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Prevalence of inadequacy and associated indicators with mineral intake in Brazilian adolescents and young adults

Prevalência de inadequação e fatores associados à ingestão adequada de minerais em adolescentes e adultos jovens brasileiros

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ABSTRACT

Objective
To describe the prevalence of inadequate mineral intake and associated factors with calcium, iron, zinc, magnesium, phosphorus, and sodium intakes in individuals aged 15-24.9 years.

Methods
We analyzed 476 individuals from the Brazilian Study of Nutrition and Health, stratified into two age groups (adolescents aged 15-18.9 years and young adults aged 19-24.9 years). Mineral intake was obtained from two 24-hour Dietary Recalls. The values of the Estimated Average Requirement and the Tolerable Upper Intake Levels were considered to calculate the prevalence of inadequacy. Multiple logistic regression was used to determine associated factors with mineral intake.

Results
Calcium and magnesium had the highest prevalence of inadequacy (>83%) in both sexes and age groups. Sodium intake was above Tolerable Upper Intake Levels for the majority of the population studied (>68%). The intake of all minerals was different between the sexes for the two age groups (p<0.01), and it was not different between age groups (p>0.05). The associated factors with mineral intake were sex (calcium, iron, phosphorus, and sodium), age

group (calcium, magnesium, phosphorus, and sodium), and physical activity (calcium, iron, and magnesium), followed by socioeconomic level (zinc and sodium) and body weight status (iron and sodium).

Conclusion

The expressive portion of the studied population is at nutritional risk for calcium, magnesium, and sodium. Such data can contribute to the national public policy revision that is related to micronutrient intake and the adoption of healthier habits by adolescents and young adults.

Keywords: Eating intake. Epidemiology. Public health. Youth.

RESUMO

Objetivo

Descrever as prevalências de inadequação e fatores associados à ingestão de cálcio, ferro, zinco, magnésio, fósforo e sódio em indivíduos dos 15 aos 24,9 anos.

Métodos

Foram analisados 476 indivíduos do Estudo Brasileiro de Nutrição e Saúde, estratificados em dois grupos etários (adolescentes de 15-18,9 anos e adultos jovens de 19-24,9 anos). A ingestão de minerais foi obtida por meio de dois recordatórios de 24hs. Os valores de Requerimento Médio Estimado e do Limite Superior Tolerável de Ingestão foram considerados para calcular as prevalências de inadequação. Regressão logística múltipla foi utilizada para determinar os fatores associados à ingestão de minerais.

Resultados

Cálcio e magnésio tiveram elevadas prevalências de inadequação (>83%) em pacientes de ambos os sexos e grupos etários. A ingestão de sódio foi acima Limite Superior Tolerável de Ingestão para a maioria da população estudada (>68%). O consumo de todos os minerais foi diferente entre os sexos para os dois grupos etários (p<0,01) e não foi diferente entre os grupos etários (p>0,05). Os fatores associados à ingestão dos minerais foram sexo (cálcio, ferro, fósforo e sódio), grupo etário (cálcio, magnésio, fósforo e sódio) e atividade física (cálcio, ferro e magnésio), seguidos por nível socioeconômico (zinco e sódio) e estado de peso corporal (ferro e sódio).

Conclusão

Expressiva parcela da população estudada encontra-se em risco nutricional para cálcio, magnésio e sódio. Esses dados podem contribuir para a revisão de políticas públicas nacionais que se relacionam à ingestão de micronutrientes e à adoção de hábitos mais saudáveis pelos adolescentes e adultos jovens.

Palavras-chave: *Ingestão de alimentos. Epidemiologia. Saúde pública. Juventude.*

INTRODUCTION

Diet quality during adolescence and early adulthood can have immediate repercussions on health, affecting body composition, bone mineralization, and academic performance; as well as bringing long-term consequences, predisposing to chronic non-communicable diseases [1-3].

In adolescents, changes in body composition added to biopsychosocial changes can contribute to behavioral changes and the development of inappropriate eating habits, with substantial changes in eating patterns culminating in the emergence of eating disorders and situations of nutritional risk [4-10]. Similar consequences can be observed in young adults, as a product of the socioeconomic transitions to which they are exposed [11]. Added to this, the nutritional transition currently experienced in Brazil, characterized by the coexistence of health problems related to overweight and/or obesity and nutritional deficiencies, and the global syndemic of obesity, malnutrition, and climate change, requires monitoring and identification of individuals at nutritional risk [12]. Especially, the understanding of the factors that are associated with the ingestion of minerals, to promote public policies in the face of problems related to nutritional deficiencies [13,14].

Adolescents are more vulnerable to nutritional deficiencies due to the increased demand for nutrients to meet the intense growth typical of this phase [4]. The adequate supply of calcium, magnesium, and phosphorus is justified by accelerated bone metabolism [15,4]. Magnesium also plays an important role in cellular energy metabolism, essential in this phase, due to volume expansion, increase in muscle tissue, and respiratory capacity [16]. In this context, adequate sodium consumption is of paramount importance, as it regulates blood volume, in addition to participating in muscle contraction processes. Therefore, hematopoietic functions also demand a significant supply of iron and zinc, essential for cell division processes [4,17,18].

Evaluating the prevalence of inadequacy of the minerals mentioned above is justified by the relevance of their functions, as well as the scarcity of studies about the Brazilian population using the same protocol, including two stages of life, such as adolescents and young adults [14,19,20]. Given the above, this study aims to describe the prevalence of inadequate intake of minerals and factors associated with an adequate intake of calcium, magnesium, phosphorus, sodium, iron, and zinc in adolescents and young adults from the *Estudo Brasileiro de Nutrição e Saúde* (EBANS, Brazilian Study of Nutrition and Health).

METHODS

The EBANS is part of the *Estudo Latino-americano de Nutrição e Saúde* (ELANS, Latin American Study of Nutrition and Health), a multicenter study conducted in eight Latin American countries; characterized by being cross-sectional, population-based, with 15 to 65-year-old individuals [21].

The sample calculation was stratified by gender, age group, and Socioeconomic Level (SEL). Approved by the Ethics Committee of the Federal University of São Paulo (CAAE: 53532516.8.0000.5505), all participants signed the Informed Consent Form and/or the Term of Assent. Methodological details of EBANS have been previously published [19].

In this work, part of the data from EBANS [19] was analyzed, comprising 15 to 24.9-year-old individuals (Table 1), considering the age strata of the Dietary Reference Intakes (DRI) for nutrient intake recommendations [22-25]. Therefore, the age groups from 15 to 18.9 years old (adolescents) and from 19 to 24.9 years old (young adults) were analyzed.

Briefly, the selection of cities included in EBANS was made by systematic sampling (urban agglomeration) and random sampling (smaller cities). Within the agglomerations, cities, neighborhoods, and residential areas (Primary Sampling Units) were randomly selected using probability proportional to size. Within each Primary Sampling Unit, a sampling point was randomly selected through the probability proportional to size: the census tracts (Secondary Sampling Units) were defined based on the cartographic division [26]. In a systematic way (residential block traversed clockwise, a sampling interval of three households), households were selected within each Secondary Sampling Units; and individuals were selected by quotas [19]. Those with neuropsychiatric and/or genetic diseases that could affect food intake and/or energy expenditure were excluded – while those with metabolic and/or heart disease were maintained; individuals with physical or mental disabilities; unable to read; pregnant or lactating women were also excluded as well as the ones who were absent from home or who refused to carry out the second interview; and adolescents under 15 years of age, since they are biologically vulnerable and it would be necessary to verify their pubertal maturation stage (since the pubertal stage can affect nutritional status and body composition), which would be impractical from a logistical point of view for a population-based study such as EBANS.

Table 1 – Characterization of the study population according to the age group proposed by the Dietary Reference Intakes for adolescents and young adults.

Indicators	Total Sample n=476 (100%)	Adolescents 15-18,9 years old n=188 (39.5%)	Young Adults 19-24,9 years old n=288 (60.50%)	*p*-value**
	%			
Region				
North	7.14	8.51	6.25	0.355
Northeast	20.17	20.21	20.14	
Southeast	55.67	56.38	55.21	
South	7.56	5.85	8.68	
Mid-West	9.45	9.04	9.72	
Gender				
Male	57.56	60.64	55.56	0.911
Female	42.44	39.36	44.44	
Socioeconomic Level				
High	9.03	8.51	9.38	0.674
Middle	50.42	53.72	48.26	
Low	40.55	37.77	42.36	
Educational Level*				
Basic education	50.42	77.13	32.99	<0.001
Higher Education	49.58	22.87	67.01	
Type of occupation				
Working	40.21	16.58	55.83	<0.001
Student	38.30	72.19	15.90	
Homemaker	5.32	3.74	6.36	
Unemployed	16.17	7.49	21.91	
Physical Activity				
Insufficiently active	51.42	46.74	54.55	0.647
Active	48.58	53.26	45.45	
Body weight Status				
No overweight and/or obesity	63.66	72.34	57.99	0.010
Overweight and/or obesity	36.34	27.66	42.01	

Note: *Educational level was categorized into two levels: basic education (up to high school) and higher education (complete or incomplete); **Chi-square at 5% significance level.

Food consumption data were obtained through two 24-hour recalls (R24h) and the Multiple Pass Method was considered; in two home visits respecting a seven-day interval, with a representation of one day of the week and a weekend day [27,28]. Consumption was reported using household measures; and later converted to values in grams (g) and milliliters (mL), by trained nutritionists. Dietary intake data were analyzed using the Nutrition Data System for Research software, version 2013 [29]. Some culinary preparations related to Brazilian habits were standardized for the analysis of dietary intake [30].

Data were energy-adjusted using the Willet et al. method [31]; and were also adjusted considering intrapersonal variability through the Multiple Source Method statistical modeling technique program, which uses consumption data from two R24h. Briefly, this method consists of three statistical steps: 1) the probability model; 2) the quantity model, and 3) the product of the two models. The probability model estimates nutrient intake per day using logistic regression with random effects for each individual. Then, for the quantity model, the data were transformed to a normal distribution (Box-Cox), and through linear regression with random effects, the usual quantity of food consumption was estimated. Finally, the usual nutrient intake was calculated by multiplying the probability of nutrient intake by the usual amount of intake [32,33].

Sociodemographic information (age, sex, region, educational level and type of occupation) was self-reported by participants. To determine the SEL, the *Critério de Classificação Econômica*

Brasil (CCEB, Brazilian Economic Classification Criteria) was used, categorized into three levels: high (classes A1, A2, B1), medium (classes B2, C1) and low (classes C2, D, E) [34].

Data related to the practice of physical activity (PA) were obtained through the International Physical Activity Questionnaire (IPAQ) long form, using only the transport and leisure domains; since these domains include the most relevant practices to guide public health programs and policies in the Latin America region [35]. The IPAQ is validated for Brazilian adolescents and young adults and has acceptable measurement properties to monitor their PA levels [36,37]. The average total PA practice time in minutes per week (min/week) was obtained by multiplying the weekly frequency (days per week) by the average daily time for each domain ([transport: bicycle + walking] + [leisure: walking + moderate PA + vigorous PA]) and participants were classified as "active" or "insufficiently active" based on the World Health Organization recommendation for PA; which recommends the practice of ≥150 min/week of PA for over 18-year-old individuals and the practice of ≥300 min/week for individuals from 5 to 17.9 years old [38].

Body weight and height data were measured in the population using a portable scale (Seca®, Hamburg, Germany) and a portable stadiometer (Seca®, Hamburg, Germany) [19]. The body weight status was determined based on the calculation of the body mass index according to the World Health Organization for individuals >19 years of age [39], and according to gender and age for adolescents [40], being characterized as "not overweight and/or obese" or "overweight and/or obese".

Dispersion measures related to mineral intake were calculated, according to sex and age group, respecting the age stratifications of the DRI. The Kolmogorov-Smirnov test verified non-parametric data distribution, and the Mann-Whitney test was used to verify the difference in mineral intake between age groups and genders ($p<0.05$). The Chi-square test was used to compare the sociodemographic characteristics, physical activity, and body weight status of the sample ($p<0.05$).

To calculate the prevalence of inadequate intake of minerals, the Estimated Average Requirement values were considered according to gender and age group [22-25]. Thus, it was considered inadequate intake of nutrients when individuals had an intake lower than the Estimated Average Requirement. For sodium, an intake greater than the Tolerable Upper Intake Level (UL) was considered inadequate.

To verify the factors associated with mineral intake, multiple logistic regression was used considering the stepwise method, selecting which variables had the greatest influence on intake. Initially, the independent variables were sociodemographic factors, physical activity and body weight status, with an adequate intake of each mineral being the dependent variable. The predictive contribution of each variable was analyzed using simple regression (cutoff=value $p\leq0.20$) and combined in the final regression model using stepwise forward modeling [41]. Six different regression models were performed for each micronutrient as an outcome. The analyzes were pondered considering the sample weight in Stata software (Statistics/Data Analysis, v.13.0, Texas, USA) [21].

RESULTS

The characterization of the population is described in Table 1, stratified into adolescents (15 to 18.9 years old) and young adults (19 to 24.9 years old), comprising 58% of males, 56% from the Southeast region, 50% belonging to the middle SEL, 51% insufficiently active and 64% of them not overweight and/or obese. Such characteristics are not statistically different between adolescents and young adults ($p>0.05$). There is a statistically significant difference between the age groups

in relation to the presence of overweight and/or obesity, which was more prevalent among young adults (p=0.010), on the educational level and type of occupation (p<0.001).

Considering both sexes, the prevalence of inadequate calcium and magnesium intake stood out, as they presented figures above 83% for both age groups. There was a low prevalence of inadequacy (<50%) for phosphorus among young adults, and for iron and zinc in both age groups. Most of the studied population had sodium intake above the UL. The intake of all minerals analyzed was not different between the two age groups (p>0.05) (Table 2).

Table 2 – Dietary intake of minerals* and prevalence of inadequacy, in both sexes, according to the age group proposed by the Dietary Reference Intakes for adolescents and young adults.

Minerals	Average	95% CI	Percentiles			*p*-value**	Prevalence of Inadequacy	
			25	50	75		%	95% CI
Calcium (mg)								
a	497.86	456.58-539.14	319.27	476.70	624.93	0.269	97.28	94.88-99.68
b	498.98	443.63-554.32	297.23	441.47	581.78		88.67	81.64-95.68
Iron (mg)								
a	11.47	10.64-12.31	8.89	10.62	13.20	0.308	13.53	8.68-18.38
b	11.06	10.52-11.60	8.38	10.52	13.51		16.07	11.65-20.49
Zinc (mg)								
a	11.18	10.53-11.83	8.67	10.71	13.13	0.475	17.33	11.78-22.88
b	11.67	10.91-12.43	8.78	11.24	13.98		19.00	14.13-23.87
Magnesium (mg)								
a	221.96	208.49-235.43	171.15	216.64	257.76	0.918	93.13	89.34-96.92
b	228.22	214.24-242.20	175.96	213.70	262.57		83.91	76.78-91.05
Phosphorus (mg)								
a	1021.78	966.09-1077.47	797.11	991.52	1152.82	0.744	58.07	50.42-65.72
b	1065.35	977.66-1153.05	807.17	1004.18	1227.28		6.17	3.29-9.04
Sodium (mg)								
a	2883.18	2716.91-3049.45	2150.86	2754.51	3543.20	0.413	68.51	61.58-75.44
b	2951.60	2803.98-3099.22	2329.65	2846.12	3544.72		76.35	71.09-81.60

Note: *Mineral intake was adjusted for individual energy intake [31] and within-person variability [32,33]. **Mann-Whitney at the 5% significance level. a: Age group 15-18.9 years of age; b: Age group 19-24.9 years of age; CI: Confidence Interval.

For males, a low prevalence of inadequacy for iron, zinc and phosphorus was observed. Sodium intake reached average consumption above 3000mg for both age groups (Table 3). Among women, the prevalence of 100% inadequacy for calcium among adolescents stands out; and nearly 35% of adult women were at nutritional risk for iron deficiency (Table 4). Consumption of all nutrients was statistically different between genders for both adolescents and young adults. For all nutrients, the statistical difference was p<0.001; except for calcium among adolescents (p<0.01) [data not shown in the table].

Table 3 – Dietary intake of minerals*, distribution and prevalence of inadequacy in the male population, according to the age group proposed by the DRIs (Dietary Reference Intakes) for adolescents and young adults.

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Minerals [EAR/UL]	Average	95% CI	Percentiles			*p*-value**	Prevalence of inadequate intake of minerals	
			25	50	75		%	95% CI
Calcium (mg)								
a [1100]	547.61	495.08-600.13	357.94	517.99	717.62	0.518	95.37	91.31-99.44
b [800]	551.54	463.15-639.93	344.81	491.26	700.17		82.99	71.74-94.25
Iron (mg)								
a [7,7]	12.35	11.33-13.36	9.79	11.66	15.06	0.588	8.88	3.85-13.91
b [6,0]	12.09	11.43-12.75	9.63	11.51	13.81		3.03	0.01-6.05

Table 3 – Dietary intake of minerals*, distribution and prevalence of inadequacy in the male population, according to the age group proposed by the DRIs (Dietary Reference Intakes) for adolescents and young adults.

Minerals [EAR/UL]	Average	95% CI	Percentiles			*p*-value**	Prevalence of inadequate intake of minerals	
			25	50	75		%	95% CI
Zinc (mg)								
a [8,5]	12.07	11.32-12.82	9.36	11.47	15.06	0.284	18.17	10.69-25.65
b [9,4]	12.87	11.78-13.95	10.16	12.30	15.56		19.88	13.06-26.70
Magnesium (mg)								
a [340]	239.51	223.90-255.12	188.58	237.13	277.37	0.801	93.06	88.29-97.83
b [330]	250.19	229.38-271.01	194.48	232.14	289.58		83.15	71.89-94.41
Phosphorus (mg)								
a [1055]	1101.52	1037.15-1165.90	882.52	1091.90	1227.85	0.350	45.06	35.26-54.87
b [580]	1187.20	1053.62-1320.79	899.44	1112.37	1384.27		3.82	0.45-7.18
Sodium (mg)								
a [2300]***	3098.40	2922.99-3273.81	2269.01	3050.05	3687.12	0.375	74.16	65.78-82.53
b [2300]***	3208.51	3001.10-3415.91	2523.41	3157.66	3809.91		85.65	79.62-91.69

Note:*Mineral intake was adjusted for individual energy intake [31] and within-person variability [32,33]. **Mann-Whitney at the 5% significance level. ***UL values. a: Age group 15-18.9 years of age; b: Age group 19-24.9 years of age. CI: Confidence Interval; EAR: Estimated Average Requirement; UL: Tolerable Upper Intake Level.

Table 4 – Dietary intake of minerals*, distribution, and prevalence of inadequacy in the female population, according to the age group proposed by the Dietary Reference Intakes for adolescents and young adults.

Minerals [EAR/UL]	Average	95% CI	Percentiles			*p*-value**	Prevalence of inadequate intake of minerals	
			25	50	75		%	95% CI
Calcium (mg)								
a [1100]	426.98	383.15-470.80	285.54	411.87	541.55	0.455	100.00	–
b [800]	426.12	390.18-462.05	267.78	390.85	549.47		96.53	93.09-99.96
Iron (mg)								
a [7,9]	10.23	9.33-11.13	8.04	9.18	10.85	0.418	20.16	10.82-29.50
b [8,1]	9.64	8.96-10.31	7.66	9.18	11.30		34.15	25.64-42.66
Zinc (mg)								
a [7,3]	9.91	9.24-10.59	7.97	9.99	11.55	0.861	16.14	7.75-24.53
b [6,8]	10.01	9.44-10.57	7.26	10.08	12.06		17.78	10.86-24.69
Magnesium (mg)								
a [300]	196.95	181.32-212.58	159.20	184.22	228.29	0.678	93.23	86.90-99.56
b [250]	197.76	189.21-206.31	156.72	193.70	227.91		84.97	78.18-91.76
Phosphorus (mg)								
a [1055]	908.15	851.58-964.72	736.27	892.85	1046.42	0.889	76.61	65.70-87.53
b [580]	896.46	860.63-932.29	709.13	886.65	1060.17		9.43	4.41-14.44
Sodium (mg)								
a [2300]***	2576.52	2361.51-2791.52	2096.29	2493.88	2915.35	0.544	60.46	48.53-72.39
b [2300]***	2595.51	2493.09-2697.93	2034.17	2592.90	3069.94		63.45	54.85-72.06

Note: *Mineral intake was adjusted for individual energy intake [31] and within-person variability [32,33]; **Mann-Whitney at the 5% significance level; ***UL values. a: Age group 15-18.9 years of age; b: Age group 19-24.9 years of age; CI: Confidence Interval; EAR: Estimated Average Requirement; UL: Tolerable Upper Intake Level.

Factors associated with mineral intake are presented in Table 5, as well as the final models of logistic regression analysis. It was found that the associated factors were sex (for the nutrients calcium, iron, phosphorus and sodium), age group (for calcium, magnesium, phosphorus and sodium) and physical activity (for calcium, iron and magnesium); followed by socioeconomic status (zinc and sodium) and body weight status (iron and sodium). The educational level and type of occupation variables were not included in any final regression model and therefore are not described in Table 5.

Table 5 – Final model of the multivariate logistic regression analysis of mineral intake adequacy* with studied factors, according to the age range proposed by the DRIs (Dietary Reference Intakes).

Factors	Calcium		Iron		Zinc		Magnesium		Phosphorus		Sodium	
	OR	*p*	OR	*p*	OR	*p*	OR	*p*	OR	*p*	OR	*p*
Gender												
Female	1	–	1	–	–	–	–	–	1	–	1	–
Male	6.9	0.004	6.1	<0.001	–	–	–	–	3.6	<0.001	0.4	<0.001
Age group												
15-18,9	1	–	–	–	–	–	1	–	1	–	1	–
19-24,9	5.1	0.007	–	–	–	–	3.0	0.015	26.3	<0.001	0.6	0.027
Region							**					
North	–	–	–	–	–	–	1	–	–	–	–	–
Northeast	–	–	–	–	–	–	0.8	0.629	–	–	–	–
Southeast	–	–	–	–	–	–	0.6	0.419	–	–	–	–
South	–	–	–	–	–	–	0.4	0.279	–	–	–	–
Mid-West	–	–	–	–	–	–	1.1	0.914	–	–	–	–
SEL												
High	–	–	–	–	1	–	–	–	–	–	1	–
Average	–	–	–	–	0.2	0.048	–	–	–	–	2.8	0.047
Low	–	–	–	–	0.2	0.017	–	–	–	–	3.2	0.027
Physical Activity												
Insuf. act.	1	–	1	–	–	–	1	–	–	–	–	–
Active	5.0	0.003	1.9	0.031	–	–	3.0	0.005	–	–	–	–
Body weight status					**		**					
No OW/OB	–	–	1	–	1	–	1	–	–	–	1	
OW/OB	–	–	0.5	0.021	0.7	0.091	0.5	0.084	–	–	2.1	0.002

Note: *Dependent variable: 0 = inadequate intake and 1 = adequate intake. Mineral intake was adjusted for individual energy intake [31] and within-person variability [32,33]; **Adjustment variable. SEL: Socioeconomic Level; Insuf. Act.: Insufficiently Active; OR: Odds Ratio; OW/OB: Overweight and/or Obesity.

DISCUSSION

The nutritional quality of foods consumed by Brazilians has been changing over the years [42], with an increase in the consumption of foods with low nutritional density being observed, which is positively associated with the accumulation of body fat [43-45]; as well as eating habits, with a decrease in the consumption of foods characteristic of Brazilian culture (for example, rice and beans), including among adolescents [42,46]. The literature suggests that adolescents have inadequate intake of micronutrients, being more prominent in females; a fact that was observed in this study [4,13,14,20].

In a study carried out with the urban population of São Paulo, a low intake of calcium and magnesium was found in all age groups studied [13]. Data was also found in this study, with the average intake lower than the intake recommendation for calcium and magnesium; as well as phosphorus for female adolescents. The adequate supply of these minerals is of vital importance, especially during the period of bone mineralization (<25 years), contributing to adequate bone growth and prevention of bone problems [15,1]. The low consumption of milk and derivatives by the Brazilian population, including adolescents contributes to an inadequate intake of calcium, magnesium and phosphorus [13,20,47-50]. The literature also suggests an association of these minerals with cardiovascular diseases and associated diseases, which are currently the most common causes of death worldwide and one of the main challenges of the 21st century [51,52].

National data on magnesium intake is scarce [16]. However, data from surveys carried out in Brazilian cities, added to the finding of this study, reveal low magnesium intake by the Brazilian population, making future investigations necessary. On the other hand, there are more epidemiological

data on calcium intake in the Brazilian population, denoting the high prevalence of inadequacy [13,14,20,48]. In the present study, the prevalence of 100% calcium inadequacy among adolescent girls was worrying and puts this entire population at nutritional risk for calcium deficiency, without neglecting the high prevalence of inadequacy found among males and young adults. Currently, national public policies emphasize the mandatory fortification of some foods with iodine, iron and folic acid [53,54]. It is opportune to review some public health strategies and/or increase the scope of existing ones, including other micronutrients that are notably deficient in the Brazilian population.

Complying with international recommendations for PA practice was associated with adequate calcium intake, as suggested in the literature [13]. In a study that analyzed data from *Pesquisa Nacional de Saúde do Escolar* (National Adolescent School-based Health Survey) 2012, it was found that physical inactivity was one of the factors associated with inadequate milk consumption [47]. In the present study, another factor that was associated with adequate calcium intake was belonging to the age group of 19 to 24.9 years of age, since the recommended amount of calcium intake decreases by approximately 30% for the 19-30-year-old group compared to the 14-18-year-old group [24]. The decrease in phosphorus intake recommendation for individuals over 19 years of age culminated in a decrease of approximately 90% in the prevalence of phosphorus inadequacy for adults in this study when compared to adolescents for both sexes.

Sodium was another nutrient with a high prevalence of inadequacy, which corroborates other findings that denote high sodium intake in the Brazilian diet, including adolescents [14,20,49]. The average intake exceeded the UL for both sexes and age groups, data that requires attention and public health actions. High sodium intake is associated with non-communicable diseases at all stages of life [55]. Many metabolic changes in childhood and adolescence result from an inadequate lifestyle already practiced at this stage of life [20]. The SEL is a factor generally associated with food consumption. Some studies demonstrate that socioeconomic factors contribute to an ongoing process concerning improving diet quality [56]. In the present study, belonging to the middle and low SEL increased the chance of having an adequate sodium intake by three times when compared to the high SEL, a fact that can be explained by the contribution of sodium in the diet that comes from processed foods with added salt, which increases linearly according to the availability of income; however, the most significant contribution of sodium in the Brazilian diet comes from added salt [57]. Being overweight and/or obese was also positively associated with adequate sodium intake, which may be related to the fact that overweight and/or obese people have hypertension as associated comorbidity, and, therefore, the reduction in sodium intake is a guideline to be followed [58].

The prevalence of iron inadequacy was low among men; being a male increased the chances of adequate iron intake, which the higher iron intake recommendation for females can explain. Iron deficiency among adolescents can be frequent since there is an increase in muscle mass with volume expansion, being more prevalent among girls as menstrual blood loss is added. However, there is an expected physiological increase in hemoglobin levels among adolescents due to pubertal phenomena [17]. Being overweight and/or obese decreases the probability of adequate iron intake, which may be related to the consumption of low-nutrient-density foods, greater need for mineral intake about body weight, and insufficient PA practice [17].

When considering the ratio of milligrams of zinc per kilogram of body weight, the dietary need for zinc is greater for adolescents than for adults since cell growth is accelerated [23]. Inadequate intake of antioxidant micronutrients, including zinc, is positively associated with cardiometabolic risk in adolescents and adults [59-61].

Considering that the average intake of all minerals analyzed in the present study was not different between age groups, it was observed that the lowest recommended intake value of some minerals for over 19-year-old individuals associated this age group with a higher adequate intake of calcium, magnesium, and phosphorus; with no significant increase in the amount of minerals consumed by young adults from EBANS. This fact may indicate little or no change in food consumption with the advancing of age, although the EBANS is a cross-sectional study, which limits data analysis over time [9]. Few studies propose to evaluate the dietary transition that occurs in late adolescence and early adulthood [1]. Conducting research with the correct experimental design to assess this transition can be highlighted as a scientific opportunity.

The main strength of this study is the methodology, with the use of two R24h and the application of additional techniques to minimize errors and biases, such as the Multiple Pass Method, which helps the interviewee remember and detailing the food report, contributing to better data quality [27,28]. The use of the same methodological protocol in all regions of Brazil, including the population of adolescents and young adults, is another strength of this study. The generalization of the results must be cautious since the rural area was not included in EBANS.

CONCLUSION

It is concluded that a significant portion of the population studied is at nutritional risk for calcium, magnesium, and sodium. The identification of factors associated with the intake of minerals by Brazilian adolescents and young adults contributes to a greater understanding of the investigated topic; and may contribute to the review of national public policies, both those related to inadequacies in nutrient intake and those related to lifestyle, encouraging the adoption of healthier habits by adolescents and young adults.

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CONTRIBUTORS

APWT DEL'ARCO was responsible for the data analysis and interpretation; manuscript writing; review and approval of the final version. AN PREVIDELLI was responsible for the data collection; statistical analysis; review and approval of the final version. G FERRARI contributed to the interpretation of data; review and approval of the final version. M FISBERG contributed to the conception, design, project planning; review and approval of the final version.