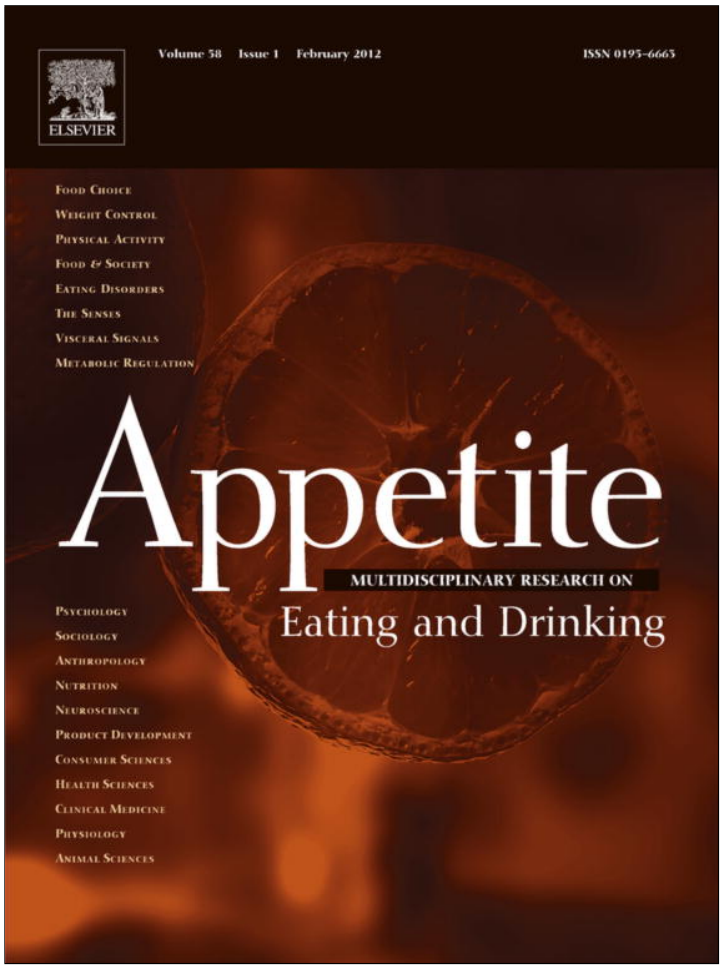

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Research report

Understanding the correlates of adolescents' dietary intake patterns. A multivariate analysis

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ABSTRACT

We investigated dietary intake patterns (DIP) in adolescents (14–18 year-olds) and the association with demographic and socioeconomic characteristics and lifestyle variables. This school-based survey was carried out among high school students from the city of Maringá in the state of Paraná (PR), Brazil (2007). The sample included 991 students (54.5% girls) from high schools. DIPs were investigated by the frequency of weekly consumption of each food group: vegetables, fruit, rice, beans, fried food, sweet food, milk, soda, meat, eggs, alcoholic drinks. Independent variables were: demographic and socioeconomic characteristics and lifestyle variables. DIPs were identified using principal component analysis with orthogonal rotation (varimax). Three components were extracted. Component 1 (fried foods, sweets and soft drinks) was positively associated with not having breakfast for girls and dinner for boys. Moreover, component 2 (consumption of fruit and vegetables) was positively associated with having breakfast at home for boys and number of meals for girls. Component 3 (beans, eggs and meat) was positively associated with having lunch, employment and sedentary behavior level for girls. However, it was negatively associated with having lunch and dinner for boys. Adolescents who have healthier eating patterns also had other healthier behaviors regardless of gender. However, factors associated with dietary patterns differ between boys and girls.

Introduction

It is well known that there is a relationship between eating habits and the development of several non-communicable diseases (Popkin, 2001; Yach, Hawkes, Gould, & Hofman, 2004). A healthy eating pattern in adolescence can prevent the incidence of such diseases in adulthood (Twisk, Kemper, Van Mechelen, & Post, 2001).

However, several studies suggest that adolescents have developed poor eating habits in recent decades (Kourlaba et al., 2009; Prochnik Estima, da Costa, Sichieri, Pereira, & da Veiga, 2009; Song, Park, Paik, & Joung, 2010). It is therefore important to determine the factors underlying such behavior in order to develop and implement strategies to improve diet. Recent studies have found that eating behavior is a function of individual and environmental influences such as age, gender (Pedrozo et al., 2008), anthropometric variables (Prochnik Estima et al., 2009), food preferences (Nago et al., 2010), lifestyle (Vereecken et al., 2009), parental influences (Pearson, Atkin, Biddle, Gorely, & Edwardson, 2009) and socioeconomic level (Kourlaba et al., 2009).

The low-income and middle-income countries are in the process of nutritional transition. In Brazil (Sichieri, Chiuve, Pereira, Lopes, & Willett, 2010) and other Latin American countries (Rivera, Barquera, González-Cossío, Olaiz, & Sepúlveda, 2004), there are data for adults showing a reduction in the consumption of cereals, legumes, roots and tubers and increased consumption of the ultra-processed foods. Dietary pattern analysis has now emerged as an approach to evaluate the association between diet and health outcomes, rather than the analysis of individual nutrients or food items. Principal component analysis (PCA) has been used as a statistical technique to evaluate dietary patterns (Kourlaba et al., 2009; Northstone & Emmett, 2008; Romaguera et al., 2008). The aim of this study is to investigate the dietary intake patterns (DIP) of Brazilian adolescents (14–18 year-olds) and their relationship with socio-economic and lifestyle characteristics.

Methods

The present study was carried out in the city of Maringá, located in the northwest of Paraná state (PR), Southern Brazil, which has a

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population of approximately 330,000 (51,428 adolescents, 50.1% female). The city presents a high Human Development Index (HDI = 0.84, above the score for Brazil of HDI = 0.79) (UN, 2007). The fieldwork started in August and ended in October, 2007 (from the end of winter to the beginning of spring). The schools involved in this study were classified into two groups. Public schools were defined as those funded by the national government. Private schools were defined as not being funded by the national government. A cross-sectional school-based survey was then designed to assess the health status of a representative sample of adolescents.

A formal request to conduct this survey was sent to and subsequently accepted by the school boards of several schools in the city. This study was also approved by the Ethics Committee in Research involving Human Participants of the University Center of Maringá and authorized by the Ethics Committee in Research Projects of the University of São Paulo in accordance with Brazilian laws.

Sample size

The complete methodology of this study has been described in an earlier study (de Moraes, Delaporte, Molena-Fernandes, & Falcão, 2011). Briefly, the population included 14–18 year-old adolescents of both sexes who were enrolled in public or private high schools in Maringá, PR in 2007. The populations of both public and private schools were included in the sampling process; data were obtained from the State Department of Education of Paraná and the Union of Private Schools of Maringá/PR (Secretaria de Estado Educação do Paraná, 2007).

Sample size calculations were performed. Parameters included a confidence interval of 95%, a power of 80%, a 50% prevalence as most the expected outcome with a margin of error of 5 percentage points and a design effect of 2, since it is considered a complex sample size. Based on these parameters, it was estimated that data from at least 734 adolescents would have to be collected. Because this study was part of a larger health survey including other outcomes requiring larger samples, an extra 10% for possible losses and refusals and an extra 15% for multivariate analysis were added, resulting in a minimum requirement of 918 subjects. This sample size allowed the detection of a prevalence ratio of 1.2 to be statistically significant at 5%, with 80% power for 50% prevalence exposure by age.

The sample was obtained via a classroom selection process divided into two stages: by school categories (primary sampling unit) and by classes. Schools were classified into two categories: public and private. In the first stage, in which eight public and four private schools were selected, schools were randomly selected with respect to the proportional probability of population in each high school stratum. In the second stage, classes were selected by simple random sampling; their number was proportional to the population of students in each grade (10th through the 12th grade).

Data collection

Data were collected in the classroom by a team of four interviewers who were trained for a period of 40 h prior to data collection by author ACdeM to standardize the questionnaires and anthropometric assessments. Two pilot studies, 1 week apart, were then performed for this training at schools that were not part of the final sample. These pilot studies were carried out with the following objectives: (a) to perform a final test of the questionnaire; (b) to organize field data collection; (c) to evaluate the performance of each interviewer in real data collection situations.

Dietary intake patterns (DIPs)

DIPs were verified by using a food consumption frequency questionnaire recommended by WHO for epidemiology research in adolescents (World Health Organization, 2004). The questionnaire was translated and modified for Brazilian dietary habits (Government, 2007), after being submitted for a reliability study among Brazilian adolescent students (Romanzini, Reichert, Lopes, Petroski, & de Farias Júnior, 2008). For example, the question "How often do you usually ingest fruit in a habitual week?" assessed fruit consumption. No specific amount was recorded, therefore only data collected were used to assess the frequency of weekly consumption of each food group. The food groups assessed were: vegetables, fruit, rice, beans, fried food, sweet food (i.e. energy-dense foods such as candies and chocolate), milk and milk products, soda, meat, eggs, and alcoholic drinks. According to the frequency of weekly consumption, food groups were assigned scores: 7 d/week = 4; 5–6 d/week = 3; 4–3 d/week = 2; 1–2 d/week = 1; no consumption = 0. In this study, we used the Kappa coefficient to verify the agreement and reproducibility of the questionnaire. Results observed were high (vegetables: $k = 0.83$; fruit: $k = 0.85$ rice: $k = 0.75$; beans: $k = 0.87$; fried food: 0.92; sweet food: 0.91; milk and milk products: $k = 0.76$; soda: $k = 0.82$; meat: $k = 0.93$; eggs: $k = 0.90$ and alcoholic drinks: $k = 0.95$).

Independent variables

Independent variables included in this study were: age, socioeconomic level (Brazil Criterion of Economic Classification (ABEP, 2006), which divides families into five income groups, where "A" is the wealthiest and "E" the poorest taking into consideration – among other aspects – consumer goods available at home), whether the mother is employed (yes or no), whether the adolescent is employed (yes or no), living with parents (yes or no – including grandparents, alone, hostel, husband and/or wife), eating behavior [number of makes meals; number of meals at home; which makes meals at home; on diet (no performing diet; yes, for loss weight; yes, for increase weight)], smoking habits (those who reported smoking at least one cigarette in a typical week were considered to be smokers), physical activity level (min/d, physical activity data collected by questionnaire for adolescents (Arvidsson, Slinde, & Hulthèn, 2005)), insufficient physical activity (was defined as <300 min/week of moderate to vigorous-intensity physical activity practice (Strong et al., 2005)), sedentary behavior (h/d spent in front of the television/computer/games) and waist circumference (WC) (measured in cm with a non-elastic metal tape at the midpoint between the lowest rib cage and the top of the iliac crest, with the average of two measurements recorded (World Health Organization, 1995)).

Statistical analysis

The PCA was used to identify the dietary patterns. This technique is necessary to explain variables in terms of smaller number of factors or components which usually account for the variance of more than one variable (Norman & Streiner, 2003). From the entire database, eleven food groups were entered into factors or components retained through the Kaiser criterion, i.e. eigenvalues >1, confirmed by a 'knee' in the scree plot. An orthogonal rotation (varimax) was used and loadings factors $\geqslant 0.4$ were necessary to identify whether a food group was contributing in a component and then it was named according to foods entered. Scores of each component were used as outcomes.

The multiple linear regression models were fitted to assess the relationship between each component obtained through the principal component analysis and independent variables. The *p*-values

Table 1
Prevalence (%) or median for independent variables in relation to gender among adolescents. Maringá – Brazil (2007).

Variables	Gender				p-value
	Girls (n = 540)		Boys (n = 451)		
	Median	%	Median	%	
Age	16		16		0.030
Socioeconomic level[a]					0.043
A (richest)		13.7		14.6	
B		50.0		55.7	
C		28.5		25.7	
D + E (poorest)		7.8		4.0	
Mother's employment		69.6		62.3	0.015
Employment		13.5		26.8	<0.001
Number of meals	3		4		0.047
Breakfast		62.2		65.4	0.299
Lunch snack		35.9		29.3	0.026
Lunch		92.4		94.2	0.254
Afternoon snack		64.6		64.1	0.857
Dinner		78.2		88.5	<0.001
Dinner snack		21.7		25.9	0.115
Number of meals in household	1		1		0.091
Breakfast in household		54.6		51.4	0.316
Lunch in household		21.5		17.1	0.081
Dinner in household		38.7		36.4	0.449
On a diet					<0.001
No		65.4		85.4	
Yes, for loss weight		32.2		11.1	
Yes, for increase weight		2.4		3.5	
Smokers		5.2		6.4	0.402
Physical activity level (min/week)	195.5		260		0.001
Waist circumference (cm)	76		78		<0.001

[a] Brazil Criterion of Economic Classification.

⩽0.20 were adopted in the univariate analysis (not shown) as necessary to include variables in the multivariate analysis and then it was entered through the forward method. Significance was adopted when p-values were <0.05 or when there was more than 10% modification in β of any variable already in the model. Moreover, homoscedasticity was graphically assessed in all regression models. The statistical software package Stata version 11.0 (Stata Corp., College Station, TX, USA) was used for all statistical calculations. All analyses were adjusted for the clustered nature of the sample using the Stata "svy" set of commands.

Results

The number of adolescents selected from samples of public and private schools was 774 and 492 students, respectively. This sample presented 275 (21.7%) lost/denials: 92 students were not present on the day of data collection (76.1% students from public schools, n = 70) and 183 failed to deliver consent or did not want to participate in the study (82% students from private schools, n = 150). Thus, the final sample consisted of 991 high school students (67.7% students from public schools, n = 671).

The sample was comprised of 55.5% girls, 6.1% students belonging to socioeconomic levels D and E, 77.2% students were classified as normal weight (non-obese) and 32.7% students with abdominal obesity. The mean age was 16.3 (standard deviation = 0.9) years.

Table 1 describes the sample according to independent variables by gender. Boys present a higher proportion of employment than girls (p < 0.001), having dinner (p < 0.001), no performing diet (p < 0.001), and also higher levels of physical activity (min/week) (p < 0.001) and waist circumference (p < 0.001). On the other hand, girls were a higher proportion of the poorest socioeconomic level (p = 0.04) and their mothers' employment was higher than that for boys (p < 0.001). Owing to these differences, analysis of association between outcomes and independent variables was stratified by sex.

Table 2
Score coefficients[a] derived from principal components analysis regarding food groups frequency of weekly consumption by adolescents (n = 991). Maringá/Brazil (2007).

	Component[b]		
Food groups	1	2	3
Fruit	−0.01	**0.63**	0.04
Vegetables	0.06	**0.66**	−0.03
Rice	**−0.40**	0.34	−0.04
Beans	0.04	0.02	**0.42**
Fried food	**0.56**	−0.01	−0.05
Sweet food	**0.50**	−0.01	0.07
Milk	−0.01	−0.01	−0.05
Soda	**0.52**	0.20	−0.04
Meat	0.039	0.04	**0.61**
Eggs	−0.06	−0.03	**0.66**
Alcoholic drinks	0.01	−0.02	0.01

[a] Higher absolute values indicate that the food group variable was consumed with more frequency.
[b] Description of the components: 1 = "junk food" pattern; 2 = "healthy food" pattern; 3 = protein food pattern.

According to the analysis of the scree plot graph, three components presented eigenvalues >1.0 and explained 49% of total PCA variation and were extracted. In Table 2 scores for three food components are described; coefficients with absolute value ⩾0.4 are shown in bold. The components were named based on food characteristic on the highest coefficient scores.

Table 3 describes coefficients from multivariate linear regression models in girls to examine the association between component scores and independent variables. For "junk food" the pattern was positively associated with number of meals and was negatively associated with breakfast and waist circumference. The "healthy food" pattern was positively associated with physical activity level (60 min/week) and number of meals. The "protein food" pattern was positively associated with lunch and employment.

Table 4 describes the coefficients from multivariable linear regression models in boys to examine the association between

Table 3
Results from multivariable linear regression analysis that evaluated the association between independent variables and dietary patterns extracted by principal components analysis in the girls adolescents (n = 540). Maringá/Brazil (2007).

Dietary pattern	Independent variables	β	CI 95%[a]	p-value
Junk food				
	Waist circumference (per 1 cm increase)	−0.18	−0.03 to −0.01	0.003
	Number of meals (per 1 meal increase)	0.26	0.16–0.37	<0.001
	Breakfast (0 = no; 1 = yes)	−0.31	−0.60 to −0.17	0.038
	Sedentary behavior (per 60 min/d)	0.03	−0.03 to 0.06	0.081
	Breakfast in household (0 = no; 1 = yes)	0.15	−0.12 to 0.42	0.282
Healthy food				
	Physical activity level (per 60 min/week)	0.04	0.03–0.05	<0.001
	Number of meals (per 1 meal increase)	0.21	0.18–0.29	<0.001
	Living with parents (0 = no; 1 = yes)	−0.30	−0.63 to −0.02	0.065
Protein food				
	Lunch (0 = no; 1 = yes)	0.40	0.06–0.74	0.020
	Employment (0 = no; 1 = yes)	0.33	0.07–0.59	0.014
	Sedentary behavior (per 60 min/d)	0.22	−0.002 to 0.51	0.080

[a] Confidence intervals of 95%.

Table 4
Results from multivariable linear regression analysis that evaluated the association between independent variables and dietary patterns extracted by principal components analysis in the boys adolescents (n = 451). Maringá/Brazil (2007).

Dietary pattern	Independent variables	β	CI 95%[a]	p-value
Junk food				
	Employment (0 = no; 1 = yes)	0.41	0.17–0.66	0.001
	Dinner (0 = no; 1 = yes)	−0.59	−0.93 to −0.24	0.001
	Afternoon snack (0 = no; 1 = yes)	0.32	0.10–0.55	0.005
	Waist circumference (per 1 cm increase)	−0.01	−0.02 to 0.01	0.062
	Mother's employment (0 = no; 1 = yes)	−0.26	−0.49 to −0.04	0.023
Healthy food				
	Breakfast in household (0 = no; 1 = yes)	−0.72	−0.83 to 0.61	<0.001
	Number of meals in household (per 1 meal increase)	−0.13	−0.20 to 0.07	<0.001
	Mother's employment (0 = no; 1 = yes)	−0.08	−0.15 to −0.04	0.039
	Lunch (0 = no; 1 = yes)	−0.19	−0.35 to −0.03	0.017
Protein food				
	Lunch (0 = no; 1 = yes)	−0.23	−0.51 to 0.05	0.111
	Dinner (0 = no; 1 = yes)	−0.28	−0.61 to 0.05	0.102
	Living with parents (0 = no; 1 = yes)	0.39	0.04–0.78	0.048

[a] Confidence intervals of 95%.

component scores and the independent variables. "Junk food" pattern was positively associated with employment and afternoon snack and was negatively associated with dinner and mother's employment. The "healthy food" pattern was positively associated with breakfast at home and negatively associated with number of meals at home, having lunch and mother employment. The "protein food" pattern was positively associated with living with parents.

In both genders, we found that adolescents who perform a weight loss diet had higher values of waist circumference (boys = 91.6 cm; girls = 81.1 cm) than adolescents who did not diet (boys = 79.0 cm; girls = 75.6 cm), $p < 0.001$.

Discussion

This cross-sectional study to assess factors associated with dietary intake patterns in Brazilian high school adolescent students is important because low-income and middle-income countries are in the process of nutritional transition (Cecchini et al., 2010). In this study we found independent variable distributions to be different in each gender and therefore we stratified our analyses by gender; demographic, socioeconomic characteristics and lifestyle variables being associated to eating patterns. Three components were derived representing three different dietary patterns and for each dietary pattern we identified different independent variables associated with it. The first component could be described as "junk food", which explained fried food, sweet food and soda consumption. Our study finds a negative association between having breakfast and junk food, consistent with the findings of other studies (Vereecken et al., 2009; Yang, Wang, Hsieh, & Chen, 2006). A possible explanation for this correlation is that breakfast is positively associated with the consumption of healthy foods (Yannakoulia, Ntalla, Papoutsakis, Farmaki, & Dedoussis, 2010) and girls who skip this meal have lower dietary quality index (de Andrade et al., 2010).

The number of meals for girls was positively associated with junk food and healthy components. These results highlight the importance of promoting more consumption of healthy foods (i.e. fruit and vegetables) and decreasing the higher caloric food intake (Klepp et al., 2005), rather than promoting a simple increase in the number of meals.

The current findings revealed that, for girls, "healthy food" patterns were positively associated with having breakfast at home, having lunch and being physically active. Studies have shown physically active girls are more likely to have healthy eating patterns (Berkey et al., 2000; Boone-Heinonen, Gordon-Larsen, & Adair, 2008). The possible explanation is due to physically active girls having more concern about their weight (Kirchengast & Marosi, 2008).

In boys, we found a positive association between living with parents and a "protein food" pattern, which highlights the parents' influence on the eating habits of adolescents. In a recent review, Pearson, Biddle, and Gorely (2009) found that family correlates positively influences the consumption of fruit and vegetables in adolescents principally through parental education and intake of fruits and vegetables, and this influences the consumption of these foods by adolescents. Therefore, it is important that programs promoting the consumption of healthy foods should be extended to the families of adolescents, since there is evidence that family factors may positively influence the eating behavior of adolescents (Pearson, Atkin, et al., 2009; Rasmussen et al., 2006).

Girls having lunch had higher scores for the "protein food" pattern, probably because it is the meal that normally will contain the highest caloric intake (Trumbo, Schlicker, Yates, & Poos, 2002), which is directly related to the consumption of protein foods, especially in Brazil where consumption of protein food sources such as beans is encouraged by the Ministry of Health (Government, 2007). In addition, it was revealed that employment in girls decreased scores for the "protein food" pattern. The possible explanation is that adolescents with employment have greater autonomy (Souza & Silveira Filho, 2007) and formal work in this age group may have a negative effect on the adolescents' behaviors (Chalela, Velez, & Ramirez, 2007; Fischer, Oliveira, Teixeira, Teixeira, & Amaral, 2003).

The negative association between the waist circumference and "junk food" patterns in girls may be attributed to the fact that adolescents with high WC values carry out more weight loss diets leading to less caloric food consumption and tend to worry more about body weight control (Pirouznia, 2001).

One limitation in this study is the cross-sectional design and consequently temporality cannot be established. Another important limitation is the dietary assessment method, which is self-reported. However it would be difficult to use more accurate methods in population-based epidemiological research, such as direct observation.

Dietary patterns are influenced by other behaviors, and social and family factors. However, these determinants differ between boys and girls. This article has demonstrated that there are different factors associated with dietary patterns in boys and girls, which has implications in terms of planning practices to promote healthy eating. Actions to improve the quality of nutrition of adolescents should therefore recognize these differences and be designed differently for each sex and also take into account the situations that influence this behavior (Silveira, Taddei, Guerra, & Nobre, 2011). Adolescents with healthier eating patterns have other healthy behaviors, such as performing physical activity. Our result may help public health planners in designing appropriate interventions. These programs should be multi-component interventions that address social, family and behavioral factors which can be tailored for gender specific activities.

Authors' contributions

A.C.F.M. was the principal design researcher responsible for the data collection; A.C.F.M., F.A. analyzed and performed data interpretation, as well as helping draft the manuscript; M.C.F. was involved in revising the manuscript critically for important intellectual content. A.C.F.M. has primary responsibility for the final content. All authors read and approved the final manuscript.

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