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Dietary patterns among adolescents and associated factors: longitudinal study on sedentary behavior, physical activity, diet and adolescent health

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Abstract *The aim of the present study was to identify dietary patterns and associations with socioeconomic characteristics, lifestyle, nutritional status, lipid profile and inflammatory profile in adolescents. A cross-sectional study was conducted with a probabilistic sample using baseline data (2014) from the Longitudinal Study on Sedentary Behavior, Physical Activity, Eating Habits and Adolescent Health. A total of 1,438 adolescents (10 to 14 years old) from public schools in the city of João Pessoa, Brazil, participated in the study. Data were collected on socioeconomic characteristics, nutritional status, lifestyle and the results of biochemical tests. Dietary data were obtained using the 24-hour recall method and dietary patterns were identified by exploratory factor analysis. Associations of interest were estimated using multiple logistic regression. Three dietary patterns were found: "Traditional", "Snacks" and "Western". These patterns were associated with age, socioeconomic status, parental education and lifestyle. The "Traditional" pattern was associated lower adiposity and a better lipid profile. However, with the increase in age, greater frequencies of the "Snacks" and "Western" patterns were found. The present findings underscore the need for strategies that encourage healthy behaviors.*

Key words *Dietary patterns, Adolescents, Socioeconomic status, Lifestyle, Nutritional status*

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Introduction

Epidemiological studies on nutrition in Brazil have traditionally focused on food and nutrient intake in an isolated manner. However, investigations of eating patterns may be more advantageous, as foods are analyzed simultaneously in this approach, considering complex combinations of nutrients[1-4], and facilitating the description of the effects of diet on health and disease outcomes[5,6]. Moreover, dietary patterns are influenced by socioeconomic, demographic, cultural, psychological and lifestyle issues, with healthier patterns found in the female sex, older individuals and those with more schooling[7-11].

Adolescence is a phase marked by physical and emotional changes as well as the development of greater autonomy and is therefore considered decisive to the establishment of habits and behaviors that exert an influence on health[12]. The eating habits Brazilian adolescents are characterized by a high intake of energy-dense foods rich in fats and sugar and poor in fiber[13-17].

This type of behavior can lead to excess weight and the development of chronic non-communicable diseases (NCDs). Studies have shown that eating habits established in adolescence are related to the development of health problems that can persist into adulthood[18,19], affecting morbidity and mortality rates[20-22]. Therefore, the identification of eating patterns among adolescents is of considerable importance to public health, enabling the development of strategies aimed at changing dietary habits in this group to reduce the risk of obesity and the occurrence of NCDs[23,24]. However, few Brazilian studies have identified the dietary patterns of adolescents and associations with different factors, such as markers of cardiometabolic risk[25].

The aim of the present study was to identify dietary patterns and associations with socioeconomic characteristics, lifestyle, nutritional status, the lipid profile and inflammatory profile in adolescents in the city of João Pessoa, Northeastern Brazil.

Methods

Sample

In this study, we used data from the baseline (2014) of the *Estudo Longitudinal sobre Comportamento Sedentário, Atividade Física, Alimentação e Saúde dos Adolescentes* (LONCAAFS [Longitudinal Study on Sedentary Behavior, Physical Activity, Eating Habits and Adolescent Health]) conducted with a representative sample of adolescents in the 6th year of public schools in the city of João Pessoa. The aim of the LONCAAFS study is to analyze interrelations between sedentary behavior, physical activity, diet and health among adolescents.

The sample size was calculated considering a reference population of 9520 6th grade students enrolled at public schools in the city in the year 2011, a 50% prevalence rate of the outcome, 4% rate of error, a 95% confidence interval and a design effect of 2. The minimum sample size was established to be 1,130 adolescents, but the sample was increased by 40% to compensate for possible refusals and dropouts, resulting in a total of 1,582 adolescents.

Twenty-eight schools (14 municipal schools and 14 state-run schools) were systematically selected to compose the sample. The schools were distributed proportionally to number of students enrolled in the 6th grade and geographic region (North, South, East and West). All 6th grade students at the selected schools were invited to participate in the study.

Among the 28 schools selected to compose the sample, 17 were randomly chosen based on the same selection criteria to compose a subsample for the biochemical exams. This decision was made for reasons of logistics. The subsample had the same representativeness of the population regarding the distribution of schools by type and region of the city.

The exclusion criteria for the LONCAAFS study were adolescents outside the age range of interest (<10 and >14 years of age), any physical or intellectual limitation that would impede or hinder answering the questionnaire and currently being pregnant. For the present study, adolescents who did not undergo anthropometric measurements or did not do the 24-hour recall (24hR) were also excluded.

Data collection

Data collection was performed between February and December 2014 during school hours by a trained team composed of university students as well as professionals in the fields of nutrition and physical education. Sociodemographic variables, sedentary behavior and the practice of physical activity were obtained using a questionnaire administered in interview format. Average application time was 50 minutes.

Information on food intake was collected using the 24hR method administered by nutritionists and students of the nutrition course. The adolescents provided information on all foods and beverages consumed in the previous 24 hours, how meals were prepared, the commercial brands of processed foods, weight and portion size. The 24hR data were tabulated using the Virtual Nutri Plus software program, which was chosen based on the need to use information on Brazilian foods and the ease of entering foods, meals and nutritional information. A second 24hR was applied to 30% of the total sample to estimate intrapersonal variability and increase the precision of the estimate of dietary intake[26].

The foods were first grouped into 29 categories and then regrouped into 14 categories based on correlations and/or similarities regarding nutritional composition. Items on the 24hR consumed by less than 5% of the population were excluded from the analysis.

The following sociodemographic variables were collected: sex (male and female), age in completed years (difference between the collection data and birthdate), skin color (white and non-white), mother's and father's schooling (incomplete primary school, incomplete high school and complete high school or more) and economic class (based on the criteria of the Brazilian Association of Research Firms[27], which consider the presence of material goods, a live-in housekeeper and schooling of the parents, grouping individuals in the following classes: A, B, C, D and E).

Sedentary behavior ("screen time") was determined based on the average time spent watching television, using a computer or tablet and playing videogames on weekdays and weekends (considered separately). For the purposes of analysis, the arithmetic mean was calculated by multiplying the average time on weekdays by five and the average time on weekends by two, adding these figures and then dividing by seven to obtain the mean number of hours per day dedicated to sedentary behavior. A cutoff point of more than two hours a day was used to define excessive screen time (sedentary behavior)[28].

The level of physical activity was measured using the Physical Activity Questionnaire for Adolescents[29]. Based on a checklist of 19 physical activities of moderate to vigorous intensity plus active movement from place to place, the adolescents reported practicing or not practicing each activity for at least 10 minutes in the previous week. They also reported the frequency and duration of each activity practiced. The physical activity score was estimated in minutes per week based on the sum of the time spent per week practicing all activities. The adolescents were classified as physically active when practicing 300 minutes or more of physical activity per week[30].

Body mass and height were measured in triplicate always by the same examiner and the mean was considered in the analysis. Body mass was determined on a digital scale (Techline) with a precision of 100 grams. Height was determined using a portable stadiometer (Sanny). The body mass index (BMI) was classified using the guidelines of the World Health Organization considering sex and age. BMI was then categorized as without excess body weight and with excess body weight[31]. The waist-to-height ratio was calculated using waist circumference (cm) measured at the midpoint between the last rib and the iliac crest divided by height (cm). The median of the population was used as the cutoff point for the classification of the adolescents[32].

For the evaluation of the lipid and inflammatory profiles, blood was collected after 12 hours of fasting. Blood was collected at the schools after taking patient histories to identify factors that may interfere with the biochemical analyses (use of medications, allergies, having failed to fast for 10 to 12 hours and the practice of vigorous physical activity). The collections were performed by nursing technicians with experience in collecting blood from children and adolescents.

Concentrations of triglycerides, total cholesterol and high-density lipoprotein (HDL) cholesterol were determined by turbidimetry using the Labmax 240 Premium automated biochemical analyzer (Labtest, Lagoa Santa, Brazil). Low-density lipoprotein (LDL) cholesterol was determined using the Friedwald equation considering the concentrations of HDL, VLDL and total cholesterol ([total cholesterol - HDL cholesterol] - [triglycerides/5]). The classification of lipid profile markers as normal or altered was based on the reference cutoff points for children and adolescents stipulated in the updated Brazilian Guidelines of Dyslipidemia and the Prevention of Atherosclerosis[33]. Triglycerides were considered altered when higher than 90 mg/dL. Total cholesterol was considered altered when higher than 170 mg/dL. LDL was considered altered when higher than 170 mg/dL and HDL was considered altered when lower than 45 mg/dL.

The inflammation profile was evaluated considering the serum concentration of C-reactive protein (CRP), which was determined using ultrasensitive ELISA. Serum CRP is considered

a predictor of cardiovascular events and is frequently used in studies involving adolescents[34-36]. CRP was classified using the values stipulated in the updated Brazilian Guidelines of Dyslipidemia and the Prevention of Atherosclerosis[33]: CRP≤1 mg/L=low risk; CRP>1 mg/L and ≤2 mg/L=medium risk; and CRP>2 mg/L=high risk.

Statistical analyses

The data were tabulated using the EpiData 3.1 program (Epidata Assoc., Odense, Denmark), with double-entry and the automatic checking of consistency and the response range of the variables.

To identify dietary patterns, principal component factor analysis was performed considering the 14 food categories. The habitual consumption of the food categories was estimated using the multiple source method (MSM), which estimate dietary data based on intrapersonal variability. The adequacy of the data from the factor analysis was checked using the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity[37]. To identify the number of patterns to be retained, we used eigenvalues (value higher than 1.0), a scree plot and the interpretability of the patterns[37]. Varimax orthogonal rotation was used to facilitate the interpretation of the findings. Factor loadings higher than 0.30 were considered for naming the patterns encountered[37]. The naming of the patterns was based on the interpretability and characteristics of the items retained in each pattern.

The Shapiro-Wilk test was used to determine the normality of the data. The Student's t-test and ANOVA were used to compare the mean score of the patterns according sociodemographic characteristics (sex, age group, time of classes [morning or afternoon], type of school [municipal or state-run], region of the city, skin color, economic class and parents' schooling). The chi-square test was used to compare the proportion of adolescents in different strata of nutritional status, level of physical activity, sedentary behavior, lipid profile and inflammatory profile according to dietary patterns.

To analyze associations between dietary patterns and the characteristics of the adolescents, the tertiles of the pattern scores were determined and dichotomized; the third tertile indicated greater adherence to a given pattern and the other tertiles were considered the reference category. Logistic regression analysis was performed to evaluate the associations of interest. In the adjusted model, variables were selected using the stepwise method. The goodness-of-fit of the model was checked using the Hosmer-Lemeshow test. The level of significance was set to 5% ($p<0.05$) for all tests. All analyses were performed using the Stata 13.0 program (StataCorp LP, College Station, USA).

Ethical aspects

The LONCAAFS study received approval from the Human Research Ethics Committee of the Center for Health Sciences of the Federal University of Paraíba. The volunteers and their legal guardians received clarifications regarding the objectives of the study and signed a statement of informed consent. The present study received approval from the Human Research Ethics Committee of the School of Public Health of the University of São Paulo.

Results

The final sample was composed of 1,438 adolescents, 53% of whom were girls and 44% were 11 years of age. Most declared themselves non-white (81%) and belonged to economic class C (58%). Approximately 32% were classified with excess weight. One-third (33%) was classified as physically inactive and 77% were classified as having sedentary behavior.

Three eating patterns were found. The first was denominated "Traditional", which was characterized by high positive factor loadings for the group of base foods (rice, corn-based couscous and tubers), beans and meat as well as a negative factor loading for soup. The second group was denominated "Snacks", which was characterized by processed meats, butter, margarine, bread, crackers, cheese, coffee and tea. The third group was denominated "Western", which was characterized by sweets, pastries and chips/crisps, sweetened beverages and cheese (Table 1).

The "Traditional" pattern was more frequent among boys and students at schools located in the southern and western portions of the city of João Pessoa. The "Snacks" pattern was more frequent among boys, individuals between 12 and 14 years of age, students at schools in the southern and western portions of the city, those who studied in the afternoon, those whose mother's had a lower level of schooling, those in economic classes C and D and physically active individuals. The "Western" pattern was more frequent among

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white adolescents, those whose fathers had a higher level of schooling, those in the highest economic classes (A e B), those classified as physically active and those with more than two hours of sedentary behavior per day (Table 2).

The majority of adolescents with adiposity (waist/height ratio) below the median was in the third tertile of the "Traditional" pattern, demonstrating greater adherence to this pattern (p=0.05). Likewise, the majority of adolescents with LDL in the normal range was in the third tertile of this same pattern (p=0.03) (Table 3).

The "Traditional" pattern was positively associated with age between 12 and 14 years (OR=1.44; 95%CI: 1.07 to 1.94) and inversely associated with the female sex (OR=0.65; 95%CI: 0.48 to 0.87), adiposity above the median for the population (OR=0.61; 95%CI: 0.45 to 0.82) and altered LDL (OR=0.71; 95%CI: 0.51 to 0.98) (Table 4).

The "Snacks" pattern was positively associated with age between 12 and 14 years (OR=1.64; 95%CI: 1.29 to 2.08), economic class C (OR=1.39; 95%CI: 1.08 to 1.80) and economic class D/E (OR=2.62; 95%CI: 1.52 to 4.53). This pattern was also inversely associated with the female sex (OR=0.60; 95%CI: 0.47 to 0.77) (Table 4).

The "Western" pattern was positively associated with age between 12 and 14 years (OR=1.53; 95%CI: 1.15 to 2.03) and adolescents whose fathers had a complete high school education or higher (OR=1.89; 95%CI: 1.37 to 2.60). Moreover, this pattern was inversely associated with adolescents with excess weight (OR=0.76; 95%CI: 0.41 to 0.99) and those classified as physically inactive (OR=0.67; 95%CI: 0.49 to 0.92) (Table 4).

Discussion

In the present study, we identified three dietary patterns among adolescent students in the city of João Pessoa, denominated "Traditional", "Snacks" and "Western". The "Traditional" pattern was composed of foods from the traditional diet of northeastern Brazil, such as rice, beans, cassava and corn-based couscous. The "Snacks" pattern was characterized by the consumption of bread, butter, margarine, cheese, processed meats and coffee and the "Western" pattern was characterized by the consumption of energy-dense, nutrient-poor foods.

In agreement with both national[13,38] and international[39-42] studies, the present investigation found that the diet of adolescents is increasingly composed of foods with a high energy value rich in sugar, fat and salt and with a low nutritional value, such as sweets, desserts, ice creams, cookies, crackers, cakes, torts, sweetened beverages,

Table 1. Dietary patterns of adolescents in João Pessoa, Brazil, 2014.

Groups	2014		
	Traditional pattern	Snacks pattern	Western pattern
Basic foods	0.73	0.03	0.01
Meats	0.72	-0.04	0.09
Beans	0.55	0.16	0.08
Sweetened beverages	0.16	0.07	0.75
Coffee and tea	0.16	0.51	-0.30
Butter and margarine	0.10	0.54	-0.23
Fruits, legumes and vegetables	0.08	-0.08	0.14
Sweets	0.05	-0.08	0.52
Bread, toast and grains	0.01	0.83	0.09
Dairy products	-0.02	0.03	0.17
Cheese	-0.06	0.46	0.35
Processed meats	-0.24	0.34	0.24
Pastries and chips/crisps	-0.27	-0.16	0.42
Soup	-0.34	-0.05	-0.18

KMO=0.57. Variance explained=0.35.

Source: Elaborated by the authors.

Table 2. Scores of dietary patterns according to sociodemographic characteristics, sedentary behavior and physical activity among adolescents in João Pessoa, Brazil, 2014.

Variables	N (%)	Pattern 1 score (Traditional)	p	Pattern 2 score (Snacks)	p	Pattern 3 score (Western)	p
Sociodemographic							
Sex							
Male	660 (47.0)	0.099	0.00	0.137	0.00	0.056	0.06
Female	746 (53.0)	-0.096		-0.128		-0.048	
Age							
10	162 (11.3)	-0.039	0.39	-0.110	0.00	-0.120	0.25
11	624 (44.4)	-0.052		-0.112		-0.039	
12	354 (25.4)	0.043		0.017		0.068	
13	185 (13.3)	0.074		0.228		0.082	
14	81 (5.6)	0.022		0.420		0.064	
Type of school							
State-run	657 (45.7)	-0.017	0.55	-0.001	0.60	0.026	0.33
Municipal	781 (54.3)	0.003		-0.011		-0.022	
Region of city							
North	349 (24.3)	-0.028	0.04	-0.130	0.01	0.064	0.11
South	613 (42.6)	0.016		0.085		0.032	
East	148 (10.3)	-0.216		-0.168		-0.099	
West	328 (22.8)	0.072		0.031		-0.082	
Class hours							
Morning	581 (40.4)	0.003	0.48	-0.048	0.04	-0.039	0.30
Afternoon	801 (55.7)	0.001		0.038		0.038	
Full time	56 (3.9)	-0.206		-0.202		-0.137	
Skin color							
White	271 (19.0)	-0.095	0.11	-0.019	0.95	0.095	0.04
Non-white	1160 (81.0)	0.019		-0.002		-0.026	
Mother's schooling							
Incomplete primary school	483 (40.6)	0.073	0.18	0.059	0.04	-0.052	0.47
Incomplete high school	339 (28.5)	0.016		-0.042		0.045	
Complete high school or +	368 (30.9)	-0.040		-0.102		0.060	
Father's schooling							
Incomplete primary school	426 (45.7)	0.083	0.07	0.006	0.23	-0.061	0.01
Incomplete high school	216 (23.2)	-0.053		0.068		0.028	
Complete high school or +	290 (31.1)	-0.084		-0.084		0.152	
Economic class							
A	7 (0.5)	0.202	0.37	-0.083	0.02	0.692	0.00
B	460 (36.4)	-0.042		-0.129		0.108	
C	734 (58.1)	0.024		0.049		-0.031	
D	61 (4.8)	0.234		0.180		-0.275	
E	2 (0.2)	0.014		-0.486		-1.430	
Atividade Física							
Physical activity							
Active	962 (67.0)	0.017	0.34	0.051	0.01	0.085	0.00
Inactive	475 (33.0)	-0.053		-0.124		-0.171	
Sedentary behavior							
No	325 (22.2)	-0.013	0.53	-0.078	0.09	-0.198	0.00
Yes	1142 (77.8)	0.004		0.024		0.055	

Source: Elaborated by the authors.

Table 3. Tertiles of dietary patterns according to nutritional status, adiposity, lipid profile and inflammatory marker among adolescents in João Pessoa, Brazil, 2014.

Variable	N (%)	Pattern 1 (Traditional)			p	Pattern 2 (Snacks)			p	Pattern 3 (Western)			p
		T1	T2	T3		T1	T2	T3		T1	T2	T3	
Nutritional status													
Underweight	36 (2.5)	27.8	30.5	41.7	0.75	30.5	30.6	38.9	0.44	30.6	33.3	36.1	0.10
Ideal range	933 (65.4)	33.6	33.1	33.3		32.1	34.5	33.4		32.6	31.4	36.0	
Overweight	268 (18.8)	31.4	36.4	32.2		39.1	29.1	31.8		33.3	38.0	28.7	
Obesity	189 (13.3)	36.9	33.0	30.1		33.5	35.2	31.3		38.0	35.7	26.3	
Adiposity													
Normal	716 (48.8)	32.8	30.9	36.3	0.05	32.2	32.4	35.4	0.26	31.5	32.5	36.0	0.09
Above	751 (51.2)	33.9	35.6	30.5		34.4	34.3	31.3		35.2	34.1	30.7	
Total cholesterol													
Normal	541 (67.0)	33.0	30.8	36.2	0.12	36.6	31.4	32.0	0.48	31.2	33.5	35.3	0.12
Altered	266 (33.0)	33.7	36.8	29.5		39.8	32.2	28.0		37.9	32.6	29.5	
LDL													
Normal	551 (68.3)	32.5	30.7	36.8	0.03	36.6	31.4	32.0	0.47	31.6	33.6	34.8	0.23
Altered	256 (31.7)	34.7	37.5	27.8		39.9	32.3	27.8		37.5	32.3	30.2	
HDL													
Normal	303 (37.5)	34.0	31.3	34.7	0.77	39.1	33.3	27.6	0.342	32.3	32.3	35.4	0.64
Altered	504 (62.5)	32.7	33.7	33.5		36.8	30.7	32.5		34.2	33.7	32.1	
Triglycerides													
Normal	533 (66.2)	34.7	31.4	33.9	0.37	38.2	32.8	29.0	0.350	32.7	34.5	32.8	0.60
Altered	272 (33.8)	30.2	35.5	34.3		36.6	29.5	33.9		34.7	31.0	34.3	
CRP													
Low risk	244 (30.4)	29.7	34.7	35.6	0.06	33.5	35.2	31.3	0.381	28.4	31.4	40.2	0.07
Medium risk	149 (18.6)	34.0	24.5	41.5		35.4	30.6	34.0		37.4	34.0	28.6	
High risk	409 (51.0)	34.7	34.7	30.6		40.5	30.4	29.1		35.4	33.9	30.6	

Source: Elaborated by the authors.

snacks in general and chips/crisps. These findings are worrisome, as this dietary profile combined with low levels of physical activity and considerable time spent on sedentary activities contribute directly to the development of NCDs, which can emerge in adolescence and persist in adulthood[43,44].

The proportion of adolescents with a sedentary behavior was high and this behavior was positively associated with the "Western" dietary pattern. This result is in agreement with data from previous studies that report an association between this behavior and the consumption of foods belonging to the "Western" pattern[45-50]. One explanation for this result may be the fact that adolescents are exposed to an increasing number of advertisements that stimulate the consumption of foods rich in fat, sugar and salt[51,52], leading to the consumption of these products during "Screen" activities, such as watching television[47-49].

Although the prevalence of excess weight was high in the population of the present study (32%), nutritional status evaluated based on the BMI was not significantly associated with any of the dietary patterns, which is in line with data reported in a systematic review study[53]. Moreover, adiposity above the median was inversely associated with both the "Traditional" and "Western" patterns, which is in disagreement with data reported in previous studies[54,55]. These results may be explained by reverse causality, which is common among cross-sectional studies[56,57], as well as possible under-reporting on the part of the adolescents with excess weight, who may have stated consuming smaller amounts than they actually consumed. This is one of the main limitations of the dietary assessment method employed[58,59].

Although several studies have found a positive association between a dietary pattern similar to the "Western" pattern and serum levels of LDL in adolescents[60,61], no such association was

Table 4. Dietary patterns and associated factors among adolescents in João Pessoa, Brazil, 2014.

Variables	Traditional pattern OR	95%CI	Snacks pattern OR	95%CI	Western pattern OR	95%CI
Sex						
Male	1.00	0.48 - 087	1.00	0.47 - 0.77	1.00	0.73 - 1.29
Female	0.65		0.60		0.97	
Age						
10-11	1.00	1.07 - 1.94	1.00	1.29 - 2.08	1.00	1.15 - 2.03
12-14	1.44		1.64		1.53	
Mother's schooling						
Incomplete primary school	*	*	*	*	1.00	
Incomplete high school					1.14	0.80 - 1.62
Complete high school or +					1.89	1.37 - 2.60
Economic class						
A/B	*	*	1.00		*	*
C			1.39	1.08 - 1.80		
D/E			2.62	1.52 - 4.53		
Physical activity						
Active	*	*	1.00	0.62 - 1.06	1.00	0.49 - 0.92
Inactive			0.82		0.67	
Adiposity						
Normal	1.00	0.45 - 0.82	*	*	1.00	0.58 - 0.99
Above	0.61				0.76	
Serum LDL						
Normal	1.00	0.51 - 0.98	*	*	*	*
Altered	0.71					

Traditional pattern: model adjusted by sex, age, adiposity and serum LDL; Snacks pattern: model adjusted by sex, age, economic class and physical activity; Western pattern: model adjusted by sex, age, father's schooling, physical activity and adiposity. *Variable not incorporated into adjustment of model.

Source: Elaborated by the authors.

found in the present investigation. However, an altered LDL level was inversely associated with the "Traditional" pattern. A probable hypothesis for this finding is related to the high fiber content in some of the foods that compose the "traditional" pattern, such as beans, corn-based couscous, roots and tubers[62].

With the increase in age, adolescents become more autonomous and independent with regards to their food choices. However, this greater autonomy is generally associated with inadequate dietary behavior[63,64]. The present results confirm this, as adolescents between 12 and 14 years of age had a 52% and 49% greater chance of adhering to the "Snacks" and "Western" patterns, respectively.

According to the United Nations, health disparities among adolescents are related to socioeconomic inequalities in different countries of the world, including Brazil[65]. The schooling and, consequently, income levels of parents are factors that exert an influence on the dietary pattern to which adolescents adhere[8,66]. In the present study, economic level was positively associated with the "Western" pattern, which was more frequent among 12-to-14-year-old adolescents whose fathers were in the highest stratum for schooling. This result is similar to data described in Brazilian studies[9,23], which report greater consumption of junk food (similar to the "Western" pattern) among adolescents from families with a higher socioeconomic status.

Regarding economic level, the lower economic classes were positively associated with the "Snacks" pattern. A school-based study conducted in the city of Cuiabá, Brazil[9], also found an association between a lower socioeconomic status and greater adherence to a dietary pattern with the same foods as those pertaining to the "Snacks" pattern in the present study. This association may be due to a less varied diet, indicating less availability of and access to a variety of foods[67].

The fact that students at schools in the southern and western portions of the city adhered more to the "Traditional" and "Snacks" patterns may be explained by the fact that the Northern and Eastern regions are higher income areas with a higher human development index when the heads of families have higher schooling, whereas lower mean values are found for these indicators in the southern and western portions. These results are in disagreement with findings from a Brazilian study that used data from the 2009 National Student Health Survey, which reported a negative correlation between the human development index and a dietary pattern composed of sweetened carbonated beverages, cakes and cookies/crackers[68].

Adolescents who studied in the afternoon adhered more to the "Snacks" pattern compared to those who studied in the morning and those who studied full time. This association may be due to the fact that adolescents who study in the afternoon (generally between 1 and 6 pm) tend to have breakfast later, which may affect their appetite at lunchtime, preferring to consume foods outside the home, which favors the choice of convenience foods, such as those that compose the "Snacks" and "Western" patterns[9,69].

The results of the present study reflect the nutritional transition that has been occurring in recent decades in Brazil. This process involves a set of changes in nutritional patterns resulting from changes in the structure of the diet, which are associated with social, economic, demographic and health-related changes[70,71]. Thus, diet in adolescence merits attention, as inadequate eating habits established in this phase of life can have immediate harmful effects, such as physical and psychosocial alterations, as well as long-term effects, such as the development of NCDs in adulthood.

The present study has limitations that should be considered. Although the LONCAAFS study has a longitudinal design, we only analyzed baseline data, exploring associations between variables in a cross-sectional analysis. It was therefore not possible to determine causal relations. Despite being the most widely used technique for deriving dietary patterns, factor analysis involves arbitrary decision making, even though it is the basis of scientific knowledge on the diet of the population studied. Thus, the patterns identified are specific to the population studied and comparisons to different populations are limited. The food intake assessment method based on self-reports is also subject to recall bias and under-reporting.

Conclusion

The analysis of dietary patterns in the present study enabled a global assessment of diet, contributing knowledge on the dietary patterns of the adolescents. The results indicate that the dietary patterns of adolescents are associated with several factors, especially age, socioeconomic status, parents' schooling and lifestyle. The "Traditional" pattern seems to have a protective effect regarding adiposity and LDL levels. However, the increase in age was associated with greater adherence to the "Snacks" and "Western" patterns. It is therefore important for all adolescents to be the focus of strategies that encourage healthy behaviors by broadening knowledge on nutrition as well as a healthy diet and lifestyle in the school and family settings.

Collaborations

ACP Arruda Neta substantially participated in the conception and design of this work, collecting, analyzing and interpreting data, as well as writing the manuscript. J Steluti participated in the conception and design of this work, analyzing and interpreting data, as well as writing the manuscript. FELL Ferreira participated in the conception and design of this work, collecting and revising the manuscript. JC Farias Junior participated in the conception and design of this work, collecting and revising the manuscript. DML Marchioni substantially participated in the conception and design of this work, analyzing and interpreting data, as well as writing the manuscript.

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