nutrition labeling law and energy density (kcal/100 g) of the processed foods analyzed. *Florianópolis* (SC), Brazil, 2011.

Note: Spearman correlation; Coefficient=-0.2; N=1,954.

yet present high energy density. It can also be observed that, if all the foods reported the reference serving size, their energy value would not be the same as that established by law. This data indicates that the energy density of the analyzed foods is different from the theoretical energy density that was used to calculate serving sizes for nutrition labeling legislation.

In analyzing the compliance of reported serving sizes with the law, it was found that 72.4% (Confidence Interval of 95% - 95%CI=70.3; 74.3) of the foods had serving sizes equal to the reference value. Among the foods that did not exactly match the reference serving size, 10.1% (95%CI=8.7; 11.5) and 3.9% (95%CI=3.0; 4.8) still complied with the law, as they were 70-99% and 101-130% in agreement, respectively. The remaining foods did not comply with the law, as 9.3% (95%CI=8.0; 10.6) had serving sizes that were too small and 4.1% (95%CI=3.2; 5.0) had serving sizes that were too large.

DISCUSSION

This study's results show that the reference serving sizes under the Brazilian nutrition labeling legislation[8] and the "Food Guide for the Brazilian Population"[12] are different for some food groups while the serving sizes reported on labels do not generally follow either of these references. Reported serving sizes were also heterogeneous even among foods of the same group.

We point out that there are currently two official documents that provide different reference serving sizes for the Brazilian population, even though both are based on a 2,000 kcal diet[8,12]. The disagreement between the serving sizes defined by these two public policies is also found in other countries such as the United States and Canada. In these countries, this difference is justified by the different purposes of the policies, as serving sizes on labels represent the amount of the food that is typically consumed while serving sizes in the Food Guides are recommended amounts[2,12,21]. However, this justification is not applicable in Brazil since both documents have the same goal of promoting the selection of healthy foods in appropriate amounts.

Furthermore, research has shown that the disagreement between the serving size on nutritional labels and that of the Food Guide can cause confusion[22] or lead consumers to underestimate serving sizes[23,24]. In addition,

several studies analyzed by Abramovitch *et al.*[25] have shown that merely publishing reference serving sizes in food guides does not seem to be sufficient to educate the public about consuming food in appropriate amounts, and that other educational strategies are necessary. In this sense, the authors understand that agreement between these two documents could facilitate nutrition education programs for the public[26,27].

The present study also found that the serving sizes reported on the labels did not conform with the reference serving sizes in grams or milliliters, nor with the reference energy values[8,12]. Variation was observed in reported serving sizes among foods of the same group and the greatest range was found in the ready and semi-ready pre-prepared dishes group. This group is also the one that does not have a reference serving size in Brazil - neither in the labeling legislation[8] nor in the Food Guide[12].

According to a study conducted in Ireland, food guides rarely define reference serving sizes for the public for foods with high energy values, such as ready-to-consume dishes. This is due to the fact that such foods do not belong in a healthy diet. In these cases, there are merely warnings that such foods should be consumed sporadically or in small portions[22]. Even so, the terms 'sporadically' and 'small portions' may have no practical significance, as their interpretation is subjective. Furthermore, high consumption of these foods by Brazilians[20] has been linked to rising rates of chronic diseases[15,28]. Therefore, it is suggested that defining reference serving sizes for these foods can be a means of promoting nutrition education and improving the quality of information for consumers.

The lack of standardization in the reporting of serving size in nutrition labeling was also reported in a Brazilian study that analyzed 142 labels for yogurt, dairy drinks and fermented milk sold in the state of *Minas Gerais* and found a range of serving sizes from 100 to 200 g (the legislated reference serving size is 200 g)[29]. The variability of the foods analyzed in the present study was even greater, reaching a range of 75 to 300 g. It is suggested that such a difference could result from a difference in sample size, as the present study used a sample that was 31% larger than that of the Grandi & Rossi study[29]. Similar results have also been found in studies conducted in other countries where nutrition label information is also presented per serving. In Australia, for example, 1,070 processed foods were analyzed and serving sizes for snacks ranged from 18 g to 100 g, demonstrating a lack of uniformity[13]. In the United States, research has indicated that the serving sizes reported on labels can vary from 50% to 200% of the reference values defined by the Food and Drug Administration (FDA)[30,31]. According to the scientific literature, a lack of serving size standardization can compromise the comparability of processed foods and thus food choices, if this is the only information reported on nutrition labels[13,22,29,32].

Furthermore, even though Brazilian law allows a variability of 30.0% more or 30.0% less than the reference value when reporting serving sizes, the present study found that 13.4% of the foods analyzed did not comply and exceeded the permitted range, which already seems quite wide. Other studies conducted in Brazil have also found high nonconformity of food labels with the Brazilian law[33-36]. These studies have identified the greatest irregularities on food labels to be those referring to nutrition information[33-36]. Such studies reinforce the recommendation to better regulate the nutrition information provided on food labels.

In addition to the lack of serving size uniformity, low conformity has also been observed in the reported energy value per serving compared to the legislated reference value. This agrees with the findings of Piernas & Popkin[5], who elucidated changes in the energy density of American processed foods in 1977-1978 and 2002-2003, mainly among salty snacks, processed fruit juices, French fries, hamburgers, and pizza.

Therefore, it is necessary to review the serving sizes in grams and milliliters defined by

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Brazilian law, so that they reflect on food labels the energy recommendations per serving established by the same legislation. Furthermore, the definition of reference serving sizes per subgroup can explain this result, as foods with different flavors can have different energy densities. For example, the Food Guide defines different serving sizes for foods with different flavors that belong to the same group. In the case of corn bread and rye bread, for instance, the serving size is 70 g for the former and 60 g for the latter[12]. Therefore, it is suggested that the nutrition labeling legislation's classification of foods into subgroups also be assessed so that the reference serving sizes reflect reference energy values on food labels. Ferreira & Lanfer-Marquez[37] emphasize the importance of updating Brazilian nutrition labeling regulations to incorporate new knowledge and fill in existing gaps in order to strengthen these policies as a strategy for reducing obesity rates.

Despite a lack of studies evaluating the effects of defining reference serving sizes for the population, Faulkner *et al.*[22] point out that it is important that reference serving sizes be established and effectively disclosed to consumers. Researchers also point to the need for establishing more realistic serving sizes than the public currently customarily consumes[2,22]. It is noteworthy that the scientific community considers reference serving sizes and their respective household measurements to be essential to understanding the applicability of nutrition labeling[22,38]. However, studies also emphasize that it is vital to equip the Brazilian consumer to know how to interpret nutrition labels. Thus, such information can potentially play an educational role and facilitate food choices[39,40].

Finally, it is recommended that nutrition information per 100 g be included together with serving size information. According to some authors, the inclusion of such information could facilitate consumer analysis of nutrient quantities present in foods as well as comparisons between foods[41,42].

Limitations of this study include using only information from labels and not performing physical or chemical analyses on the foods or even weighing them. Even so, we analyzed the information that is available to consumers on labels, which is the only information that is currently available to guide their food choices at the time of purchase. Therefore, considering the rights of the consumer and the goals of labeling as a public health policy, the reliability of this information should be guaranteed by manufacturers and be subject to oversight to ensure compliance with the law. Another of this study's potential limitations was the inclusion of processed foods from a single supermarket. However, this store is part of a large supermarket chain and many of the processed foods analyzed are sold throughout the country.

CONCLUSION

This study showed a lack of standardization in reference serving size information for Brazilian consumers. There are differences between the serving sizes established by the "Food Guide for the Brazilian Population and Brazilian" nutrition labeling legislation and those reported on processed food labels. In addition, we observed that not all foods reported the legislated reference serving sizes, demonstrating serving size variability on labels. Finally, we point out that the energy density used to calculate reference serving sizes in the legislation is different from that found on the food labels we analyzed.

Therefore, we conclude that it is necessary to review Brazilian nutrition labeling legislation in regard to the food classification, reference serving sizes and energy density used. In addition, considering that reference serving sizes can be different among foods with different flavors due to differences in energy density, we recommend the inclusion of nutritional information per 100 g. Including such information can serve as a strategy for facilitating comparisons between foods and using this information to make food choices.

Finally, we emphasize the importance of standardizing reference serving size information in the "Food Guide for the Brazilian Population", Brazilian nutrition labeling legislation and on food labels. Such standardization aims to facilitate access to information on reference serving sizes by consumers and the use of this information in public nutrition education programs. Therefore, we suggest reviewing the permitted variation in serving sizes reported on labels, which currently can range from 30% less to 30% more than the reference serving size. The data reported here indicate that this range may be too wide, virtually precluding the possibility of comparing similar foods.

Finally, we found that 13% of the foods analyzed reported serving sizes that did not comply with the legislation despite the wide variability permitted. This seems to point to the need to carefully monitor the information reported on the labels of food products sold in Brazil.

CONTRIBUTORS

N KLIEMANN helped to conceive, design, and implement the study, analyze and interpret the data, and write the manuscript. DA GONZALEZ-CHICA helped to analyze the data statistically and interpret and discuss the results. MB VEIROS and RPC PROENÇA conceived, designed, coordinated, and supervised the study and the manuscript writing.

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Hygienic, sanitary, physical, and functional conditions of Brazilian public school food services[1]

Condições físico-funcionais e higiênico-sanitárias das unidades de alimentação e nutrição de escolas da Região Centro-Oeste, Brasil

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ABSTRACT

Objective

To verify the physical, functional, hygienic, and sanitary conditions of the food services of municipal schools located in the Brazilian Midwest region.

Methods

This is a cross-sectional study of 296 school food services conducted from February to June 2012. The food services were assessed by a semi-structured check list divided into the following sections: physical conditions, available equipment, food handlers' conduct, and food service cleaning processes and procedures. The study variables were classified as compliant or noncompliant with the regulations passed by the National Sanitary Surveillance Agency.

Results

Noncompliances were found in all study food services, especially with respect to food service conditions, and the wiring and plumbing in the food preparation area. In this section, 62.7 to 95.9% of the food services did not comply with nine out of the thirteen study items. The main problems were: poorly cleaned external areas,

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deteriorated walls, floors, ceilings, roofs, drains, and roof gutters; and unscreened doors and windows, allowing the entrance of insects; among others. The main noncompliance regarding processes and procedures was the uncontrolled temperature of the ready-to-eat foods.

Conclusion

The conditions of the study food services are unsatisfactory for the production of safe meals, possibly compromising meal quality, food safety, and the effectiveness of the School Food Program.

Indexing terms: Food security. Good manipulation practices. School food.

RESUMO

Objetivo

Verificar as condições físico-funcionais e higiênico-sanitárias das Unidades de Alimentação de Nutrição de escolas públicas municipais localizadas na Região Centro-Oeste do País.

Métodos

Estudo transversal, realizado entre fevereiro e junho de 2012, em 296 unidades de alimentação e nutrição escolares. Aplicou-se nestas unidades checklist *semi-estruturado, dividido em blocos referentes às condições estruturais, disponibilidade de equipamentos, atuação dos manipuladores de alimentos, processos e procedimentos e higienização ambiental. Considerando as determinações da Agência Nacional de Vigilância Sanitária para Unidades de Alimentação e Nutrição, classificou-se as variáveis analisadas em conforme ou não conforme.*

Resultados

Em todas as unidades de alimentação e nutrição que participaram do estudo identificou-se inadequações, com destaque para às condições dos edifícios e instalações da área de preparo dos alimentos. Neste bloco, 62,7 a 95,9% das unidades apresentaram não conformidade para nove dos treze itens avaliados, os principais problemas foram: higienização precária da área externa; paredes, pisos, forros, tetos, ralos e canaletas inadequados; portas e janelas sem telas de proteção contra a entrada de insetos, dentre outros. Quanto aos processos e procedimentos, a principal inadequação foi a falta de controle de temperatura dos alimentos prontos para o consumo.

Conclusão

As unidades de alimentação e nutrição pesquisadas apresentam-se em condições insatisfatórias para a produção de uma alimentação escolar segura do ponto de vista higiênico-sanitário, o que pode comprometer a qualidade da refeição, a Segurança Alimentar e Nutricional no ambiente escolar e a efetivação do Programa Nacional de Alimentação Escolar.

Termos de indexação: *Segurança alimentar e nutricional. Boas práticas de manipulação. Alimentação escolar.*

INTRODUCTION

A food service is "an organized service performing a sequence of actions that aim to supply balanced meals within established dietary and hygienic standards and meet the nutritional needs of its clientele, according to the financial means of the institution" (p.35)[1]. In schools, these food services are the kitchens where school food is prepared.

The supply of microbiologically safe foods in schools is regulated by Law nº 11.947/2009[2] because their clientele consists of children, the most vulnerable group to foodborne diseases[3-5]. These disease are caused by foods contaminated with pathogenic microorganisms or chemical products[6].

The use of good practices, including appropriate and safe procedures, from facility construction to meal distribution, allows food services to ensure safe preparations[7].

The characteristics of the physical structure of a food service, such as flooring, wall and ceiling coating, door and window conditions, drain size

and location, lighting, ventilation, temperature, and moisture, among others, directly affect its cleanliness[8]. Identifying the risk of food contamination allows determining what needs improvement and the stage of food preparation that is compromising food safety[9].

Today the Technical Regulations for Good Food Service Practices is provided by *Resolução da Diretoria Colegiada* (RDC, Board Resolution) nº 216, passed on September 15, 2004 by the *Agência Nacional de Vigilância Sanitária* (Anvisa, National Sanitary Surveillance Agency). The objective of this RDC is to improve sanitary control and better protect people's health[7]. However, numerous school food services do not comply with these regulations and risk cross-contamination[3,4,9-12]. In *Salvador* (BA), the conditions of approximately 57% of the 235 schools assessed were unsatisfactory[3].

Given this perspective and that sanitation is directly associated with the assurance of safe foods[13], school meals must be produced in food services with good infrastructure and handling practices.

The *Programa Nascional de Alimentação Escolar* (PNAE, National School Food Program) is one of the social policies and programs that aim to promote food and nutrition security. Created in the 1950s, this nationwide, government-sponsored school food program became structured for the first time. Until then the program was known as school "lunch"[14]. The guidelines of the program include the use of healthy foods that promote schoolchildren's growth and development according to their age group, health status, and occasionally, special needs[14,15].

The municipal and state PNAE managers must ensure the acquisition, transportation, storage, and preparation of meals that remain safe until consumption[15].

Given the above, RDC nº 216/2004[7], and Law nº 11.947/2009[2], the present study aimed to check the physical, functional, hygienic, and sanitary conditions of the food services of municipal schools located in the Midwest region of the country.

METHODS

This is a cross-sectional, descriptive study with a quantitative approach[16] approved by the Research Ethics Committee of the *Universidade Federal de Goiás* (UFG) on October 21, 2011, under Protocol number 354/11. All participants signed an Informed Consent Form before study enrollment.

Data were collected by six dieticians who received 20-hour training to standardize personal conduct and checklist scoring. These dieticians visited the food services of municipal schools in the Brazilian Midwest states, namely *Goiás, Mato Grosso do Sul*, and *Mato Grosso*, from February to June 2012.

The schools were sampled in two stages. The first stage consisted of selecting municipalities in the Midwest that did not comply with Article 14 of Law nº 11.947 passed on June 6, 2009[2]. This article establishes that at least 30% of the funds transferred to PNAE by the *Fundo Nacional de Desenvolvimento da Educação* (FNDE, National Education Development Fund) be used for purchasing foods from family farms[2]. There was a survey of municipalities that received training or consulting services from the *Centro Colaborador em Alimentação e Nutrição* (Cecane) of the UFG of the Midwest Region in the last years, also excluded these municipalities, because these activities have a positive impact on the physical, functional, hygienic, and sanitary conditions of school food services[17].

A total of 168 municipalities with 938 municipal elementary and high schools were selected. Based on the number of schools in these municipalities, a prevalence of food services with unsatisfactory sanitary conditions of approximately 50%, and a 95% Confidence Interval (95%CI), the final sample should contain at least 273 municipal schools. An additional 10% was added

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to the minimum sample size to compensate for losses, so the final sample consisted of 300 schools, as recommended by Hoffmann[18].

Sixty municipalities were randomly selected from the 168 that met the inclusion criteria, on the additional condition that they had a dietician in charge of the PNAE, as determined by Law nº 11,947/2009[2].

In the second stage, the schools were selected. The number of schools selected per municipality was given by the proportional distribution of the total number of schools. Only municipal elementary and high schools were included. State, indigenous, and *Quilombola* schools, preschools, and daycare centers were excluded. State schools were excluded because they are managed and followed by their State Department of Education; indigenous and *Quilombola* schools were excluded because they have particularities related to these communities; and preschools and daycare centers were excluded because they require special food services, capable of catering for sucklings.

As determined by RDC nº 216/2004[7], a semi-structured checklist was created for data collection. The checklist was divided into the following sections: a) Physical, plumbing, and wiring conditions in the food preparation area; b) Equipment, utensils, and handlers; c) Handlers; d) Processes and procedures; and e) Food service cleaning.

Food handlers were asked to answer a specific questionnaire called "Handlers," which consisted of the following variables: type of job, type of employment contract, weekly hours of work, participation in training courses and subjects covered by said courses, having jobs other than food handling, and health checkup frequency. The instruments created and validated by Cecane of the *Universidade Federal de São Paulo* (Unifesp)[19] helped to assess the physical, functional, hygienic, and sanitary conditions and the food handling practices of the study food services.

As the data were tabulated, the following categories were attributed to each study item: noncompliant (0); compliant (1); and not applicable (2); as recommended by RCD nº 216/2004[7]. A period (.) was attributed to unanswered questions, considered losses.

The database was created in the spreadsheet Microsoft Excel version 2007. The data were entered twice to check for inconsistencies, which was done by the statistical package Stata/SE version 11.0.

The percentages of adequacy were estimated for the entire sample and by state (*Goiás, Mato Grosso,* and *Mato Grosso do Sul*) and segment (urban and rural). Measures of association based on the Chi-square statistic assessed the relationship between compliance and noncompliance. A type I error of 0.05 was considered for the statistically significant results. The compliance rates of the study variables were calculated to diagnose the conditions of the school food services and to identify the points with the greatest noncompliance rates.

RESULTS

Of the 59 municipalities in the Midwest region that participated in the study, 22.0% (n=13) were in *Goiás*, 30.5% (n=18) were in *Mato Grosso do Sul*, and 47.5% (n=28) were in *Mato Grosso*. The single loss was due to political problems in one of the selected municipalities. Hence, the sample consisted of 296 municipal school food services, of which 76.0% (n=225) were in urban areas and 24.0% (n=71) were in rural areas.

None of the study food services were compliant with all Good Handling Practices (GHP). In 294 (99.3%) schools, the meals were prepared in-house; in two rural schools, the meals were prepared at the cooks' homes.

Many items regarding the physical, plumbing, and wiring conditions of the food preparation area (Section A) were noncompliant

with RDC nº 216/2004. Items with noncompliance rates in excess of 86% were (Table 1): problems in the external areas of the food services, such as unused objects, insects and other animals, and/or exposed garbage; hard-to-clean floors; walls with mildew, moisture, peeling paint, and cracks; ceilings and roofs that leak or allow the entrance of insects; drains and gutters unprotected against the entrance of rodents and/or insects in the 67 food services with drains and gutters inside the food service; unscreened doors and windows; storage areas with poor lighting and ventilation, and unused objects;

Items with noncompliance rates below 40.0% were (Table 1): use of water from wells, cisterns, springs, rivers, streams, and water trucks, among others, none of which were guaranteed to be treated or potable; inappropriate food storage, such as foods inside cardboard boxes, on tables, chairs, floor and/or in unventilated cabinets. The storages in 268 (90.6%) schools were near the food preparation area; in 28 (9.5%) schools the foods were stored far from the food preparation area, such as in classrooms or even outside the school; inappropriate storage of foods that required refrigeration but were not refrigerated. Foods were stored close to cleaning materials in 57 (19.6%) food services, and close to school materials (books, paper, furniture, etc.) in 18 (6.1%) food services; water tank not cleaned often enough: in 50 (19.3%) food services, the water tanks had not been cleaned in over six months, and in 36 (13.9%) food services, they had never been cleaned. Only 84 (37.7%) food services kept a water tank cleaning record and 10 (3.4%) food services did not have a water tank; of these, six (60.0%) were in urban areas and four (40.0%) were in rural areas.

Noncompliant items in the food distribution and consumption areas were found in 73.4% of the food services because they did not have cafeterias. In these schools the meals were served in the courtyard or classrooms (Table 1).

With respect to equipment (Section B), all food services had a stove; 294 (99.3%) food services had commercial stoves; one food service located in a rural area had a wood-burning stove and a residential stove (Table 2).

Six (2.0%) food services located in rural areas had no refrigerators. Nine (3.0%) food services had only a freezer, and of these, six (66.7%) were in urban areas and the remainder, in rural areas.

Only 53 (17.9%) food services had conventional weighing scales; six (2.0%) had platform scales; one (0.3%) had the two types of scales; and 238 (80.4%) had no scale. Only two

Table 1. Compliance of municipal schools in the Brazilian Midwest region with RDC nº 216/2004 regarding physical, plumbing, and wiring variables in the food preparation areas (Section A). Brazil, 2012.

Variables	Compliant		Non-compliant		Total	
	n	%	n	%	n	%
Food service water source	180	60.8	116	39.2	296	100.0
External area cleanliness	20	6.8	275	93.2	295	100.0
Food service flooring	20	6.8	276	93.2	296	100.0
Food service walls	18	6.1	278	93.9	296	100.0
Food service ceiling and roof	12	4.1	283	95.9	295	100.0
Food service drains and gutters	9	13.4	58	86.6	67	100.0
Door and window screens	16	5.4	278	94.6	294	100.0
Proper storage lighting, ventilation, and/or absence of unused objects	8	2.7	285	97.3	293	100.0
Raw materials stored on shelves, racks, or pallets.	176	61.1	112	38.9	288	100.0
Storage conditions of items that require refrigeration	239	84.7	43	15.3	282	100.0
Proper food distribution and consumption areas	78	26.6	215	73.4	293	100.0
Water tank cleaning frequency	173	66.8	86	33.2	259	100.0
Record of water tank cleanings	84	37.7	139	62.7	223	100.0

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Table 2. Availability of equipment and utensils (Section B) in the food services of municipal schools of the Brazilian Midwest region. Brazil. 2012.

Equipment/Utensils	Number of school food services with the equipment/utensil	
	n	%
Commercial stove	294	99.3
Residential stove	19	6.4
Wood-burning stove	1	0.3
Single-door residential refrigerator	172	58.1
Double-door residential refrigerator	112	37.8
Freezer	275	92.9
Walk-in cooler	9	3.0
Conventional weighing scale	53	17.9
Platform weighing scale	6	2.0
Thermometer	2	0.7

Table 3. Compliance of municipal schools in the Brazilian Midwest region with RDC nº 216/2004 regarding processes and procedures performed in the food preparation areas (Section D). Brazil, 2012.

Variables	Compliant		Non-compliant		Total	
	n	%	n	%	n	%
Goods receiving clerk checks the raw materials upon receipt	58	20.4	227	79.6	285	100.0
Hand washing frequency	233	80.9	55	19.1	288	100.0
Hand sanitization	54	19.0	230	81.0	284	100.0
Utensils used on raw foods are sanitized before being used on cooked foods	17	6.0	268	94.0	285	100.0
Sanitization of fruits and vegetables	102	37.2	172	62.8	274	100.0
Food thawing process	207	72.1	80	27.9	287	100.0
Ready-to-eat foods are protected	140	50.7	136	42.3	276	100.0
Control of ready-to-eat food temperature	1	0.3	288	99.7	289	100.0
Leftover storage	23	85.2	4	14.8	27	100.0

(0.7%) food services had thermometers (Table 2). Equipment maintenance was done regularly in 175 (60.1%) food services.

Meals were prepared by cooks in 275 (92.9%) food services, and by handymen, teachers, and even students' parents in the remainder food services (Section C).

In 52 (18.1%) food services, the food handlers were properly dressed with uniforms in good conditions (clean and without holes or tears) and wearing closed shoes. In 264 (91.7%) food services, the handlers were wearing disposable caps, hair nets, or headscarves. The use of accessories and/or nail polisher was seen in 135 (47.0%) food services.

Many processes and procedures were noncompliant (Section D), reflecting the lack of GHP in the meal preparation area, from goods receiving to meal distribution.

The main noncompliances (Table 3) were: the temperature of the ready-to-eat foods was not controlled. Only one food service had a food warmer to keep the food above 60ºC. However, 289 (99.7%) food services served the meals as soon as they were ready; utensils used on raw foods were not sanitized before they were reused on cooked foods; hands were not sanitized properly because only water and soap or water alone was used for hand washing; upon receipt, goods' temperature, expiration date, and package integrity were not checked; in 37.2% of the food services, the fruits and vegetables were not sanitized properly because only water or water and soap and/or vinegar were used.

The highest compliance rates were found for the following items (Table 3): storage of leftovers under refrigeration: 85.2% of the 27 food services that saved the leftovers stored them properly; proper hand washing frequency, since the handlers reported washing their hands before they started their work, every time they changed activities, after going to the restroom, after touching the garbage can, and whenever necessary. However, two (0.7%) food services did not have running water; foods thawed under refrigeration, by a microwave oven, or cooked without prior thawing; the manner in which ready-to-eat foods were protected: with a plastic or paper food wrap, or a closed container. Noncompliant food services either did not protect the foods or covered them with a dish towel.

In 289 (99.7%) food services, the meats were always well done; all units (100.0%) served their eggs hard cooked. Forty-seven (16.4%) food services served pies, potato salad with mayonnaise, and creams, items whose ingredients include raw eggs.

Food service cleaning (Section E) included washing the floor daily (93.5%, n=272), weekly, or monthly; 149 (59.1%) food services used chlorine-based bleach, 96 (33.0%) food services used only water and soap, and 21 (7.2%) food services used only water or water and some other non-sanitizing product.

In 252 (86.6%) food services, the tables were washed daily; 28 (9.6%) food services washed them weekly; and five (1.7%) food services had never washed them. Of the food services that cleaned the tables, 149 (52.6%) used water, soap, and a sanitizing substance (chlorine-based bleach, 70% alcohol, or quaternary ammonium compounds).

Eighty-five (29.0%) food services had step garbage cans with garbage bags; 208 (71.0%) food services did not dispose of their garbage properly (inappropriate container or location). One hundred (35.0%) food services cleaned their garbage cans, 165 (57.7%) food services washed their garbage cans with water and soap, and 21 (7.3%) food services did not wash their garbage cans or used only water to wash them.

Most (n=188, 68.6%) food services relied on professional chemical pest control. Forty-five (16.4%) food services had some employee or another untrained individual do the job, and 41 (15.0%) food services did not control pests; 173 (67.8%) food services performed chemical pest control every semester or more often; 48 (18.8%) performed chemical pest control annually; and 51 (22.8%) food services did not perform chemical pest control regularly or at all.

When the food services located in urban and rural areas were compared, those in urban areas presented higher compliance rates for the following items: water source, storage conditions of foods that require refrigeration, meal distribution and consumption area, water tank cleaning frequency, record of water tank cleanings, dedicated cook, use of headgear, use of uniforms, hand sanitization, preparations containing eggs, food thawing, table sanitization, garbage cans, and professional pest control (Table 4).

Food services located in rural areas presented higher compliance rates only for their storage conditions: they had proper lighting, ventilation, and absence of unused objects ($p<0.05$) (Table 4).

All food handlers from all study food services who were present on data collection day were interviewed, totaling 482 food handlers or 1.6 food handlers per food service.

The jobs of 425 (89.8%) food handlers were compatible with food handling, that is, they were either the cook or the cook's assistant, but 48 (10.2%) jobs did not include food handling; these individuals were either handymen or administrative workers. Most (69.7%, n=331) food handlers had passed an admission test for the job; 120 (25.3%) were hired without a test, and 24 (5.0%) were outsourced. Roughly half (51.6%, n=245) of the food handlers worked from 30 to 40 hours a week, 213 (44.8%) worked

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Table 4. Comparative distribution of the food services of municipal schools located in the Brazilian Midwest region regarding compliance with RDC nº 216/2004. Brazil, 2012.

Variables	Number of schools compliant with RDC nº 216/2004				*p*-value*
	Urban		Rural		
	n	%	n	%	
Section A: *Physical, plumbing, and wiring conditions of the food preparation areas*					
Food service water source	178	79.1	2	2.8	0.00**
External area cleanliness	16	7.1	4	5.6	0.66
Food service flooring	17	7.6	4	5.6	0.58
Food service walls	13	5.8	5	7.0	0.70
Food service ceiling and roof	7	3.1	5	7.0	0.14
Screened doors and windows	13	5.8	3	4.2	0.74
Proper storage lighting, ventilation, and/or absence of unused objects	3	1.8	5	7.2	0.01**
Raw materials stored on shelves, racks, or pallets	139	62.6	38	57.6	0.46
Storage conditions of items that require refrigeration	189	85.5	49	80.3	0.00**
Cleaning materials stored away from foods	181	82.3	52	74.3	0.14
School materials stored away from foods	210	94.6	67	95.7	0.87
Proper meal distribution and consumption areas	67	30.0	11	16.9	0.02**
Water tank cleaning frequency	146	71.9	26	44.1	0.00**
Record of the water tank cleanings	73	39.7	11	25.0	0.00**
Section C: *Food handlers*					
Dedicated cook	215	95.6	60	84.5	0.00**
Use of headgear	217	98.6	51	83.6	0.00**
Use of proper uniforms	49	21.9	4	6.3	0.00**
Use of accessories	119	53.1	34	54.8	0.16
Section D: *Processes and procedures*					
Hand washing frequency	172	77.1	57	87.7	0.06
Hand sanitization	36	16.4	10	15.9	0.03**
Raw materials checked upon receipt	47	21.2	12	19.0	0.71
Ready-to-eat foods are protected	102	47.4	35	57.4	0.17
Utensils used on raw foods are sanitized before being used on cooked foods	15	6.8	2	3.2	0.26
Ready-to-eat food holding time	224	100.0	65	100.0	0.59
Storage of ready-to-eat foods	1	0.4	0	0.0	0.59
Preparations with eggs	194	87.4	47	72.3	0.00**
Proper food thawing	156	70.6	37	56.9	0.06
Section E: *Food service cleaning*					
Table sanitization	121	55.0	27	42.8	0.07
Floor sanitization	129	57.3	43	65.2	0.26
Garbage can	76	33.8	12	17.6	0.01**
Garbage can sanitization	77	34.8	23	35.4	0.86
Professional chemical pest control	165	78.6	23	36.5	0.00**

Note: **p*-value associated with Chi-square tests of independence (Pearson's Chi-square, Fisher's exact test, or likelihood ratio as needed); ***p*-value <0.05.

from 20 to 30 hours a week, and the remainder (3.6%) worked fewer than 20 hours a week.

Most (78.5%, n=373) food handlers were dedicated exclusively to meal preparation, and 102 (21.5%) were teachers, handymen, or administrative workers. Some (26.9%, n=128) food handlers underwent health checkups every semester, 179 (37.7%) had not undergone a health checkup in the last year or more, and the remainder (35.4%) never underwent any health checkup to handle food.

Regarding training, 115 (24.2%) food handlers had never attended a training course, 112 (23.6%) food handlers had not attended a

training course for at least one year, 188 (39.7%) food handlers had attended a training course in the last semester, and 59 (12.4%) food handlers had attended a training course in the last year. The most common subject in training courses was food hygiene, reported by 321 (89.4%) food handlers.

When the compliance rates for the physical, plumbing, and wiring conditions of the food preparation areas, food handlers' conduct,

Table 5. Percentage of compliance with RDC nº216/2004 of the study items of food services of municipal schools in the Brazilian Midwest region. Brazil, 2012.

Variables	GO		MS		MT		*p*-value*
	n	%	n	%	n	%	
Section A: Physical, plumbing, and wiring conditions of the food preparation areas							
Food service water source	35	67.3	57	81.4	88	50.6	0.00**
External area cleanliness	2	3.8	6	8.6	12	6.9	0.59
Food service flooring condition	3	5.8	10	14.3	8	4.6	0.03**
Food service wall condition	7	13.5	4	5.7	7	4.0	0.04**
Food service ceiling and roof condition	6	11.5	3	4.3	3	1.7	0.01**
Screened doors and windows	3	5.8	6	8.6	7	4.1	0.61
Proper storage lighting, ventilation, and/or absence of unused objects	1	1.9	1	1.4	6	3.5	0.63
Raw materials stored on shelves, racks, or pallets	40	80.0	39	58.2	98	57.3	0.01**
Storage of items that require refrigeration	49	94.2	59	85.5	130	80.7	0.01**
Cleaning materials stored away from foods	47	94.0	48	70.6	138	80.2	0.01**
School materials stored away from foods	49	100.0	66	94.3	162	93.6	0.00**
Proper meal distribution and consumption areas	4	7.8	15	21.7	59	34.1	0.00**
Water tank cleaning frequency	21	47.7	55	85.9	96	62.3	0.00**
Record of water tank cleanings	19	51.4	24	41.4	41	30.8	0.04**
Section C: Food handlers							
Dedicated cook	52	96.2	70	97.1	174	90.2	0.10
Use of headgear	47	97.9	70	100.0	164	92.7	0.02**
Use of proper uniforms	46	34.8	70	42.9	171	4.1	0.00**
Use of accessories	45	68.9	70	62.9	171	45.6	0.00**
Section D: Processes and procedures							
Hand washing frequency	48	91.7	70	64.3	170	82.4	0.00**
Hand sanitization	48	25.0	70	22.9	166	10.8	0.04**
Raw materials checked upon receipt	46	15.2	70	30.0	169	18.3	0.08
Ready-to-eat foods are protected	44	63.6	69	30.4	163	54.0	0.00**
Utensils used on raw foods are sanitized before being used on cooked foods	47	4.3	69	18.8	169	1.2	0.00**
Ready-to-eat food holding time	49	100.0	70	100.0	171	99.4	0.70
Storage of ready-to-eat foods	48	0.0	70	1.4	171	0.0	0.21
Sanitization of fruits and vegetables	49	28.6	68	45.6	168	30.3	0.01**
Preparations with eggs	48	64.6	68	92.6	171	86.0	0.00**
Proper food thawing	48	93.8	68	70.6	170	58.8	0.00**
Section E: Food service cleaning							
Table sanitization	48	81.2	70	94.3	168	87.5	0.17
Floor sanitization	49	46.9	70	64.3	172	60.5	0.14
Garbage can	49	32.7	70	40.0	174	25.3	0.07
Garbage can sanitization	48	45.8	70	40.0	168	29.8	0.20
Professional chemical pest control	44	52.3	63	82.5	166	68.1	0.02**

Note: *p-value associated with Chi-square tests of independence (Pearson's Chi-square, Fisher's exact test, or likelihood ratio as needed); **p-value <0.05.

GO: *Goiás*; MS: *Mato Grosso do Sul*; MT: *Mato Grosso*.

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rightness of the processes and procedures, and food service cleaning were compared by state, *Goiás* presented the highest compliance rates and *Mato Grosso* the lowest (Table 5).

DISCUSSION

School food quality includes not only nutritional aspects but also safety aspects. Compliance with sanitary requirements protects and promotes the health of public school students[4] and avoids foodborne disease outbreaks.

In the United States, foodborne diseases affect approximately one in every six people; yearly, 128,000 people are hospitalized and 3,000 die[20]. Of the cases reported in Brazil from 2000 to 2011, 9.09% occurred in educational institutions[21].

The lack of strict control during food preparation, poor physical conditions of the food preparation areas, and bad practices during food preparation processes and procedures may contaminate foods and compromise their safety, increasing the risks of foodborne diseases and their consequences[22].

Foodborne disease outbreaks and food service studies indicate that many areas where school meals are prepared and distributed are not appropriate for meal production[9,10,12].

High noncompliance rates may stem from the lack of specific regulations for school food services, which are much more similar to residential kitchens than commercial kitchens. School and institutional food services are subject to the same legislation, which may impair the implementation of more complex regulations[9]. However, this does not justify noncompliance with the basic requirements for the production of safe meals, such as personal and food service hygiene.

Regarding physical, plumbing, and wiring conditions (Section A), a study pointed out that even food services of daycares located in the municipality of *São Paulo* (SP) had physical noncompliances, especially doors without door sweeps and unscreened windows[9]. These noncompliances were also found in 94.6% of the study food services, and were the second most common noncompliances.

In *Salvador* (BA), of the 253 municipal and state school food services covered by PNAE, only 0.4% were in good conditions; 57.0% were unsatisfactory, especially regarding their physical, plumbing, and wiring conditions, which compromises the preparation of safe school meals[4].

In the same city, some of the main problems were inappropriate cleaning of the food preparation areas and surfaces, unscreened doors and windows, unprotected lamps, inappropriate garbage can sites, and absence of liquid soap and paper towels in restrooms and kitchens[11].

Contrary to the study data, 37.5% of the 24 food services of state schools in the city of *São Paulo* (SP) presented good hygienic and sanitary conditions; the most common problem was inappropriate cleaning of stoves and refrigerators[12].

In agreement with the present study, 100% of the school food services assessed in *Natal* (RN) presented noncompliances. The lack of cafeterias and meal distribution outside the kitchen, that is, in classrooms, halls, and sport courts[10] were among the greatest problems in both studies. The lack of cafeterias is also common in the schools of Ghana and South Africa, but these countries do not yet have effective school food programs like Brazil[23].

According to RDC nº 216/2004[7], water tanks should be cleaned at least once per semester, and the cleanings should be recorded. In the present study, 66.8% of the food services cleaned the water tanks at least once per semester, but most kept no records. Water is one of the most important recourses for meal production and a determinant of food safety. Improper water tank cleaning method and/or frequency can affect food safety and quality[24].

Regarding equipment and utensils (Section B), good use of the food service layout and enough devices to meet meal production requirements reduce workload and improve efficiency[8]. However, the present study found that essential items, such as refrigerator, weighing scale, and thermometer, were not available in all food services.

Thawing should be done under refrigeration with a temperature below 5 °C or in a convection oven[7]. Thawing in a microwave, water, or at room temperature requires controlling thawing time and temperature of the surface layer of the food[25]. Although nine food services did not have a refrigerator, only ten food services had a microwave oven, and nearly all food services did not have a thermometer, 72.1% of the food services thawed foods correctly: in the absence of the necessary equipment, they cooked the food in a pan or oven without prior thawing.

When foods are ready, they must be kept in clean food warmers in perfect working condition[7]; only one food service had a food warmer. However, 99.7% of the study food services served the meals as soon as they were ready, minimizing the risk of contamination.

Given the numerous physical noncompliances and absence of essential equipment in the study food services, public managers need to invest more in this sector, and dieticians, together with the School Food Council (CAE) need to participate more, to improve surveillance and guarantee safer meals.

In *Salvador* (BA), 49.4% of the food handlers had long nails, 70.6% used nail polishers, and in 51.7% of the food services, food handlers did not wash their hands often enough[3]. In Andalusia, Spain, the food handlers in 35.0% of the school canteens did not wash their hands properly, and in some canteens food handlers did not wash their hands at all[25]. The findings for the study food services were similar, except for hand washing frequency because 80.9% of the interviewed food handlers complied with the legislation.

Food handlers are one of the main sources of contamination by staphylococci and coliforms because these microorganisms inhabit human skin[24]. However, although hand washing is critical for the production of safe meals, a study of 38 elementary schools in *Hulu Langat* (Malaysia) found that only 15.3% of the food handlers knew all the steps for proper hand washing and that this activity was neglected by most food handlers[26].

Regarding processes and procedures (Section D), Silva Jr[24] reported that during goods receiving, the first stage of hygienic and sanitary control, the receiving clerk should check the expiration date, perform sensory analysis, check the packaging, observe the conditions of the delivery person, and weigh, measure, and record the temperature of the foods that require refrigeration. In the study food services, the lack of thermometers and weighing scales prevented verification of the temperature and weight of the delivered goods.

Vegetables should be washed by immersing them in chlorine-based bleach (150 to 200 ppm of chlorine) for 10 to 15 minutes, and both chlorinated isocyanurates and sodium hypochlorite may be used as the chlorine source[24]. Appropriate cleaning reduces the amount of pathogenic microorganisms to an amount compatible with our immunity[24]. However, most school food services did not wash the vegetables, which may place students' health at risk.

According to Kaku *et al*.[27], poor meal preparation hygiene in a school food service located in *Pontalina* (SP) caused 211 people to acquire foodborne disease from a mayonnaise sauce containing raw eggs. The main symptoms were diarrhea, fever, abdominal pain, vomiting, shivering, and headache, and 38.9% of those affected required hospitalization. Analysis of biological material and leftovers attributed the disease to *Salmonella* enteritidis[27]. Although all study food services served only hard-boiled eggs, 16.4% offered preparations that contained raw eggs, which may increase the risk of foodborne disease outbreaks.

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Given that dieticians are in charge of the PNAE and that their tasks include planning, creating, following, and assessing the school food menu[15], their presence in schools is critical, as well as their submitting of food handlers to periodical training to minimize risks and provide a safe and healthy menu.

Regarding table cleaning, only 52.6% of the study food services cleaned tables properly, corroborating a study done in school canteens in *Andalusia* (Spain) that found unsatisfactory table cleaning and disinfection conditions[25].

Gomes *et al.*[28] found that 44.4% of the 18 food services they investigated in the state of *Goiás* did not perform chemical pest control, different from this study, which found that only 13.8% of the food services did not perform this control.

According to RDC nº 216/2004[29], food services must take measures to prevent the presence of pests and hire professional chemical pest control when their measures are not effective[7]. Pest control providers must follow a series of practical and operational regulations regarding type of product used and application techniques to minimize environmental impact and ensure consumer and operator health, and service quality and safety[29].

Most food handlers interviewed by the present study reported not undergoing periodical training. Frequent training minimizes the risk of foodborne diseases substantially[30]. Food handlers are not knowledgeable about foodborne diseases, and their work has low social status and does not require a high education level[31].

The legislation determines that food handlers undergo regular training on personal hygiene, safe food handling, and foodborne diseases, and have documented proof of their participation in such training sessions[7]. However, many study food services did not comply with this regulation, as did not 72.2% of the 13 food services investigated by another study conducted in the state of *Goiás*, which did not train their food handlers[28].

Since dieticians are in charge of the PNAE, they must train these professionals[32]. Under this perspective and given that one of the inclusion criteria was the presence of a dietician in charge of the municipal school food, it is strange that so many food handlers did not undergo training regularly or at all, which may explain the high noncompliance rates of the GHP processes and procedures.

School food services located in urban areas differed significantly from those located in rural areas. The former presented higher compliance rates for almost all study variables, except for storage lighting, ventilation, and absence of unused objects (Table 3).

The results show that, since meals are prepared at school, the school should have proper places for storing foods, and preparing and distributing meals, to minimize the risks of contamination and provide safe foods to all public school students[23].

CONCLUSION

In light of the legislation, the food services of municipal schools in the Brazilian Midwest region present unsatisfactory physical and functional conditions, the food handlers do not comply with the proper hygienic and sanitary guidelines, and the GHP have not been implemented. The study results indicate that safe and quality meals cannot be guaranteed in the study schools.

The numerous noncompliances regarding the physical, plumbing, and wiring conditions of the food preparation areas and the lack of equipment suggest the need of greater interventions and involvement of municipal managers (mayor, head of the department of education), dieticians in charge of the school food, school principals, school food councils, and food handlers. Team work can ensure school compliance with food safety regulations, especially in schools located in rural areas.

Regarding processes and procedures, food handlers must be continuously and periodically trained to minimize the risk of food contamination stemming from the poor physical conditions of the school food services.

Over the years, the PNAE has made many advances to guarantee food and nutrition security. However, all social actors who work in the program need to invest, incentivize, intervene, and work more to ensure compliance with school food-related laws (Laws nº 11,947/2009 and 11,346/2006) and RDC nº 216/2004.

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CONTRIBUTORS

KM ALMEIDA helped to conceive and design the study, collect, analyze, and interpret data, review the literature and write the article. MCP ANDRÉ helped to conceive and design the study and write and review the article. MRH CAMPOS helped to conceive and design the study and review the article. MEP DÍAZ helped to define the methodological strategy, analyze and interpret the data and write and review the article.

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Prevalence of malnutrition and associated factors in hemodialysis patients[1]

Prevalência de desnutrição e fatores associados em pacientes em hemodiálise

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ABSTRACT

Objective

To assess the prevalence of malnutrition and associated factors in hemodialysis patients.

Methods

This is a cross-sectional study of 344 hemodialysis patients from *Goiânia*, *Goiás* aged 18 years or more. The dependent variable, malnutrition, was investigated by the Subjective Global Assessment. The independent variables included socioeconomic, demographic, and lifestyle data, clinical history, and energy and protein intakes. The patients underwent anthropometric measurements and laboratory tests. Multiple Poisson regression determined the associated factors ($p<0.05$).

Results

Mild or moderate malnutrition was found in 22.4% of the patients. Malnourished patients had lower body mass index, mid-arm muscle circumference, percentage of body fat, serum creatinine ($p<0.001$), and normalized protein nitrogen appearance ($p=0.001$). Multivariate analysis identified the following factors associated with malnutrition: age between 19 and 29 years (PR=1.23, 95%CI=1.06-1.43), family income less than 2 minimum salaries (PR=1.13, 95%CI=1.01-1.27), hemodialysis vintage ≥60 months (PR=1.08, 95%CI=1.01-1.16), Kt/V≥1.2 (RP=1.12, 95%CI=1.03-1.22), calorie intake <35 kcal/kg/day (PR=1.22, 95%CI=1.10-1.34), and normalized protein nitrogen appearance <1.0 g/kg/day (PR=1.13, 95%CI=1.05-1.21).

[1] Article based on doctoral dissertation of ATVS FREITAS intitled "*Prevalência e fatores associados à desnutrição e à obesidade abdominal em pacientes em hemodiálise na cidade de Goiânia-GO*". Universidade Federal de Goiás; 2011.

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Conclusion

The prevalence of malnutrition in this population was high, corroborating the literature. The prevalence was higher in patients aged less than 29 years and those with low family income, longer hemodialysis vintage, higher Kt/V, and inadequate protein and calorie intakes. Strategies to reverse this situation should include more nutritional care.

Indexing terms: Malnutrition. Nutrition assessment. Renal dialysis.

RESUMO

Objetivo

Avaliar a prevalência e os fatores associados à desnutrição em pacientes em hemodiálise.

Métodos

Estudo transversal com 344 pacientes maiores de 18 anos em hemodiálise em Goiânia, Goiás. A variável dependente, desnutrição, foi obtida por meio da avaliação subjetiva global. As variáveis independentes envolveram aspectos socioeconômicos, demográficos, estilo de vida, história clínica, ingestão energética e proteica. Realizaram-se antropometria e exames laboratoriais. A análise dos fatores associados foi realizada por regressão de Poisson múltipla (p<0,05).

Resultados

A prevalência de desnutrição leve ou moderada foi constatada em 22,4% dos pacientes. Os pacientes desnutridos apresentaram menor índice de massa corporal, menor circunferência muscular do braço, menor porcentagem de gordura corporal, menor valor de creatinina sérica (p<0,001) e nPNA (p=0,001).O resultado final da análise multivariada identificou os fatores associados à desnutrição: idade de 19 a 29 anos (RP=1,23; IC95%=1,06-1,43), renda familiar <2 salários-mínimos (RP=1,13; IC95%=1,01-1,27), tempo em HD ≥60 meses (RP=1,08; IC95%=1,01-1,16), Kt/V ≥1,2 (RP=1,12; IC95%=1,03-1,22), ingestão calórica inferior a 35 kcal/kg/dia (RP=1,22; IC95%=1,10-1,34) e nPNA <1,0 g/kg/dia (RP=1,13; IC95%=1,05-1,21).

Conclusão

Observou-se alta prevalência de desnutrição na população estudada em acordo com o encontrado na literatura. A prevalência foi maior entre os pacientes com idade inferior a 29 anos, renda familiar baixa, maior tempo em hemodiálise, maior Kt/V e ingestão calórica e proteica inadequadas. Estratégias para reverter esta situação devem envolver maior atenção nutricional.

Termos de indexação: *Desnutrição. Avaliação nutricional. Diálise renal.*

INTRODUCTION

With a prevalence of 10 to 60%[1], malnutrition continues to be a problem in Chronic Renal Failure (CRF) patients on Hemodialysis (HD), increasing their morbidity and mortality[1,2-5].

Factors that discourage food intake and promote hypercatabolism can lead to malnutrition. Among them are anorexia due to uremia, gastrointestinal disorders, psychological factors, severe dietary restrictions, social problems, comorbidities, inflammatory processes, and hypercatabolism due to nutrient losses during dialysis and metabolic changes[6,7].

Detecting malnutrition in CRF patients is a challenge[2]. There is no single objective method capable of diagnosing malnutrition accurately in HD patients[5]. Biochemical and anthropometric indicators can be influenced by comorbidities, inflammatory status, hydration status, observer experience, and absence of reference standards for HD individuals[8].

In this context, the Subjective Global Assessment (SGA) has been used to assess the nutrition status of HD patients[9]. This technique relates objective and subjective aspects of the clinical history and physical examination[2]. The SGA is inexpensive, quickly administered, requires little

interviewer training, and has good reproductibility[4,10], being recommended by the National Kidney Foundation-Kidney Disease Outcomes Quality Initiative (NKF-K/DOQI)[10]. Multicentric and longitudinal studies have claimed that the SGA is associated with morbidity, mortality, and hositalization[1,2], and correlates well with anthropometric measurements[4].

In addition to diagnosing nutritional status, identifying clinically controllable risk factors that promote nutritional deficits is very important for planning specific interventions[9]. However, given the multicausality of malnutrition in CRF[6,7], one should consider the relationships between its determinants when implementing prevention, diagnostic, and control strategies.

Considering this logic, the magnitude of CRF in Brazil, its impacts on nutritional status, and the absence of data on the prevalence of malnutrition in HD patients in the Brazilian Midwest Region, especially *Goiás*, this study aimed to estimate the prevalence of malnutrition in an HD population and establish the determinants of malnutrition.

METHODS

This cross-sectional study with a proportional, stratified sample from ten centers representative of the HD population of the city of *Goiânia* (GO) collected data from May 2009 to March 2010.

The sample size was given by the number of municipal HD patients aged 18 years or more (n=1,400), the prevalence of malnutrition, which varies from 10 to 60% in HD patients[3-5], sample maximization to 50%, confidence interval of 95%, and error of 5%. Hence, the estimated sample size was 302 patients. An extra 20% was included to compensate for losses and refusals, totaling 362 individuals, of which 344 remained in the study. The remainder (n=18) either dropped out or did not provide all the required information.

Considering the total number of patients in each clinic, the sample was selected by simple random sampling and consisted of clinically stable, not institutionalized males and females aged 18 years or more who had been undergoing hemodialysis for at least three months.

The exclusion criteria were: infections in the last three months, cancer, tuberculosis, acquired immunodeficiency syndrome, severe chronic obstructive pulmonary disease, severe cardiovascular disease, cerebrovascular disease, symptomatic heart failure classes III and IV, pregnancy, venous catheter dialysis, and diseases or situations that prevented anthropometric and food intake assessments, such as advanced bone diseases, stroke sequelae, physical disabilities, or amputated limbs.

The study collected socioeconomic, demographic, lifestyle, and anthropometric data, clinical history, and energy intake; administered the SGA; and performed laboratory tests. Four dieticians trained specifically for this study collected the data mentioned above using standard forms, pretested in a pilot study.

Nutritional status was classified according to the SGA, as recommended by the NKF-KDOQI[10] and validated by Steiber *et al.*[2] for HD patients. This protocol uses a 7-point scale to measure each one of the six SGA items (changes in body weight, energy intake, gastrointestinal symptoms, functional capacity, diseases and comorbidities that affect nutritional requirements, and physical examination to investigate subcutaneous fat loss, muscle mass loss, and presence of edema or ascites). The present study used the cutoff points recommended by the KDOQI, which classifies patients as nourished when the scores 6 or 7 prevail; mildly or moderately malnourished when the scores 3, 4, or 5 prevail; and severely malnourished when the scores 1 or 2 prevail[10].

The study socioeconomic and demographic data included gender, age in full years divided into age groups, marital status (living with or without a partner), education level (no education, elementary grades 1-4, elementary grades 5-8,

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high school, and higher education); and family income according to number of minimum salaries (<2, 2-5, and >5).

Lifestyle data included smoking status (nonsmoker, smoker, ex-smoker - those who had not smoked in at least six months), alcohol intake (regardless of beverage type or amount), physical activity during leisure time (yes or no), at home (performs or not physically-demanding chores), at work (has or does not have physically-demanding tasks), and physical activity commuting (inactive if the patient uses a vehicle, or walks or bicycles for less than ten minutes)[11]. Individuals inactive in all four categories above were considered inactive, and those active in at least one category above were considered active.

The clinical history data taken from the patients' medical records and confirmed with their physicians included CRF etiology, presence of comorbidities, and HD vintage.

Six 24-hour dietary recalls, three of HD days and three of non-HD days, excluding Sundays, collected dietary data. A program based mainly on the Brazilian Food Composition Table developed specifically for this study (www.dbcheckout.com.br/nutri) calculated the mean energy intake for those six days. Protein intake was estimated by calculating the Protein equivalent of total Nitrogen Appearance (PNA) of the midweek dialysis[10] as follows: PNA (g/day): pre-dialysis BUN/{[25.8+(1.15÷Kt/V)]+(56.4÷Kt/V)}+0.168, where BUN, Blood Urea Nitrogen in mg/dL= blood urea (mg/dL)÷2.14. The result was normalized to the ideal weight as recommended by NKF-KDOQI[10] and European Best Practice Guidelines (EBPG)[12]. A normalized PNA (nPNA) >1.0 g/kg was considered adequate[12].

Two dieticians took the anthropometric measurements after the midweek dialysis as recommended by Lohman *et al.*[13] and standardized the data as recommended by Habicht[14]. The measurements included weight, height, Mid-Arm Circumference (MAC), and Triceps (TST), Subscapular (SST), Biceps (BST), and Suprailiac Skinfold Thicknesses (SIST).

Body Mass Index (BMI) was given by the dry weight-to-height squared ratio, and nutritional status was classified as recommended by the World Health Organization (WHO)[15]. Mid-Arm Muscle Circumference (MAMC) was given by the equation MAMC=MAC(cm)-{3.14x[TST(mm)÷10]}, and the result by gender was compared with the reference standards proposed by Frisancho[16] and classified as recommended by Blackburn & Harvey[17].

Body fat was estimated by adding the four skinfold thicknesses (TST, SST, BST, and SIST) using the body density equations proposed by Durnin & Womersley[18]. The percentage of body fat was given by the equation proposed by Siri[19]. Since no ideal percentage of body fat has been established for HD patients, the cutoff points used by the present study were up to 25 and 32% of males' and females' body weight, respectively[20].

The biochemical tests included serum albumin (colorimetric method using bromocresol green) before dialysis, creatinine, and urea (kinetic method) before and after dialysis. All tests were performed by the clinical analysis laboratory of the *Hospital das Clínicas* of the *Universidade Federal de Goiás* (HC/UFG). Serum albumin >4 g/dL and creatinine ≥10 mg/dL were considered normal[12]. Dialysis was considered adequate when the patient's Kt/V index ≥1.2[21].

The data were entered twice in the program Epi Info 6.0 to check for consistency and analyzed by the statistical package Stata 8.0. The categorical variables were expressed as frequencies and percentages, and the continuous variables as mean and standard deviation after the Kolmogorov Smirnov test checked data normality ($p \geq 0.05$).

The prevalence of malnutrition was calculated for each study variable. Simple Poisson regression investigated which factors, if any, were associated with malnutrition. Variables with a statistical significance ≤0.20 were tested in multivariate analysis by Poisson regression with robust variance estimate, and the Wald test assessed statistical significance. The variables with $p<0.05$ remained in the final model.

The project was approved by the Research Ethics Committee of HC/UFG (nº 011/2009) and of the *Santa Casa de Misericórdia* of *Goiânia* (nº 046/2009), and all participants signed an Informed Consent Form. The entire sample was being followed regularly by dieticians.

RESULTS

Table 1 describes the demographic, clinical, and nutritional characteristics of the study sample (n=344). The prevalence of malnutrition according to the SGA was 22.40%. Malnutrition was either mild or moderate, regardless of gender (p=0.92). Most malnourished individuals were males (59.30%) with a mean age of 49.33 ± 13.76 years; the main etiologies were hypertensive nephropathy (37.70%) followed by glomerulonephritis (19.50%) and diabetic nephropathy (15.70%). High blood pressure was the most common comorbidity (66.40%). The median BMI and serum albumin were appropriate,

Table 1. Demographic, clinical, and nutritional characteristics of hemodialysis patients according to their nutritional status classified by the subjective global assessment. *Goiânia* (GO), Brasil, 2010.

Variables	Total	Nourished n=267 (77.60%)	Malnourished n=77 (22.40%)	p^*
Gender				0.929*
Males (n/%)	204 (59.30)	158 (77.45)	46 (22.55)	
Females (n/%)	140 (40.70)	109 (77.86)	31 (22.14)	
Age (years)	49.33 ± 13.76	50.07 ± 12.94	46.75 ± 16.09	0.062*
HD vintage (months)	43 (24.00 - 78.75)	42 (24 - 72)	48 (25 - 97.5)	0.092**
Kt/V	1.59 ± 0.39	1.55 ± 0.38	1.73 ± 0.38	<0.001*
CRF etiology (n/%)				0.741*
Hypertensive nephropathy	130 (37.70)	100 (37.45)	30 (38.96)	
Glomerulonephritis	67 (19.50)	55 (20.60)	12 (15.58)	
Diabetic nephropathy	54 (15.70)	39 (14.61)	15 (19.48)	
Not determined	26 (7.60)	22 (8.24)	4 (5.19)	
APKD	24 (7.00)	19 (7.12)	5 (6.49)	
Others	43 (12.50)	32 (11.99)	11 (14.29)	
Comorbidities (n/%)				0.427*
High blood pressure	228 (66.40)	177 (66.29)	51 (66.23)	
Diabetes	12 (3.60)	8 (3.00)	4 (5.19)	
High blood pressure + DM	40 (11.70)	28 (10.49)	12 (15.58)	
Others	13 (3.40)	1(4.12)	2 (2.60)	
Inexistent	51 (14.90)	43 (16.10)	8 (10.39)	
Weight (kg)	64.04 ± 12.85	67.25 ± 12.28	52.91 ± 7.46	<0.001*
BMI (kg/m²)	23.19 (20.72-26.03)	24.72 ± 3.90	20.00 ± 2.55	<0.001*
MAMC				<0.001*
<5th percentile	82 (23.80)	37 (13.90)	45 (58.40)	
≥5th percentile	262 (76.20)	230 (86.10)	32 (41.60)	
Body fat (%)	29.60 ± 8.80	31.55 ± 7.93	22.83 ± 8.35	<0.001*
LBM (kg)	44.73 ± 8.84	45.85 ± 8.95	40.84 ± 7.25	<0.001*
Serum albumin (g/dL)	4.01 (4.0 - 4.3)	4.13 ± 0.27	4.12 ± 2.69	0.642*
Pre-HD urea (mg/dL)	110.84 ± 27.52	112.13 ± 28.09	106.38 ± 25.14	0.106*
Serum creatinine (mg/dL)	9.50 ± 2.62	9.77 ± 2.60	8.57 ± 2.53	<0.001*
Energy intake (kcal/kg IW)	26.05 ± 6.64	26.25 ± 6.86	25.33 ± 5.80	0.282*
nPNA (g/Kg IW)	1.03 ± 0.27	1.05 ± 0.27	0.94 ± 0.22	0.001*

Note: *t test or Pearson's Chi-square test; **Mann Whitney test.

HD: Hemodialysis; Kt/V: Dialysis Adequacy Index; CRF: Chronic Renal Failure; APKD: Autosomal Polycystic Kidney Disease; DM: Diabetes *Mellitus*; BMI: Body Mass Index; MAMC: Mid-Arm Muscle Circumference; LBM: Lean Body Mass; IW: Ideal Weight; nPNA: normalized Protein Nitrogen Appearance.

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but mean serum creatinine was low (9.50 ± 2.62 mg/dL). Based on BMI, 8.72% of the patients were underweight, 59.01% were normal weight, and 32.27% were overweight. Most patients had appropriate serum albumin (77.91%) and low serum creatinine (58.72%).

In comparison with nourished patients (SGA), malnourished patients have smaller anthropometric parameters, namely body weight, BMI, % of body fat, MAMC, and lean body mass (p<0.001); higher Kt/V (p<0.001); and lower serum creatinine (p<0.001) and nPNA (p=0.001) (Table 1).

The prevalence of malnutrition was significantly higher in patients aged 19 to 29 years (50.00%) and in those with family income below

Table 2. Sample distribution, prevalence of malnutrition according to the subjective global assessment, and prevalence ratio of hemodialysis patients according to demographic, socioeconomic, and clinical variables, energy intake, and nPNA. *Goiânia* (GO), Brazil, 2010.

Variables	Sample distribution		Prevalence		Crude PR	*p*-value*
	n	%	n	%	(95%CI)	
Age (years)						0.030
19 to 29	24	6.98	12	50.00	1.24 (1.06 - 1.44)	
30 to 39	62	18.02	14	22.58	1.01 (0.91 - 1.13)	
40 to 49	88	25.58	17	19.32	0.98 (0.89 - 1.09)	
50 to 59	84	24.42	16	19.05	0.98 (0.89 - 1.09)	
>60	86	25.00	18	20.93	1	
Education level						0.050
No education	7	2.03	1	14.29	0.94 (0.73 -1.20)	
Elementary grades 1-4	117	34.01	33	28.21	1.05 (0.92 - 1.19)	
Elementary grades 5-8	104	30.23	14	13.46	0.93 (0.82 - 1.05)	
High school	79	22.97	21	26.58	1.04 (0.91 - 1.19)	
Higher education	37	10.76	8	21.62	1	
Marital status						0.093
Has partner	203	59.01	39	19.21	1.00	
No partner	141	40.99	38	26.95	1.06 (0.99-1.14)	
Family income						0.070
<2 MS	161	46.80	44	27.33	1.12 (1.01 - 1.25)	
2-5 MS	146	42.44	28	19.18	1.05 (0.94 - 1.17)	
>5 MS	37	10.76	5	13.51	1	
HD vintage						0.094
≥60 months	128	37.21	35	27.34	1.00 (0.99 - 1.15)	
<60 months	216	62.79	42	19.44	1	
Kt/V						0.005
≥1.2	288	83.72	71	24.65	1.12 (1.03 - 1.22)	
<1.2	56	16.28	6	10.71	1	
kcal/kg IW						0.002
≥35	29	8.43	2	6.90	1	
<35	315	91.57	75	23.81	1.15 (1.05 - 1.27)	
nPNA (g/kg IW)						>0.001
Adequate (≥1 g)	173	50.29	26	15.03	1	
Inadequate (<1 g)	171	49.71	51	29.82	1.12 (1.05 - 1.21)	

Note: *Wald test.

PR: Prevalence Ratio; 95%CI: Confidence Interval of 95%; nPNA: normalized Protein Nitrogen Appearance; MS: Minimum Salary; HD: Hemodialysis; Kt/V: Dialysis Adequacy Index; IW: Ideal Weight.

two minimum salaries (27.33%), whose prevalence was 1.12 times higher than that of patients with family income above five minimum salaries. Malnutrition was also associated with Kt/V above 1.2 (24.65%). An energy intake below 35 kcal/kg/day (23.81%) and nPNA below 1.0 g/kg (29.82%) increased the prevalence of malnutrition by 1.15 and 1.12 times, respectively (Table 2). The variables gender, physical activity, smoking status, alcohol intake, comorbidities, and etiology were not associated with malnutrition and were not tested in the final multivariate analysis model (p>0.20).

Multivariate analysis included the following variables: age, education level, marital status, family income, HD vintage, Kt/V, energy intake, and nPNA. In the final multivariate analysis model, the following factors remained associated with malnutrition: age between 19 and 29 years (PR=1.23; 95%CI=1.06-1.43), family income below two minimum salaries (PR=1.13; 95%CI=1.01-1.20), longer HD vintage (PR=1.08; 95%CI= 1.01-1.16), energy intake below 35 kcal/kg/day (PR=1.22; 95%CI=1.10-1.34), and inappropriate nPNA (PR=1.13; 95%CI=1.05-1.21) (Table 3).

Table 3. Final multivariate analysis model of malnutrition in hemodialysis patients. *Goiânia* (GO), Brazil, 2010.

Variables	Adjusted PR	95%CI	*p*-value*
Age (years)			
19 to 29	1.23	1.06-1.43	0.006
30 to 39	1.00	0.90-1.12	0.929
40 to 49	0.98	0.89-1.08	0.713
50 to 59	0.96	0.87-1.07	0.485
>60	1	-	-
Family income			
<2 MS	1.13	1.01-1.27	0.020
2-5 MS	1.05	0.94-1.17	0.356
>5 MS	1	-	-
HD vintage			
<60 months	1		
≥60 months	1.08	1.01-1.16	0.035
Kt/V			
≥1.2	1.12	1.03-1.22	0.010
<1.2	1	-	-
kcal/kg IW			
≥35	1	-	
<35	1.22	1.10- 1.34	<0.001
nPNA (g/kg IW)			
Adequate (≥1 g)	1	-	
Inadequate (<1 g)	1.13	1.05-1.21	0.001

Note: *Wald test.
PR: Prevalence Ratio; CI: Confidence Interval of 95%; nPNA: normalized Protein Nitrogen Appearance; MS: Minimum Salary; HD: Hemodialysis; IW: Ideal Weight; Kt/V: Dialysis Adequacy Index.

DISCUSSION

The prevalence of mild and moderate malnutrition in the study sample was 22.40% according to the SGA. This prevalence was lower than that found by Steiber *et al.*[2], who found a prevalence of moderate malnutrition of 29.00% in 156 HD patients, and higher than that found by the multicentric contrast study[3], which used the same diagnostic method (SGA <6) and found a prevalence of moderate malnutrition of 17.00% in 560 patients. On the other hand, the percentage of malnourished patients in the present study was similar to that reported by the Netherlands Co-operative Study Adequacy of Dialysis II (NECOSAD-II), where 23.00% (n=1,601) of the patients were moderately malnourished[1]. Severe malnutrition defined by an SGA score of 1 or 2 also was not found by other studies[2,3].

The prevalence of mild and moderate malnutrition found by earlier Brazilian studies varied from 39.7 to 80.0%[22-24]. However, comparison with such studies is inconclusive because they either used other SGA classification methods[22,23] or small sample sizes[24].

Malnutrition in HD patients has complex etiology, possibly resulting from disease- and treatment-related factors that further reduce food intake and increase protein catabolism, such as age, poor dialysis, psychosocial problems, hormonal imbalances, comorbidities, metabolic acidosis, inflammatory processes, and HD-related nutrient losses. Early detection of nutritional changes is critical since severe malnutrition is harder to treat[25]. In the present study, the risk factors that determined nutritional inadequacies were age, family income, HD vintage, dialysis adequacy, energy intake, and nPNA.

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The younger individuals in the study sample were at greater risk of malnutrition, contrary to Burrowes *et al*.[26], who found that older patients had worse nutritional status. Our younger patients had lower weight, BMI, percentage of body fat, and lean body mass, and the main etiology was glomerulonephritis (data not shown). The factors that possibly worsened the nutritional status of these younger adults were inadequate protein intake along with higher energy expenditure secondary to age and dialysis-related catabolism[6,7]. In these cases the principal recommendations for correcting nutritional status are greater surveillance, proper food intake and more physical activity to increase body weight, especially lean body mass[5,6,9].

The inverse relationship between malnutrition and family income reinforces the influence of the latter on nutritional status, exposing the individual to food insecurity and violating one of the principles of a healthy diet, which is guaranteed physical and financial access to appropriate food[27]. Poor access to appropriate food worsens nutritional status, decreases adherence to treatment, increases mortality, and reduces survival[28].

Patients with HD vintage longer than five years were more likely to be malnourished, corroborating Chumlea *et al.*[29], who found a direct association between long HD vintage and poor nutritional parameters. Additionally, hemodialysis is highly catabolic, promoting significant loss of essential nutrients, such as amino acids, proteins, vitamins, and glucose[7]. If these nutrients are not adequately replenished, nutritional status may worsen over time. Bohé & Rennie[6] claim that individuals on dialysis three times a week lose 2 kg of lean body mass a year.

The prevalence of malnutrition was also higher in study individuals with adequate dialysis according to the Kt/V index. Since malnourished individuals have smaller body volumes, they are susceptible to an increase in Kt/V, so the possibility of malnutrition exists even when dialysis is efficient[10]. However, inadequate dialysis may indirectly compromise nutritional status, since underdialyzed patients with Kt/V below 1.2[21] can experience less hunger because of the accumulation of uremic toxins[25]. Nevertheless, some studies did not find associations between Kt/V and nutritional status or survival, and shorter HD sessions (<3 hours/session) were associated with higher mortality, regardless of Kt/V[30,31]. The Hemo study (n=1,846) found that random patients receiving a high dialysis dose (Kt/V 1.65) did not consume more energy and proteins than random patients receiving the standard dose (Kt/V 1.25); moreover, both groups experienced similar weight loss and serum albumin reduction[32].

The factors mentioned earlier, namely age, income, and HD vintage, lead to low energy and protein intakes, which directly impact nutritional status. Inadequate food intake, which generally begins before the introduction of renal replacement therapy[12], is one of the main determinants of worse clinical outcomes in these patients, promoting weight loss, decreasing survival, and increasing morbidity and mortality[10,12].

Patients with inadequate energy and protein intakes had higher prevalence of malnutrition, suggesting that energy and protein deficits play an important role in malnutrition in dialysis patients. Low protein and especially energy intakes have been observed in HD patients[24].

The vast majority of the study sample (91.57%) ingested fewer than 35 kcal/kg/day; of these, 47.97% ingested fewer than 25 kcal/kg/day, and the nPNA of 49.71% was below 1.0 g/kg/day. This is concerning because, according to the classical study by Slomowitz *et al.*[25], 35-45 kcal/kg/day are necessary to revert a negative nitrogen balance in individuals consuming fewer than 25 kcal/kg/day. At least 1.0 g of protein/kg/day is necessary to replenish the nutrients lost in hemodialysis and achieve positive nitrogen balance in clinically stable patients[12]. Additionally, adequate energy intake prevents the use of protein for energy[25].

Malnutrition has an objective repercussion on anthropometric and laboratory parameters, resulting in low body weight, fat store depletion,

body protein loss, and low serum albumin and creatinine in HD patients[9,25]. These parameters were lower in the malnourished study patients, except for serum albumin. This indicates the importance of HD patients gaining body weight, especially lean body mass, because weight gain would imply better functional and immune statuses, greater independence, and lower malnutrition-related morbidity and mortality[6].

One of the study limitations was the impossibility of analyzing an inflammatory marker capable of distinguishing between malnutrition and inflammation-induced malnutrition. Only eleven (14.29%) of the malnourished study patients had serum albumin below 3.8 g/dL, suggestive of malnutrition and inflammation[2], a prevalence lower than the 18% found by Steiber *et al.*[2]. Since most of the study population had serum albumin above 4 g/dL and were not malnourished, inflammation probably had at most a small influence on their nutritional status. Another limitation is not having analyzed the residual diuresis of 27 patients to calculate PNA. However, PNA remained associated with malnutrition even when these patients' data were excluded from data analysis.

Another limitation is the use of the 24-hour recall to investigate food intake since this instrument is subject to the interviewee's memory and collaboration, and to underreporting and overreporting. However, the use of six dietary recalls improved the accuracy of the food intake data because it reduced the intrapersonal daily intake variability[33]. The study strengths are the use of a sample representative of the HD population of *Goiânia* (GO) and analysis of the isolated effect of many factors that can impact the nutritional status of these patients.

CONCLUSION

The prevalence of malnutrition in the study population was high, corroborating the literature. The prevalence was greater in patients aged less than 29 years and in those with low family income, longer hemodialysis vintage, higher Kt/V, and inadequate calorie and protein intakes. Strategies to revert this situation should include greater nutritional care.

CONTRIBUTORS

ATVS FREITAS, IMF VAZ, and SF FERRAZ helped to conceive the study; collect, analyze, and interpret the data; and write the manuscript. MRG PEIXOTO helped to analyze and interpret the results and to write the manuscript. MIVM CAMPOS helped to interpret the data. All authors reviewed the manuscript.

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Co-ingestion of carbohydrate and pea protein does not enhance muscle recovery after strenuous exercise

A ingestão simultânea de carboidratos e proteína da ervilha não melhora a recuperação muscular após a realização de exercício extenuante

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ABSTRACT

Objective

To assess the influence of carbohydrate and added pea protein concentrate supplementation on muscle recovery after a military operation called Leader's Reaction Test.

Methods

Twenty-four soldiers from the Brazilian Army were divided into three equal groups (n=8). They received either carbohydrate (0.8 g/kg body weight/h), carbohydrate+carbohydrate (1.0 g/kg body weight/h), or carbohydrate+protein (0.8 g/kg body weight/h of carbohydrate + 0.2 g/kg body weight/h of protein), immediately, 60, and 120 minutes after the Leader's Reaction Test. Prior, immediately after and 24 hours after the Leader's Reaction Test, maximal isometric strength and body composition were assessed. Blood samples were also collected for later analysis of concentrations of lactate dehydrogenase and creatine kinase.

Results

Twenty-four hours after the Leader's Reaction Test, maximal creatine kinase levels were significantly lower than its levels immediately after (501.00 ± 422.09 *versus* 275.29 ± 242.08 U/L (carbohydrate); 616.88 ± 291.45

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versus 334.57 ± 191.61 U/L (carbohydrate+carbohydrate); and 636.75 ± 340.67 *versus* 382.88 ± 234.42 U/L (carbohydrate+protein), *p*=0.004). The maximal isometric strength and lactate dehydrogenase levels were not significantly different during the time trials.

Conclusion

The present findings suggest that carbohydrate+protein co-ingestion did not improve the recovery of muscle function nor did it attenuate post-exercise muscle damage markers over carbohydrate alone.

Indexing terms: Creatine kinase. Exercise. L-Lactate dehydrogenase. Supplementary feeding.

RESUMO

Objetivo

Avaliar a influência da suplementação com carboidratos adicionada ao concentrado proteico de ervilha na recuperação muscular, após uma operação militar prática chamada Teste de Reação de Líderes.

Métodos

Vinte e quatro soldados do Exército Brasileiro foram divididos em três grupos iguais (n=8). Eles receberam a suplementação com carboidrato (0,8 g/kg de peso corporal/h) ou carboidrato mais carboidrato (1,0 g/kg de peso corporal/h) ou carboidrato mais proteína (0,8 g/kg de peso corporal/h de carboidrato + 0.2 g/kg de peso corporal/h de proteína), imediatamente, 60 e 120 minutos após o Teste de Reação de Líderes. Avaliaram-se a força isométrica máxima e a composição corporal antes do Teste de Reação de Líderes, imediatamente após e 24 horas após o teste. Amostras de sangue foram coletadas para análise posterior das concentrações de lactato desidrogenase e creatina quinase.

Resultados

Vinte e quatro horas após o Teste de Reação de Líderes, as concentrações de creatina quinase estavam significativamente reduzidas em comparação ao momento imediatamente posterior (501.00 ± 422,09 versus *275.29 ± 242.08 U/L (carboidrato); 616.88 ± 291,45* versus *334.57 ± 191,61 U/L (carboidrato+carboidrato) e 636.75 ± 340.67* versus *382.88 ± 234,42 U/L (carboidrato+proteína), p=0,004). A força isométrica máxima e os níveis de lactato desidrogenase não foram significativamente diferentes em nenhum momento.*

Conclusão

Os resultados sugerem que, em comparação à ingestão do carboidrato isoladamente, a coingestão de carboidrato e proteína não melhora a recuperação da função muscular nem atenua a liberação de marcadores de danos musculares após o exercício.

Termos de indexação: *Creatina quinase. Exercício. L-Lactato desidrogenase. Suplementação alimentar.*

INTRODUCTION

Prolonged endurance and short bouts of high intensity exercise are associated with high muscle tissue damage[1,2] and glycogen depletion[3,4]. High levels of some markers of muscle damage and soreness, such as Creatine Kinase (CK) and Lactate Dehydrogenase (LDH)[4], are associated with low physical performance[5], thus exhaustive exercise requires fast recovery. Apparently Carbohydrate (CHO) intake immediately after exercise can promote rapid glycogen repletion and athletes' recovery[6]. However, some researchers have demonstrated that combining Protein (PRO) and CHO intakes can improve athletes' recovery better than CHO alone.

Carbohydrate and protein intakes during post-exercise recovery period optimizes glycogen repletion[3,7,8] and protein balance[9]. Additionally, consumption of CHO+PRO or only CHO supplements after exercise has been associated with lower post-exercise muscle damage markers, such as plasma CK[1,10-14] and LDH[11], and could also improve muscle function[15] since it is thought to be one of the best indirect indicators of muscle damage[16,17]. Better muscle function seen after CHO+PRO intake might have practical

implications for performance in subsequent exercise[14,18].

However, the literature is controversial since no additional ergogenic effect is promoted by CHO+PRO compared with CHO alone[18-20]. Thus, the efficacy of adding PRO to CHO for endurance performance or recovery remains unclear. The studies that identified the effect of CHO+PRO on athletes' recovery used different methodological approaches, which might have contributed to the controversial results in the literature. Studies vary, principally when it comes to study design (cross-over, placebo-controlled performance trial), CHO:PRO *ratio*, and the source of protein[21].

The main protein source studied until now is whey[14,18,19,22]. Hence, researches are currently assessing underexploited sources such as alternative protein crops. The functional and bioactive properties of proteins from legume seeds, such as pea (*Pisun sativun*), have been widely studied because of their importance to novel food development and human health[23,24]. The use of pea protein in the recovery of individuals undergoing exhaustive physical activity is new and could probably bring new contribution to the development of sports supplements.

Special soldiers from the Brazilian Army engaged in a specific field operation experienced a significant increase in blood CK, featuring high muscle damage[25]. This population will probably benefit from nutritional strategies that optimize muscle recovery after an exhaustive physical activity test. Thus, the aim of this study was to assess the influence of a CHO+PRO (pea protein concentrate) supplementation on muscle recovery parameters for soldiers undergoing a Leader's Reaction Test (LRT), which is a very exhaustive stage of a military operation designed to prepare military leaders under severe food, water, and sleep deprivation in jungle crossing.

METHODS

Twenty-three soldiers with a mean ± Standard Deviation (SD) age of 26.96 ± 4.14 years, body mass of 80.74 ± 9.89 kg, body fat of 10.82 ± 3.44%, total body water of 53.43 ± 6.66 L, and height of 1.78 ± 0.06 m concluded the LRT. All participants signed an Informed Consent Form before taking part in the study. The experimental protocol was approved by the Research Ethics Committee of *Instituto de Estudos em Saúde Coletiva* (IESC, Public Health Research Institute) from *Universidade Federal do Rio de Janeiro* (UFRJ), Brazil (nº 81/2010).

The study was carried out by means of a double-blind randomized controlled trial. Maximal isometric strength, body composition, and blood samples (for analysis of serum CK and LDH) were assessed in three time Trials: prior (T1), immediately after (T2), and 24 hours post-LRT (T3). At T2 subjects were required to consume one of the three recovery treatments in gel consistency: 1) CHO; 2) CHO+CHO; and 3) CHO+PRO. All tests were conducted in a fasted state (Figure 1).

The Leader's Reaction Test is a practical military exercise that basically consists of a 100 km march (sloped roads, fields, and woods), climbs, sprints, and crawls, interspersed with classic military workshops. During those activities the subjects were wearing uniforms and carrying food supplies and weapons, totaling roughly 25 kg. The subjects' energy and water intakes and sleep were restricted and permanently controlled during the four days of LRT, according to Brazilian military doctrine (Table 1).

Body mass and height were determined using the clinical scale-mounted stadiometer Filizola™ (Brazil), a mechanical model with a maximum weight of 150 kg and accuracy of 100 g, following the Lohman protocol[26]. Percentage of body fat was assessed using the Lange™ skinfold caliper and three-site skinfold protocol: abdomen, pectoral, and thigh locations[27]. Total Body Water (TBW) was estimated by tetrapolar bioelectrical impedance using the Biodynamics™ 310 device.

Maximal isometric force was measured using the hand-held Takei™ Dynamometer to evaluate muscle function bilaterally. The subjects

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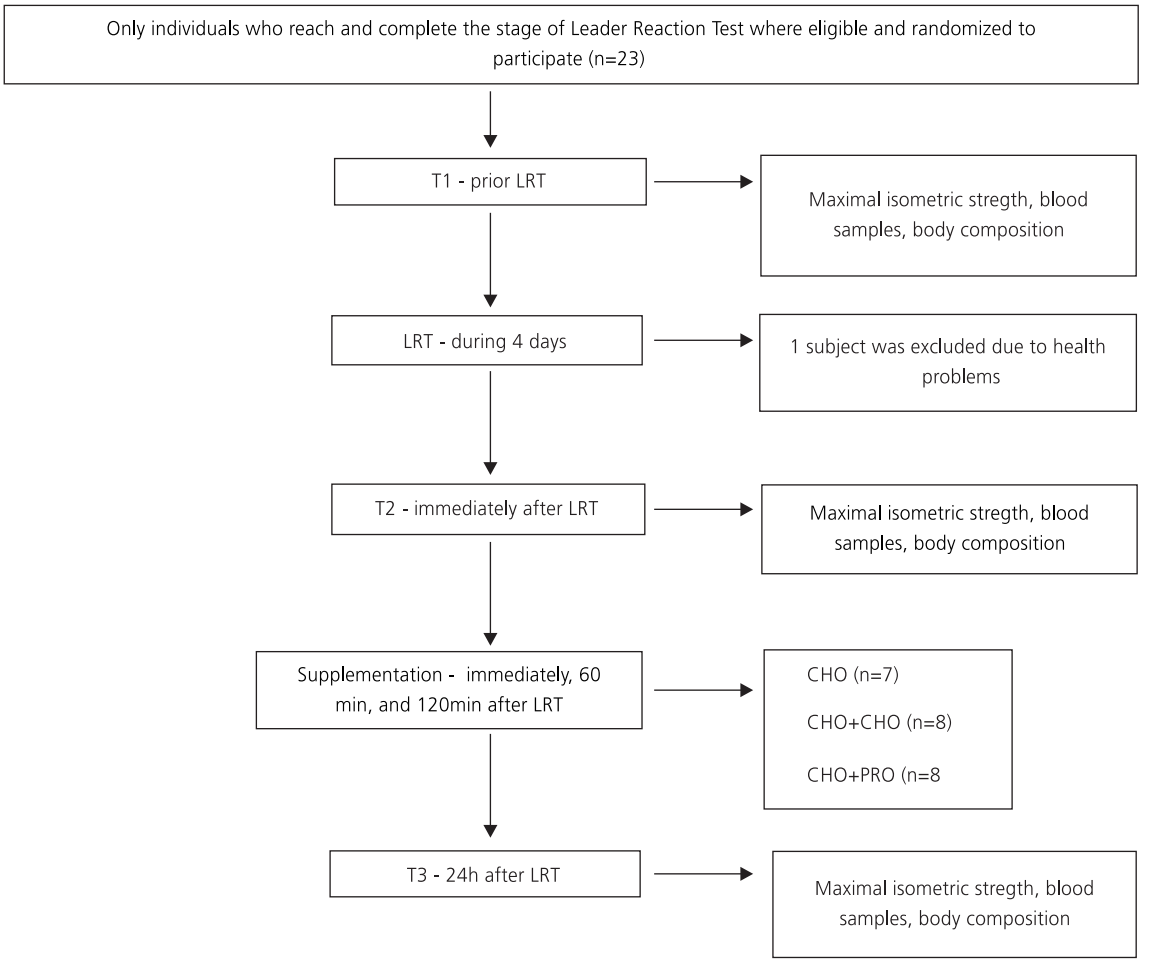

Figure 1. Experimental Design.

Note: T1 (Time Trial 1): Prior LRT (Leader's Reaction Test); T2: Immediately after LRT; T3: 24 hours post - LRT; CHO: Carbohydrate; PRO: Protein.

Table 1. Description of sleep, distance, hydration, and daily energy intake during LRT. *Rio de Janeiro* (RJ), Brazil, 2010.

Period (day)	Sleep (h)	Distance (km)	Hydration (L)	Daily energy intake (kcal)
1st	4	20	3	1.737
2nd	3	36	2	1.190
3nd	2	28	1	970
4nd	1	16	-	-

Note: LRT: Leader Reaction Test.

exerted a maximal force on the dynamometer, making three attempts for each hand, alternating every 30 seconds, according to Johnson & Nelson[28].

In each time Trial (T1, T2, and T3), a 10 mL blood sample was collected from the antecubital vein and centrifuged at 7000 rpm during 10 minutes for the extraction of blood plasma and further analysis. All plasma samples were stored at -80°C. Enzymatic analysis of LDH and CK concentration was conducted by the semiautomatic Express Plus 550™ analyzer.

Supplementation

The carbohydrate supplement provided subjects with 0.8 g/kg body weight/h; the

CHO+CHO provided the amount of CHO and more 0.2 g carbohydrate/kg body weight/h, making the total of 1.0 g carbohydrate/kg body weight/h; and CHO+PRO provided 0.8 g/kg body weight/h of carbohydrate, and 0.2 g protein/kg body weight/h. The supplementation was provided twice, in the first and in the second hour after LRT, without consuming anything else during this interval. CHO and CHO+PRO contained the same amounts of carbohydrates. CHO+CHO and CHO+PRO were isocaloric, and all the supplements were designed to have the same physical aspect.

All the supplementation provided identical types of carbohydrate in the form of maltodextrin (50%) (Corn Brazil, MOR-REX 1910), glucose (35%) (Corn Brazil, MOR-REX 1940) and fructose (15%) and Pea Protein Concentrate (PPC) (Propulse Parrheim Foods, Canada) in the CHO+PRO supplement. According to the manufacturer's label, the pea protein concentrate has the following proximate concentration of essential amino acids (g/100 g of protein): lysine (7.2); phenylalanine (5.5); threonine (3.9); methionine (1.1); tryptophan (1.0); leucine (8.4); isoleucine (4.5); valine (5.0); the last three are also branched-chain amino acids.

The subjects had their meals at the same place and time, since they were confined in the same military base. Food intake for breakfast, lunch, and dinner was controlled, although they were allowed to have two free snacks. Each subject answered a 24-hour Dietary Recall (24HDR) in T3 to quantify energy and macronutrient intakes after the LRT during the 24 hours interval between T2 and T3. The results were given by the DietPro™ 5.1i Professional software.

Descriptive statistics are presented as mean ± SD and in figures as mean ± Standard Error of the Mean (SEM). All variables were investigated using separate two-way Analysis of Variance (Anova) (time: T1, T2, and T3; x group: CHO, CHO+CHO, and CHO+PRO) with repeated measures on time, with Tukey *post hoc* analyses. The evolution of body mass, TBW, and body fat through time trials were taken as percentage of the values in T1.

All statistical analyses were performed by the Statistical Package for the Social Sciences (SPSS)™ Version 20.0, with a significance level of $p<0.05$.

RESULTS

Body Composition

Twenty-three subjects completed all the tests in this study. The body mass, TBW, and body fat recorded during the LRT are demonstrated in Figure 2. For body mass, there were no significant differences between treatments ($p=0.227$) and interactions for treatments x time ($p=0.161$). However, the main effect was only observed for time ($p=0.038$). There were significant statistical differences for T1 *versus* T2 ($p=0.020$), and T1 *versus* T3 ($p=0.035$) (Figure 2A). Statistically, the TBW was not significantly different between treatments ($p=0.664$) and interactions for treatments *versus* time ($p=0.881$). However, Anova indicated a statistically significant main effect for time ($p<0.001$). There were statistically significant differences for T1 *versus* T2 ($p<0.0001$), and T1 *versus* T3 ($p<0.0001$) (Figure 2B). In relation to body fat, there were no significant statistical differences between treatments ($p=0.068$) and interactions for treatments *versus* time ($p=0.562$). However, Anova indicated a statistically significant main effect for time ($p<0.001$). There were statistically significant differences for T1 *versus* T2 ($p<0.0001$), and T2 *versus* T3 ($p<0.0001$) (Figure 2C).

Maximal isometric force

The Maximal Isometric Force of the subjects, measured by means of dynamometry, was in average 35.58 ± 6.28 kgf, and it was not significantly different during time trials.

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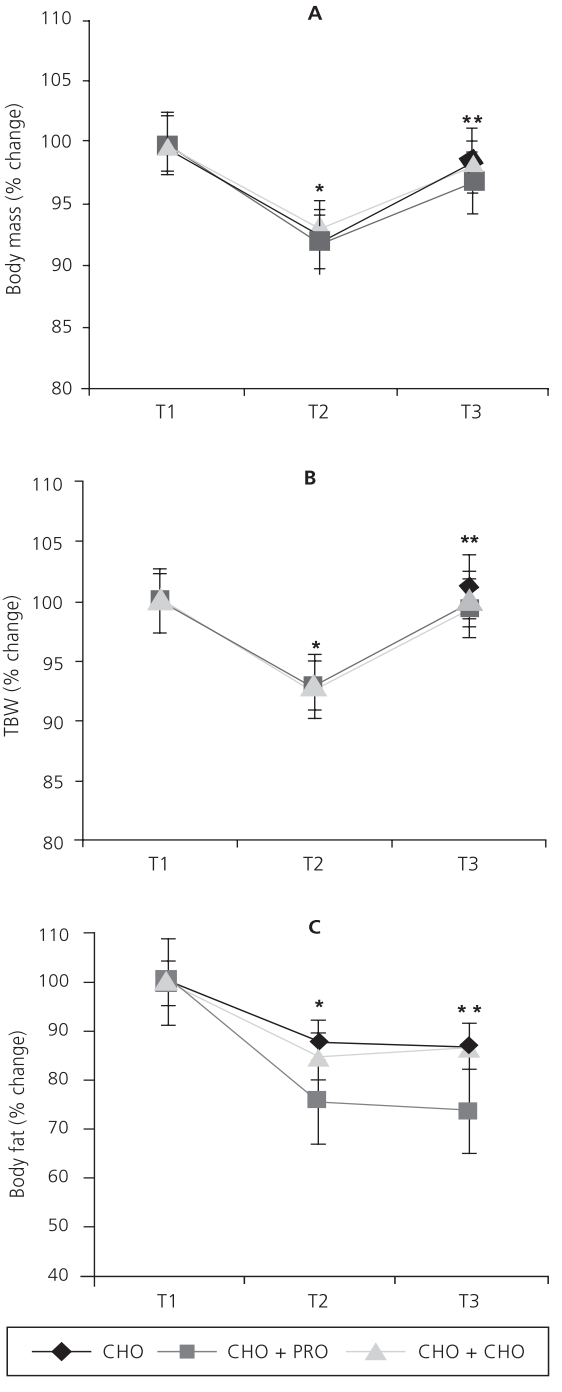

Figure 2. Body mass (A), Total Body Water (TBW) (B), and body fat (C), Mean (±standard error of the mean), through time trials, as percentage of the values in T1. Brazilian Army, Center of Special Operations, *Rio de Janeiro* (RJ), Brazil.

Note: *Significant difference between T1 *versus* T2 (p=0.020(A); p<0.0001 (B); p<0.0001(C); **Significant difference between T1 *versus* T3 (p=0.035(A); p<0.0001 (B); p<0.0001(C).

CHO: Carbohydrate; PRO: Protein; T1 (Time Trial 1): Prior LRT (Leader's Reaction Test); T2: Immediately after LRT; T3: 24 hours post-LRT.

Blood analysis

The subjects' plasma LDH levels varied from 213.00 to 820.00 U/L and statistical analysis showed that the treatments (p=0.394) or time course (p=0.125) did not differ. The plasma CK levels of the subjects at the beginning of the study varied from 104.00 to 1139.00 U/L. As demonstrated in Figure 3, CK data were statistically different in all time trials, indicating that there was an increase in T2 and a decrease in T3 (p=0.004), regardless of supplementation (Figure 3).

Food intake after the LRT

The 24-hour dietary recall administered in T3 demonstrated that there was no difference among groups in terms of energy and macronutrient intakes as shown in Table 2.

In general, free snacks have contributed with 33% of the total energy consumed. The other controlled meals have contributed with the remainder energy (22% at breakfast, 30% at lunch, and 15% at dinner).

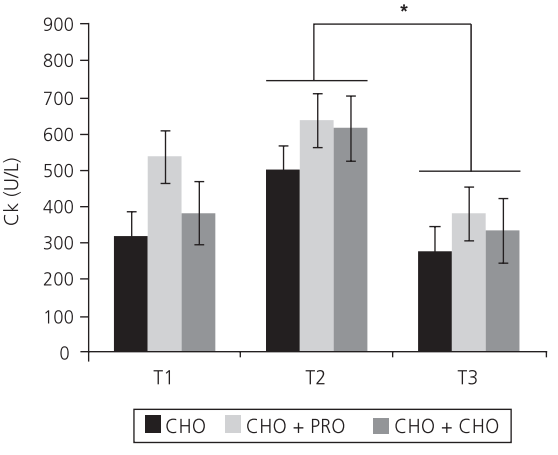

Figure 3. Creatine kinase levels (U/L), Mean (±standard error of the mean), through time trials. Brazilian Army, Center of Special Operations, *Rio de Janeiro* (RJ), Brazil.

Note: *Significant difference between T2 *versus* T3 (p=0.004).

CHO: Carbohydrate; PRO: Protein; T1 (Time trial 1): Before LRT; T2: Immediately after LRT (Leader's Reaction Test); T3: 24 hours after-LRT.

Table 2. Energy and macronutrients intake after LRT, Mean ± Standard Deviation. *Rio de Janeiro* (RJ), Brazil, 2010.

	Total Group (n=23)		CHO Group (n=7)		CHO+CHO Group (n=8)		CHO+PRO Group (n=8)	
	M	SD	M	SD	M	SD	M	SD
Total energy (kcal)	6,034.60 ±	1,272.56	5,522.77 ±	936.58	6,176.56 ±	1,297.30	6,340.49 ±	1,504.26
Carbohydrate (g)	1,061.52 ±	207.86	967.69 ±	131.51	1,119.60 ±	205.46	1,132.28 ±	271.65
Protein (g)	140.58 ±	19.35	135.58 ±	21.33	142.23 ±	21.87	143.31 ±	16.47
Lipid (g)	136.24 ±	45.33	123.30 ±	39.02	139.51 ±	55.70	152.60 ±	46.97

Note: Statistical differences were not observed between groups (p>0.05).
CHO: Carbohydrate; PRO: Protein; M: Mean; SD: Standard Deviation; LRT: Leader Reaction Test.

DISCUSSION

The primary objective of this study was to examine whether acute ingestion of CHO along with pea protein supplement, as opposed to CHO alone, over two hours following strenuous military practical exercise would have an impact on systemic indices of muscle damage and alterations in muscle function.

Recovery of muscle function and exercise performance are important for soldiers who are often taking part in military operations involving severe physical activities performed until exhaustion. Muscle recovery can be evaluated by several parameters such as plasma LDH and CK or even isometric strength, all investigated in this study, concerning the influence of the different types of supplementation administered immediately after the exercise period. According to previous studies, CK and LDH measurements in 24-hour post-exercise have a practical relevance[13,22] providing basis for the use of such analysis in this work.

The present results demonstrated that CHO+PRO intake did not improve any of the measured markers of post-exercise recovery when compared with CHO, regardless of the dose, corroborating many others studies[18-20,22]. Additionally, in accordance to our study, White *et al.*[2], Breen *et al.*[18], Betts *et al.*[19], and Green *et al.*[20] showed that the co-ingestion of CHO and PRO does not improve the recovery of isometric force.

On the other hand, controversial results have been found in the literature, since in many other studies ergogenic effect was promoted by CHO+PRO in the reduction of plasma CK[1,10-14] and LDH[11] when compared with the ingestion of CHO alone. Koopman *et al*.[9] and Miller *et al.*[29] reported that CHO+PRO ingestion could improve the balance between protein degradation and protein synthesis, which might explain reductions in muscle damage as per CHO+PRO ingestion demonstrated in those studies. According to Breen *et al.*[18], it would seem that studying direct markers of sarcolemmal disruption (biopsy or magnetic resonance imaging techniques) in concert with post-exercise tests of muscle function may provide clearer answers regarding the efficacy of CHO+PRO to improve recovery.

Many other controversial results are found in the literature. Ivy *et al*.[30] discussed some methodological variances that could explain these inconsistencies, including differences in carbohydrate and protein concentrations in supplements, supplement administration protocols, time period of recovery measurements, and applied exercise protocols. Since this is the first study to investigate, in practice, the effect of CHO supplementation along with pea protein by means of the LRT, comparisons with other findings are limited.

Not only did this study test the effects of two different CHO concentrations but also the impact of adding protein to a standardized energy supplement. According to Saunders *et al.*[1], by matching a carbohydrate portion, differences in recovery can be attributed to anything other than the absolute carbohydrate content of the supplements. So, a limitation from many studies is that the increased availability of total calories

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from the CHO+PRO supplementation may have contributed to differences between trials[1,10,12]. Apparently, when total calories are controlled, the proposed beneficial effects of the added protein are not fully supported[20]. It is unclear from some studies, however, whether benefits were the result of supplements consumed during exercises[14,18], post-exercises[10,20,22] or both[11,12,19]. Ludden *et al.*[10] provided evidence that significant attenuation in plasma CK can be achieved with only post-exercise feedings of CHO+PRO. Green *et al.*[20] and Millard-Stafford *et al.*[22] also compared the effects of post-exercise ingestion of CHO+PRO and only CHO supplementation on muscle damage prevention but neither confirmed the theory proposed by Ludden *et al*.[10], regarding CK indices.

It should be noted that CHO+PRO group received a 4:1 *ratio* of carbohydrate to protein supplementation as it has already been tested in other studies[1,7,11,12,14,20,22,31,32]. However, more recent studies have tested the 3:1 *ratio*, i.e., a larger amount of PRO in relation to CHO[18,19,33,34]. Therefore, the optimal protein concentration must be clarified so that we can better understand if the result obtained in this study could also be related to this variable.

Another possible explanation for the inconsistent findings in this area might be related to the important response of certain systemic indexes of muscle damage. That is because most studies showing significant effects have maximum CK levels between 250 and 600 U/L[10,11,14,35], while those showing no significant effects have typically reported peak CK levels in the 1000-1400 U/L region[2,20]. Considering that the subjects in the present study already had high plasma CK before the LRT, it is reasonable to suppose that our results could have been influenced by this fact, which makes comparison particularly difficult since in other studies subjects usually had normal CK before performing physical tests.

The exercise protocol used for testing the effects of supplementation could also influence the results of the study. Currell & Jeukendrup[36] highlighted the fact that the ecological validity of laboratory exhaustive exercise protocols is limited because athletes do not compete in events that require a continued fixed output for as long as possible. The study field activities are performed in real training conditions, under environmental variables that might require higher physical effort and cause generalized body soreness, differently from that experienced in the laboratory exercise protocol used by many studies. Betts *et al*.[19] and Green *et al*.[20] also adopted field exercise protocol and their reported results corroborate ours, suggesting that the additional protein in the supplement does not benefit muscle recovery in such conditions. When performance is measured in an uncontrolled environment, additional protein does not seem to be advantageous[18]. Most likely, due to that fact, the effects of a CHO supplement combined with PRO failed to demonstrate the effects on CK and LDH in the present study, even when administered after a military practical activity well-known for its high physical stress and demand.

Although diet had not been fully controlled in our study, the 24HDR showed that the military personnel consumed more energy in the recovery period than they required, and the groups did not differ. The impossibility to fully control the diet could mask the effects of supplementation, but this issue still needs to be clarified, considering that only few studies had standardized the individual's diet according to the subjects eating habits throughout the study (no significant differences in calories, protein, or carbohydrate content of diets during treatment periods)[10,11,18,19,35]. Breen *et al.*[18] did not find effects of the CHO+PRO supplementation on muscle recovery parameters, but Ludden *et al.*[10] and Romano-Ely *et al*.[11] have found that the CHO+PRO attenuated post-exercise muscle damage, when compared with CHO supplementation. The comparison between those studies turns out to be difficult since only Breen *et al*.[18] demonstrated dietary composition.

Finally, many studies have shown that consuming protein after strength training

promotes greater growth of lean tissue mass. However, when comparing the effects of soy with milk, some authors have found that animal protein is better[37,38]. Therefore, the different benefits or effects between animal and vegetable proteins on muscle function recovery should be investigated to better understand whether the tested vegetable protein (pea protein concentrate) could generate the same results as whey protein, since this is the most common protein source added to CHO supplements[1,10,11,14,18-20,22].

CONCLUSION

In conclusion, when supplementary energy intake is controlled, and CHO is ingested at rates which are considered optimal for recovery, the addition of pea protein concentrate in the first two hours after field exercise does not seem to improve either the 24-hour recovery of muscle function or post-exercise muscle damage markers better than CHO alone. In accordance with previous studies, the metabolic and physiological responses to CHO+PRO supplementation may depend on the magnitude of CK increase, the CHO:PRO *ratio*, the exercise protocol, and the type of protein used. Moreover, it is important to evaluate recovery under strict diet control throughout the research period.

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CONTRIBUTORS

LAA COUTINHO main executor of the intervention. LS CERQUEIRA statistical analyses and manuscript review. AVS RODRIGUES recruitment of subjects, data collection, and manuscript review. CPM PORTO coordinator of activities: data collection, writing, and manuscript review. APTR PIERUCCI data collection, writing, and manuscript review.

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INSTRUÇÕES AOS AUTORES

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Discussão: deve explorar, adequada e objetivamente, os resultados, discutidos à luz de outras observações já registradas na literatura.

Conclusão: apresentar as conclusões relevantes, considerando os objetivos do trabalho, e indicar formas de continuidade do estudo. **Não serão aceitas citações bibliográficas nesta seção**.

Agradecimentos: podem ser registrados agradecimentos, em parágrafo não superior a três linhas, dirigidos a instituições ou indivíduos que prestaram efetiva colaboração para o trabalho.

Anexos: deverão ser incluídos apenas quando imprescindíveis à compreensão do texto. Caberá aos editores julgar a necessidade de sua publicação.

Abreviaturas e siglas: deverão ser utilizadas de forma padronizada, restringindo-se apenas àquelas usadas convencionalmente ou sancionadas pelo uso, acompanhadas do significado, por extenso, quando da primeira citação no texto. Não devem ser usadas no título e no resumo.

Referências de acordo com o estilo *Vancouver*

Referências: devem ser numeradas consecutivamente, seguindo a ordem em que foram mencionadas pela primeira vez no texto, conforme o estilo *Vancouver*.

Nas referências com dois até o limite de seis autores, citam-se todos os autores; acima de seis autores, citam-se os seis primeiros autores, seguido de *et al*.

As abreviaturas dos títulos dos periódicos citados deverão estar de acordo com o *Index Medicus*.

Não serão aceitas citações/referências de **monografias** de conclusão de curso de graduação, **de trabalhos** de Congressos, Simpósios, *Workshops*, Encontros, entre outros, e de **textos não publicados** (aulas, entre outros).

Se um trabalho não publicado, de autoria de um dos autores do manuscrito, for citado (ou seja, um artigo *in press*), será necessário incluir a carta de aceitação da revista que publicará o referido artigo.

Se dados não publicados obtidos por outros pesquisadores forem citados pelo manuscrito, será necessário incluir uma carta de autorização, do uso dos mesmos por seus autores.

Citações bibliográficas no texto: deverão ser expostas em ordem numérica, em algarismos arábicos, meia linha acima e após a citação, e devem constar da lista de referências. Se forem dois autores, citam-se ambos ligados pelo "&"; se forem mais de dois, cita-se o primeiro autor, seguido da expressão *et al*.

A exatidão e a adequação das referências a trabalhos que tenham sido consultados e mencionados no texto do artigo são de responsabilidade do autor. Todos os autores cujos trabalhos forem citados no texto deverão ser listados na seção de Referências.

Exemplos

Artigo com um autor

Burlandy L. A construção da política de segurança alimentar e nutricional no Brasil: estratégias e desafios para a promoção da intersetorialidade no âmbito federal de governo. Ciênc Saúde Coletiva. 2009; 14(3):851-60. doi: 10.1590/S1413-81232009000300020

Artigo com mais de seis autores

Oliveira JS, Lira PIC, Veras ICL, Maia SR, Lemos MCC, Andrade SLL, *et al*. Estado nutricional e insegurança alimentar de adolescentes e adultos em duas localidades de baixo índice de desenvolvimento humano. Rev Nutr. 2009; 22(4): 453-66. doi: 10.1590/S1415-52732009000400002

Livro

Alberts B, Lewis J, Raff MC. Biologia molecular da célula. 5ª ed. Porto Alegre: Artmed; 2010.

Capítulos de livros

Aciolly E. Banco de leite. In Aciolly E. Nutrição em obstetrícia e pediatria. 2ª ed. Rio de Janeiro: Guanabara Koogan; 2009. Unidade 4.

Dissertações e teses

Duran ACFL. Qualidade da dieta de adultos vivendo com HIV/AIDS e seus fatores associados [mestrado]. São Paulo: Universidade de São Paulo; 2009.

Artigo em suporte eletrônico

Sichieri R, Moura EC. Análise multinível das variações no índice de massa corporal entre adultos, Brasil, 2006. Rev Saúde Pública. 2009 [acesso 2009 dez 18]; 43(Supl 2):

90-7. Disponível em: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0034-89102009000900900120&lng=pt&nrm=iso>. doi: 10.1590/S0034-89102009000900012.

Livro em suporte eletrônico

Brasil. Alimentação saudável para pessoa idosa: um manual para o profissional da saúde. Brasília: Ministério da Saúde; 2009 [acesso 2010 jan 13]. Disponível em: <http://200.18.252.57/services/e-books/alimentacao_saudavel_idosa_profissionais_saude.pdf>.

Capítulo de livro em suporte eletrônico

Emergency contraceptive pills (ECPs). In World Health Organization. Medical eligibility criteria for contraceptive use. 4th ed. Geneva: WHO; 2009 [cited 2010 Jan 14]. Available from: <http://whqlibdoc.who.int/publications/2009/9789241563888_eng.pdf>.

Texto em formato eletrônico

Sociedade Brasileira de Nutrição Parental e Enteral. Assuntos de interesse do farmacêutico atuante na terapia nutricional. 2008/2009 [acesso 2010 jan 14]. Disponível em: <http://www.sbnpe.com.br/ctdpg.php?pg=13&ct=A>.

Para outros exemplos recomendamos consultar as normas do *Committee of Medical Journals Editors* (Grupo Vancouver) <http://www.icmje.org>.

Lista de checagem

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- Incluir título do manuscrito, em português e em inglês.

- Incluir título abreviado (*short title*), com 40 caracteres, para fins de legenda em todas as páginas.

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- Incluir permissão de editores para reprodução de figuras ou tabelas publicadas.

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GUIDE FOR AUTHORS

Scope and policy

The **Brazilian Journal of Nutrition** is a specialized periodical that publishes articles that contribute to the study of Nutrition in its many sub-areas and interfaces. It is published bimonthly and open to contributions of the national and international scientific communities.

Submitted manuscripts may be rejected without detailed comments after initial review by at least two **Brazilian Journal of Nutrition** editors if the manuscripts are considered inappropriate or of insufficient scientific priority for publication in the Journal.

The Board of Editors does not assume responsability for concepts and illustrations emitted in signed articles.

Article category

The Journal accepts unpublished articles in Portuguese, Spanish or English, with title, abstract and keywords in the original language and in English, in the following categories:

Original: contributions that aim to disclose the results of unpublished researches, taking into account the relevance of the theme, the scope and the knowledge generated for the research area (maximum limit of 5 thousand words).

Special: invited articles on current themes (maximum limit of 6 thousand words).

Review (by invitation): synthesis of the knowledge available on a given theme, based on analysis and interpretation of the pertinent literature, aiming to make a critical and comparative analysis of the works in the area and discuss the methodological limitations and its scope. It also allows the indication of perspectives of continuing studies in that line of research (maximum limit of 6 thousand words). There will be a maximum of two reviews per issue.

Communication: information reported on relevant themes and based on recent research, whose objective is to subsidize the work of professionals who work in the field, serving as a presentation or update on the theme (maximum limit of 4 thousand words).

Scientific note: partial unpublished data of an ongoing research (maximum limit of 4 thousand words).

Essay: works that can bring reflection and discussion of a subject that generates questioning and hypotheses for future research (maximum limit of 5 thousand words).

Thematic Section (by invitation): section whose aim is to publish 2 or 3 coordinated articles from different authors covering a theme of current interest (maximum of 10 thousand words).

Article's category and subject area

Authors should indicate the article's category and subject area, namely: food and social sciences, nutritional assessment, nutritional biochemistry, nutrition, nutrition education, epidemiology and statistics, micronutrients, clinical nutrition, experimental nutrition, nutrition and geriatrics, nutrition, maternal and infant nutrition in meal production, food and nutrition policies and health.

Research involving living beings

Results of research involving human beings and animals, must contain a copy of the Research Ethics Committee approval.

Registration of Clinical Trials

Articles with results of clinical researches must present an identification number in one of the Register of Clinical Trials validated by criteria established the the World Health Organization (WHO) and International Committee of Medical Journal Editors (ICMJE), whose addresses are available at the ICMJE site. The identification number must be included at the end of the abstract.

Editorial procedures

Authorship

The list of authors, included below the title, should be limited to 6. The authorship credit must be based on substantial contributions, such as conception and design, or analysis and interpretation of the data. The inclusion of authors whose contribution does not include the criteria mentioned above is not justified.

The manuscripts must explicitly contain in the identification page the contribution of each one of the authors.

Manuscript judgment process

All manuscripts will only start undergoing the publication process if they are in agreement with the Instructions to the Authors. If not, **they will be returned**

for the authors to make the appropriate adjustments, include a letter or other documents that may be necessary.

It is strongly recommended that the author(s) seek professional language services (reviewers and/or translators certified in the Portuguese or English languages) before they submit articles that may have semantic, grammar, syntactic, morphological, idiomatic or stylistic mistakes. The authors must also avoid using the first person of the singular, "my study...," or the first person of the plural "we noticed...," since scientific texts ask for an impersonal, non-judgmental discourse.

Articles with any of the mistakes mentioned above **will be returned even before they are submitted to assessment** regarding the merit of the work and the convenience of its publication.

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Once the articles are approved in this phase, they will be sent to *ad hoc* peer reviewers selected by the editors. Each manuscript will be sent to two reviewers of known competence in the selected theme. One of them may be chosen by the authors' indicatiton. If there is disagreement, the manuscript will be sent to a third reviewer.

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The opinions of the reviewers are one of the following: a) approved; b) new analysis needed; c) refused. The authors will always be informed of the reviewers' opinion.

Reviews are examined by the Editors who will recommend or not the manuscript's approval by the Scientific Editor.

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If there are conflicts of interest regarding the reviewers, the Editorial Committee will send the manuscript to another *ad hoc* reviewer.

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Manuscripts need to be accompanied by a letter signed by all the authors describing the type of work and the thematic area, a declaration that the manuscript is being submitted only to the Journal of Nutrition, an agreement to transfer the copy rights and a letter stating the main contribution of the study to the area.

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The manuscripts need to be sent to the Editorial Center of the Journal, to the site <http://www.scielo.br/rn> with a line spacing of 1.5, font Arial 11. The file must be in Microsoft Word (doc) format version 97-2003 or better.

It is essential that the body of the article **does not contain any information that may identify the author(s)**, including, for example, reference to previous works of the author(s) or mention of the institution where the work was done.

The articles should have approximately 30 references, except for review articles, which may contain about 50 references. A reference must always contain the Digital Object Identifier (DOI).

Please use a color font (preferably blue) or underline all the changes made to the text, Include a letter to the editor confirming your interest in publishing your article in this Journal and state which changes were made in the manuscript. If the authors disagree with the opinion of the reviewers, they should present arguments that justify their position. The title and the code of the manuscript must be specified.

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Title page must contain

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b) short title with up to 40 characters (including spaces) in Portuguese (or Spanish) and English;

c) full name of all the authors, indicating the institutional affiliation of each one of them. Only one title and affiliation will be accepted per author. The author(s) should therefore choose among their titles and institutional affiliations those that they deem more important;

d) all data of the titles and affiliations must not contain any abbreviations;

e) provide the full address of all the universities to which the authors are affiliated;

f) provide the full address for correspondence of the main author for the editorial procedures, including fax and telephone numbers and e-mail address.

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Text: except for the manuscripts presented as Review, Communication, Scientific Note and Assay, the works must follow the formal structure for scientific works:

Introduction: must contain a current literature review pertinent to the theme and appropriate to the presentation of the problem, also emphasizing its relevance. It should not be extensive except for manuscripts submitted as Review Articles.

Methods: must contain a clear and brief description of the method, including the corresponding literature: procedures, universe and sample, measurement tools, and validation method and statistical treatment when applicable.

Regarding the statistical analysis, the authors should demonstrate that the procedures were not only appropriate to test the hypotheses of the study but were also interpreted correctly. The statistical significance levels (e.g. $p<0.05$; $p<0.01$; $p<0.001$) must be mentioned.

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Tables, charts and figures should be limited to five in all and given consecutive and independent numbers in Arabic numerals, according to the order the data is mentioned, and should be presented in individual sheets and separated, indicating their location in the text. **It is essential to inform the location and year of the study**. Each one should have a brief title. The charts and tables must be open laterally.

The author(s) are responsible for the quality of the figures (drawings, illustrations, tables and graphs) that should the large enough to fit one or two columns (7 and 15cm respectively); **the landscape format is not accepted**. Figures should be in jpeg format and have a minimum resolution of 400 dpi.

Graphs and drawings should be made in vector design software (Microsoft Excel, CorelDraw, Adobe Illustrator etc.), followed by their quantitative parameters in a table and the name of all its variables.

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Discussion: the discussion must properly and objectively explore the results under the light of other observations already published in the literature.

Conclusion: present the relevant conclusions, considering the objectives of the work, and indicate ways to continue the study. **Literature citations will not be accepted in this section**.

Acknowledgments: may be made in a paragraph no bigger than three lines to institutions or individuals who actually collaborated with the work.

Attachments: should be included only when they are essential to the understanding of the text. The editors will decide upon the need of their publication.

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References must follow the Vancouver style

References: must be numbered consecutively according to the order that they were first mentioned in the text, according to the Vancouver style.

All authors should be cited in references with two to six authors; if more than six authors, only the first six should be cited followed by *et al*.

The abbreviations of cited journals should be in agreement with the Index Medicus.

Citations/references of **undergraduate monographs, works** presented in congresses, symposiums, workshops, meetings, among others, and **unpublished texts** (classes among others) **will not be accepted**.

If the unpublished work of one of the authors of the manuscript is cited (that is, an in press article), it is necessary to include the letter of acceptance of the journal that will publish the article.

If unpublished data obtained by other researchers are cited in the manuscript, it is necessary to include a letter authorizing the use of such data by the original authors.

Literature citations in the text should be in numerical order, Arabic numerals, placed after the citation in superscript, and included in the references. If two authors are mentioned, both are cited using the "&" in between; if more than two authors, the first author is cited followed by the *et al*. expression.

The accuracy and appropriateness of references to works that have been consulted and mentioned in the text of the article are of the author(s) responsibility. All authors whose works were cited in the text should be listed in the References section.

Examples

Article with one author

Burlandy L. A construção da política de segurança alimentar e nutricional no Brasil: estratégias e desafios para a promoção da intersetorialidade no âmbito federal de governo. Ciênc Saúde Coletiva. 2009; 14(3):851-60. doi: 10.1590/S1413-81232009000300020.

Article with more than six authors

Oliveira JS, Lira PIC, Veras ICL, Maia SR, Lemos MCC, Andrade SLL, *et al*. Estado nutricional e insegurança alimentar de adolescentes e adultos em duas localidades de baixo índice de desenvolvimento humano. Rev Nutr. 2009; 22(4):453-66. doi: 10.1590/S1415-52732009000400002.

Book

Alberts B, Lewis J, Raff MC. Biologia molecular da célula. 5ª ed. Porto Alegre: Artmed; 2010.

Book chapters

Aciolly E. Banco de leite. In Aciolly E. Nutrição em obstetrícia e pediatria. 2ª ed. Rio de Janeiro: Guanabara Koogan; 2009. Unidade 4.

Dissertations and theses

Duran ACFL. Qualidade da dieta de adultos vivendo com HIV/AIDS e seus fatores associados [mestrado]. São Paulo: Universidade de São Paulo; 2009.

Article in electronic media

Sichieri R, Moura EC. Análise multinível das variações no índice de massa corporal entre adultos, Brasil, 2006. Rev Saúde Pública. 2009 [acesso 2009 dez 18]; 43(Supl 2):90-7. Disponível em: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0034-89102009000900012&lng=pt&nrm=iso>. doi: 10.1590/S0034-89102009000900012

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Electronic book chapters

Emergency contraceptive pills (ECPs). In World Health Organization. Medical eligibility criteria for contraceptive use. 4th ed. Geneva: WHO; 2009 [cited 2010 Jan 14]. Available from: <http://whqlibdoc.who.int/publications/2009/9789241563888_eng.pdf>.

Electronic texts

Sociedade Brasileira de Nutrição Parental e Enteral. Assuntos de interesse do farmacêutico atuante na terapia nutricional. 2008/2009 [acesso 2010 jan 14]. Disponível em: <http://www.sbnpe.com.br/ctdpg.php?pg=13&ct=A>.

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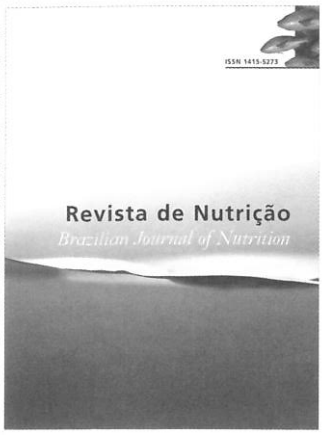

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