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Trabajo Original

Epidemiología y dietética

Risk behavior patterns for chronic diseases and associated factors among adolescents

Patrones de comportamiento de riesgo para enfermedades crónicas y factores asociados entre adolescentes

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Abstract

Background/objective: Simultaneous engagement in risk behaviors for chronic non-communicable diseases (NCDs) might exert a synergistic effect on adolescent health. This study aimed to identify risk behavior patterns for NCDs in adolescents and analyze associated factors.

Methods: Cross-sectional study conducted between 2009 and 2011, with 1,716 participants aged 10-17 years of a cohort study in Central-West Region, Brazil. Demographic, economic, anthropometric, and lifestyle characteristics were collected. Risk behaviors evaluated were alcohol consumption, tobacco experimentation, insufficient physical activity, sedentary behavior, skipping breakfast, and low diet quality. Principal component analysis was used to identify patterns of risk behaviors and multiple linear regression analysis to quantify the association between independent variables and patterns of risk behavior.

Results: Three patterns of risk behaviors were identified: "legal drugs", "diet and screens", and "silent". After adjustment, legal drugs pattern showed direct association with age (β = 0.13; 95% CI = 0.09; 0.16) and inverse association with maternal education (β = -0.07; 95% CI = -0.14; -0.01). Diet and screens pattern were directly associated with female gender (β = 0.14; 95% CI = 0.04; 0.23), age (β = 0.11; 95% CI = 0.08; 0.14), and economic class (β = 0.15; 95% CI = 0.04; 0.25). Silent pattern was directly associated with maternal education (β = 0.09; 95% CI = 0.03; 0.15), being overweight (β = 0.17; 95% CI = 0.06; 0.28), and female gender (β = 0.32; 95% CI= 0.22; 0.41).

Conclusions: Three risk behavior patterns were identified and the associated factors were socioeconomic status, age, and female gender.

Key words:

Adolescent. Risk factors. Lifestyle. Adolescent behavior. Chronic disease. Factor analysis.

Resumen

Introducción/objetivo: la participación simultánea en los comportamientos de riesgo para las enfermedades no transmisibles (ENT) podría ejercer un efecto sinérgico sobre la salud de los adolescentes. El propósito del estudio fue identificar patrones de comportamiento de riesgo para las ENT en adolescentes y analizar factores asociados.

Métodos: se realizó un estudio transversal entre 2009-2011, con 1.716 participantes de entre 10 y 17 años, de un estudio de cohorte en la Región Centro-Oeste, Brasil. Se recogieron las características demográficas, económicas, antropométricas y de estilo de vida. Los comportamientos de riesgo evaluados fueron el consumo de alcohol, la experimentación con el tabaco, la actividad física insuficiente, el comportamiento sedentario, omitir el desayuno y la baja calidad de la dieta. El análisis de componentes principales se utilizó para identificar patrones de comportamientos de riesgo y el análisis de regresión lineal múltiple para cuantificar la asociación entre las variables independientes y los patrones de comportamiento de riesgo.

Resultados: Se identificaron tres patrones de comportamientos de riesgo: "drogas legales", "dieta y pantallas" y "omisión". Después del ajuste, el patrón de drogas legales mostró asociación directa con la edad (β = 0,13; IC del 95% = 0,09; 0,16) e inverso con la educación materna (β = -0,07; IC del 95% = -0,14; -0,01). El patrón de dieta y pantallas se asoció directamente con el sexo femenino (β = 0,14; IC del 95% = 0,04; 0,23), la edad (β = 0,11; IC del 95% = 0,08; 0,14) y la clase económica (β = 0,15; IC del 95% = 0,04; 0,25). El patrón de omisión se relacionó directamente con la educación materna (β = 0,09; IC del 95% = 0,03; 0,15), el sobrepeso (β = 0,17; IC del 95% = 0,06; 0,28) y el sexo femenino (β = 0,32; IC del 95% = 0,22; 0,41).

Conclusiones: se identificaron tres patrones de comportamiento de riesgo y los factores asociados fueron el nivel socioeconómico, la edad y el sexo femenino.

Palabras clave:

Adolescente. Factores de riesgo. Estilo de vida. Enfermedades no transmisibles. Análisis factorial.

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INTRODUCTION

Chronic non-communicable diseases (NCDs) are the leading cause of death in the world and in Brazil, and share common modifiable risk factors, including alcohol consumption, tobacco use, sedentary behavior, insufficient physical activity, and inadequate eating habits (1).

Due to its specific characteristics, adolescence is considered as a vulnerable period when experimental behavior is part of normal development (2), and which is favorable to the development of most NCDs risk behaviors (3). These risk behaviors are defined as those that directly or indirectly affect the health, wellness and healthy development of an individual (4), and which may increase the risk for developing or worsening diseases (5).

Moreover, it has been shown that certain risk behaviors increase the risk of involvement in others, forming clusters of behaviors (6-8), that is, the occurrence of concurrent risk behaviors in adolescents (9,10). Simultaneity of different risk behaviors may have a synergistic effect on the deterioration of individual health; in other words, it may result in a multiplicative deleterious effect, rather than an additive effect of each behavior (11).

In addition, among adolescents, the simultaneous engagement in several risk behaviors, compared to the presence of an isolated behavior, exerts a synergistic effect on the health (12), increasing the NCDs risk and, therefore, resulting in adverse consequences, particularly when these behaviors start early in life. However, few studies have been conducted in low- and middle-income countries on the patterns of risk behaviors among adolescents. The aim of this study was to identify patterns of NCDs risk factors in adolescents in Brazil through exploratory methods and analyze the associated factors.

MATERIALS AND METHODS

PARTICIPANTS

A cross-sectional study was performed between 1999 and 2011 with 1,716 adolescents of both genders, aged 10-17 years, belonging to a cohort study of children born in Cuiabá City, Mato Grosso, Central-West Region of Brazil. This population was evaluated for the first time between 1999 and 2000, when children were under five years old, and in the second follow-up phase, as adolescents, between ten and 17 years of age. The sampling plan and follow-up strategy of this population have been previously described (13).

INSTRUMENTS AND PROCEDURE

Trained interviewers collected the study data mainly at schools, but also at adolescents' homes. The adolescents completed a questionnaire containing demographic, economic, and lifestyle characteristics, as well as a food frequency questionnaire (FFQ).

Age in full years was analyzed as a continuous variable and was categorized into three groups: 10-11 years, 12-13 years, and 14 years and over. Economic class was defined according to the Brazilian Association of Research Companies criteria (14), with categories ranging from A (highest class) to E (lowest class). Considering the number of individuals in each economic class and that only one adolescent was classified as class E, classes were grouped into two levels: "A and B" and "C, D, and E". Maternal education was assessed by full years of study, being grouped into the following categories: 0-4 years, 5-8 years, 9-11 years, and 12 years and over.

Anthropometric evaluation was performed according to standard techniques (15). Weight was measured using a body composition analyzer (UM-080 model; TANITA®, Tokyo, Japan), and an estadiometer (Sanny®, American Medical do Brazil LTDA. São Bernardo do Campo-SP, Brazil) was used to measure height. Body weight was assessed as body mass index, expressed as z-score of the World Health Organization (WHO) reference curve (16). Body mass index (BM) was classified as "no overweight" (BMI-for-age z-score $\leq +1$) and "overweight" (BMI-for-age z-score $> +1$ [overweight and obesity]).

The evaluated NCDs risk behaviors were as follows: a) consumption of alcoholic beverages, defined as the ingestion of at least one drink of any alcoholic beverage in the last 30 days; b) tobacco experimentation, defined as having smoked cigarettes at least once in life (only tobacco experimentation was analyzed due to low regular consumption among the study population); c) insufficient physical activity, defined as physical activity practice for less than 300 minutes/week, quantifying duration and frequency of leisure activities and physical activity at school (17); d) sedentary behavior, defined as TV and/or computer/video games use for more than four hours/day (84.5% of the population exceeds two hours/day, the maximum time recommended for this type of activity) (18); e) skipping breakfast, defined as breakfast consumption frequency under seven days a week; and f) low diet quality, defined as Brazilian Healthy Eating Index Revised (BHEI-R) score in the 25th percentile or below, calculated on information obtained by FFQ (further details of the BHEI-R calculation in this population are described by Wendpap et al.) (19).

STATISTICAL ANALYSES

Risk behavior patterns were identified through principal component analysis (PCA). Initially, we evaluated the adequacy of the data for the factorial method using the Bartlett's sphericity test (BTS) and the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO), with values of $p < 0.05$ for the BTS and over 0.50 for the KMO index respectively (20).

PCA was used for factor extraction and Varimax rotation was conducted to maximize the interpretation of factors. The definition of the number of factors to be retained was based on Cattell's scree plot test (21). The second model was constructed by fixing the number of retained patterns according to the number indicated by the chart.

The risk behaviors with factor loadings over 0.30 were retained in the patterns and considered as acceptable communalities with values of at least 0.20. The patterns were named according to the characteristics of the behaviors retained in each of them.

In the bivariate analysis, the Chi-squared test was used to compare the prevalence of risk behaviors and patterns according to sociodemographic, economic, and body weight status. The factor scores of the retained patterns were categorized into quartiles, and the second and third quartiles were combined into an intermediate category to facilitate the interpretation of associations.

Multiple linear regression models were used to assess the association between sociodemographic, economic, and body weight status and the risk behaviors patterns. The factor scores (continuous variables) of the patterns were the dependent variables in separate models. The independent variables in each model were those with $p < 0.20$ in the bivariate analysis. All statistical analyses were performed with SPSS version 17.0 (SPSS Inc., Chicago, IL, USA).

The present study was approved by the Research Ethics Committee at Julio Müller University Hospital (Protocol: 651/CEP-HUJM/2009). The parents or guardians who allowed the adolescents' participation in the research signed the consent form before data collection.

RESULTS

A total of 1,716 adolescents aged between ten and 17 years old were evaluated. Among them, 50.7% were male, 55.9% were between ten and eleven years old, and 59.8% belonged to economic classes C, D, or E. About 50% had mothers with education between nine and eleven years, and 27.7% were overweight (Table I). The most prevalent NCDs risk behaviors were sedentary behavior (58.1%), insufficient physical activity (49.7%), and skipping breakfast (36.2%) (Table II).

In the bivariate analysis, among the girls there was higher prevalence of insufficient physical activity and skipping breakfast compared to boys ($p < 0.01$ and $p < 0.05$, respectively). The prevalence of tobacco experimentation, alcohol consumption, sedentary behavior, and insufficient physical activity increased linearly with age ($p < 0.01$). The prevalence of sedentary behavior and insufficient physical activity were higher among those who belonged to economic classes A and B ($p < 0.01$) and increased linearly with maternal education ($p < 0.01$). Adolescents whose mothers had between five and eight years of study had a higher prevalence of alcohol consumption ($p = 0.03$). Overweight adolescents presented a higher prevalence of sedentary behavior ($p = 0.02$) and skipping breakfast ($p < 0.01$), and a lower prevalence of low diet quality ($p < 0.01$) (Table II).

Regarding PCA, both the KMO index (0.51) and BTS ($p < 0.01$) indicated a sufficient correlation between variables, allowing the construction of the data correlation matrix. Three patterns of risk behaviors were identified: "legal drugs", formed by tobacco experimentation and alcohol consumption, which explained 21.5% of the variance; "diets and screens", composed of sedentary behavior and low diet quality, explaining 18.4% of the variance; and "silent" pattern, made up of insufficient physical activity and skipping breakfast, explaining 17.8% of the variance. Together, these three patterns explained 57.6% of the variability of the NCDs risk factors. Most of the variables presented a communality higher than 0.5 (Table III).

Table I. Characteristics of participants, according to sociodemographic variables, socioeconomic position and weight status, 2009/2011 (n = 1,716)

	n	(%)
Gender		
Male	870	(50.7)
Female	846	(49.3)
Age (in years)		
10-11	960	(55.9)
12-13	505	(29.4)
≥ 14	251	(14.6)
Socioeconomic position[a]		
A-B (high-income)	689	(40.2)
C-D-E (low-income)	1027	(59.8)
Maternal education (years)		
≤ 4	103	(6.2)
5-8	460	(27.7)
9-11	841	(50.6)
≥ 12	259	(15.6)
Weight status (according to z-score of BMI-for-age)		
Normal weight	1241	(72.3)
Overweight	475	(27.7)

[a]*According to the Brazilian Association of Research Companies criteria (14).*

In the bivariate analysis, the highest quartile of the legal drugs pattern was associated with male gender, age of 14 years and over, lower economic class, lower maternal educational level, and absence of overweight. The last quartile of the diet and screens pattern was associated with female gender, age of 14 years and over, and lower economic class. As for the silent pattern, the last quartile was associated with female gender and overweight (Table IV).

After adjustments, the legal drugs pattern had a direct association with age and an inverse association with maternal education. The diets and screens pattern was directly associated with female gender, age, and economic class. Finally, the silent pattern had a direct association with maternal education, overweight, and female gender (Table V).

DISCUSSION

Sedentary behavior, insufficient physical activity, skipping breakfast, and low diet quality were the most prevalent NCDs risk

Table II. Non-communicable diseases (NCDs) risk behaviors, according to sociodemographic characteristics, socioeconomic position and weight status of adolescents, 2009/2011 (n = 1,716)

	NCDs risk behaviors (%)					
	Tobacco experimentation	**Consumption of alcoholic bevarages[c]**	**Sedentary behavior (≥ 4 hours/day)**	**Insufficient physical activity (< 300 min/week)**	**Skipping breakfast[d]**	**Low diet quality (BHEI-R ≤ 25 Percentile)**
Total	3.8	5.1	58.1	49.7	36.2	25.0
Gender						
Male	4.1	4.6	56.8	39.4	34.0	23.3
Female	3.4	5.7	59.5	60.2	38.5	26.7
p-value	0.44	0.31	0.26	< 0.01	0.05	0.11
Age (years)[a]						
10-11	1.0	3.1	52.2	44.1	35.5	23.9
12-13	4.4	6.1	64.2	54.9	36.4	25.7
≥ 14	13.1	10.8	68.5	60.6	38.6	27.9
p-value	< 0.01	< 0.01	< 0.01	< 0.01	0.65	0.38
Socioeconomic position[b]						
A-B	3.2	4.8	63.3	55.2	38.2	26.1
C-D-E	4.2	5.4	54.6	46.0	35.0	24.2
p-value	0.29	0.60	< 0.01	< 0.01	0.17	0.38
Maternal education (years)						
≤ 4	5.8	6.8	43.7	41.7	29.1	25.2
5-8	3.5	7.2	56.3	46.1	35.4	27.2
9-11	3.9	3.9	59.2	50.8	36.7	24.6
≥ 12	2.3	3.5	63.7	57.9	40.2	22.8
p-value	0.41	0.03	< 0.01	< 0.01	0.24	0.59
Weight status (according to z-score of BMI-for-age)						
Normal weight	4.2	5.3	56.4	49.2	33.4	26.8
Overweight	2.7	4.6	62.5	50.9	43.8	20.2
p-value	0.16	0.56	0.02	0.51	< 0.01	< 0.01

p-value from X^2 test; [a]p-value for linear trend; [b]According to the Brazilian Association of Research Companies criteria (14); [c]Consumption of at least one drink of any alcoholic beverage in the last 30 days; [d]Breakfast consumption frequency under seven days a week.

behaviors among the adolescents in this study. The main sociodemographic and economic factors associated with risk behavior patterns were gender, age, and maternal education.

Few studies have examined patterns of behavior in adolescents using clustering techniques, such as cluster analysis, PCA, and latent class analysis. Most studies conducted in Brazil used simple aggregation, considering only the sum of behaviors. In this study, we chose to use PCA because it allows the grouping of the most strongly correlated variables in each factor. Furthermore, this technique showed the best fit to the data set.

Other studies have aimed to identify the occurrence of behavior patterns using PCA (6-8). Among them, Busch et al. (6) identified four patterns among adolescents in the Netherlands: "behavior prone to risk" (alcohol consumption, smoking, drug use, and early sexual activity), "bully behavior" (bullying and compulsive use of the Internet), "problematic screen time" (excessive time using video games and internet), and "sedentary behavior, unhealthy eating habits, and insufficient physical activity" (excessive weekly time watching TV and using the internet, unhealthy eating habits, and insufficient physical activity). Van Nieuwenhuijzen et al., (22) also using PCA, found different patterns in Dutch adolescents according to age: for adolescents aged 12-15 years, observed patterns were "alcohol" and "delinquency", and for those aged 16-18 years the patterns were "health", "alcohol", and "delinquency". In our study, the legal drugs pattern was defined as smoking experimentation and alcohol consumption. Similarly, Busch et al. (6) also found a behavior pattern characterized by alcohol consumption and smoking. Other studies have also shown

Table III. Distribution of factor loadings and communalities (h_2) estimated for the three patterns of risk factors for non-communicable diseases (NCDs) among adolescents, 2009/2011 (n = 1,716)

	Factor loadings			h_2
	Patterns			
	"Legal drugs"	"Diet and screens"	"Silent"	
Consumption of alcoholic bevarages[a]	0.80			0.65
Tobacco experimentation	0.78			0.63
Sedentary behavior (≥ 4 hours/day)		0.78		0.62
Low diet quality (BHEI-R ≤ 25 percentile)[b]		0.59		0.37
Insufficient physical activity (< 300 min/week)			0.65	0.50
Skipping breakfast (< 7 days/week)			0.80	0.68
Eigenvalues	1.30	1.10	1.06	
% of variance explained	21.48	18.36	17.77	
% of cumulative variance explained	21.48	39.84	57.61	

[a]Consumption of at least one drink of any alcoholic beverage in the last 30 days; [b]Brazilian Healthy Eating Index Revised (BHEI-R).

an association between alcohol consumption and tobacco use in adolescents (10,23). The determinants of this relationship are not well understood, however, the etiology of multiple psychoactive substances comorbidity indicates that substances such as alcohol and tobacco share common genetic and environmental factors (24).

The factors associated with the legal drugs pattern in this study were age and maternal education. Corroborating these findings, other studies have found that increasing age was associated with both alcohol consumption and tobacco use in adolescents (25,26). The achievement of independence with increasing age may partly explain this association.

Another factor associated with the legal drugs pattern was low maternal education, suggesting that mothers with higher educational levels are more prepared to guide their children about the harmful effects of psychoactive drugs. Other authors found similar results regarding maternal education and tobacco use in adolescents (27,28). Matos et al. (28) found higher alcohol consumption among adolescents whose mothers had low education. However, Malta et al. (26) observed higher alcohol consumption among adolescents whose mothers had higher education. These differences can be explained, at least partly, by maternal education being not only a marker of education level but also an approximate measure of economic class.

A strong association was also found between sedentary behavior and low diet quality, the diet and screens pattern. Several studies have shown an association between unhealthy food consumption and sedentary behavior (6,18,19). Busch et al. (6) identified among Dutch adolescents a behavior pattern consisting of unhealthy eating habits, excessive TV and internet time, and low physical activity. Ottevaere et al. (29) observed that longer time periods spent watching television were associated with low diet quality in European adolescents. One possible explanation for this is that longer screen time increases the exposure to unhealthy foods advertising, such as processed and high-calorie food, which can influence food choice and consumption, especially among adolescents. This result is particularly important for the regulation of advertising and media in relation to the consumption of unhealthy food.

The diet and screens pattern was associated with age, economic class, and being female. In this study, the isolated assessment of low diet quality and sedentary behavior showed no association with being female; however, an association was observed when considering the pattern, reflecting the mutual influence of both behaviors. In this case, girls seem to be more vulnerable to engage in both behaviors simultaneously. Although most studies evaluating sedentary behavior and diet quality have not found significant differences between genders, Allafi et al. (30) observed that adolescent girls in Kuwait had a higher prevalence of sedentary behavior and less healthy eating habits than boys did. Brazilian studies also found an association between being female and more time in sedentary activities (31) and unhealthy eating habits (32).

Age was also associated with the diet and screens pattern. As in other studies (31,33), older adolescents spent more time in sedentary activities, and for this population this time increased linearly with age. Some other studies have shown that unhealthy food consumption increases with age among adolescents (34,35). This result can be explained by the fact that, as age increases, adolescents experience a gradual increase in their autonomy and a progressive reduction of parental influence in their food choices.

Economic class showed a direct association with the diet and screens pattern. It is speculated that high-income adolescents had greater access to electronic technology such as smartphones, video games, tablets, computers, etc. Other Brazilian studies also found an association between sedentary behavior and high socioeconomic class among adolescents (31). Regarding diet quality and economic level, this study, as other conducted in Brazil, showed an association between unhealthy eating habits and higher economic level (36).

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Table IV. Distribution (%) of adolescents according to the scores of risk behavior patterns categorized into quartiles and sociodemographic characteristics, socioeconomic position and weight status, 2009/2011 (n = 1,716)

	"Legal drugs" (%)			p-value	"Diet and screens" (%)			p-value	"Silent" (%)			p-value
	Q1	Q2 e Q3	Q4		Q1	Q2 e Q3	Q4		Q1	Q2 e Q3	Q4	
Scores	(≤ -0.32)	(-0.32; -0.17)	(≥ -0.17)		(≤ -0.77)	(-0.77; 0.68)	(≥ 0.68)		(≤ -1.12)	(-1.12; 0.46)	(≥ 0.46)	
Gender				< 0.01				< 0.01				< 0.01
Male	18.5	59.0	22.5		27.4	46.7	26.0		24.7	52.2	23.1	
Female	31.6	48.0	20.4		21.0	46.5	32.5		14.2	54.8	31.0	
Age (years)				< 0.01				< 0.01				0.98
10-11	21.8	57.3	20.9		29.7	44.6	25.7		19.6	53.6	26.8	
12-13	28.3	51.7	20.0		18.2	49.7	32.1		19.8	53.5	26.7	
≥ 14	30.3	43.0	26.7		15.5	47.8	36.7		18.7	53.0	28.3	
Socioeconomic position[a]				0.01				< 0.01				0.24
A-B	28.4	52.0	19.6		19.7	47.2	33.1		19.0	51.8	29.2	
C-D-E	22.6	54.6	22.8		27.3	46.2	26.6		19.9	54.6	25.5	
Maternal education (years)				< 0.01				0.11				0.15
≤ 4	14.6	58.3	27.2		31.1	45.6	33.6		20.4	58.3	21.4	
5 -8	23.9	51.5	24.6		24.4	44.9	30.7		21.3	51.5	27.2	
9-11	25.0	55.4	19.6		24.8	47.8	27.4		18.4	55.5	26.0	
≥ 12	32.8	49.4	17.8		31.1	49.5	19.4		17.0	49.8	33.2	
Weight status				0.01				0.43				0.03
Normal weight	23.1	54.6	22.3		24.6	45.6	29.8		20.2	54.5	25.3	
Overweight	29.7	50.9	19.4		23.4	49.1	27.6		17.7	50.9	31.4	

p-value from X^2 test; [a]According to the Brazilian Association of Research Companies criteria (14).

Table V. Crude and adjusted regression coefficient (β)[a] and 95% confidence intervals (95% CI) for factors associated with scores of risk behavior patterns for non-communicable diseases (NCDs) among adolescents, 2009-2011 (n = 1,716)

Pattern "Legal drugs"[c]						
	β crude	95%CI	p-value	β adjusted	95% CI	p-value
Gender (female/male)	-0.02	-0.11; -0.08	0.72			
Age (years)	0.14	0.11; 0.17	< 0.01	0.13	0.09; 0.16	< 0.01
Socioeconomic position (A-B / C, D-E)[b]	-0.07	-0.16; 0.03	0.16			
Maternal education (reference: ≤ 4 years)	-0.09	-0.15; -0.03	< 0.01	-0.07	-0.14; -0.01	0.03
Weight status (overweight/normal weight)	-0.08	-0.18; 0.03	0.14			
Pattern "Diet and screen"[d]						
	β crude	95% CI	p-value	β adjusted	95% CI	p-value
Gender (female/male)	0.15	0.05; 0.24	< 0.01	0.14	0.04; 0.23	< 0.01
Age (years)	0.12	0.08; 0.15	< 0.01	0.12	0.09; 0.16	< 0.01
Socioeconomic position (A-B / C, D-E)	0.17	0.08; 0.27	< 0.01	0.15	0.04; 0.25	< 0.01
Maternal education (reference: ≤ 4 years)	0.07	0.01; 0.13	0.02			
Pattern "Silent"[e]						
	β crude	95% CI	p-value	β adjusted	95% CI	p-value
Gender (female/male)	0.32	0.22; 0.41	< 0.01	0.32	0.22; 0.41	< 0.01
Maternal education (reference: ≤ 4 years)	0.11	0.05; 0.17	< 0.01	0.09	0.03; 0.15	< 0.01
Weight status (overweight/no overweight)	0.18	0.08; 0.30	< 0.01	0.17	0.06; 0.28	< 0.01

[a]Dependent variable: Risk behavior pattern score; [b]According to the Brazilian Association of Research Companies criteria (14); [c]Adjusted by sex, age, socioeconomic position, maternal education and weight status; [d]Adjusted by sex, age, socioeconomic position and maternal education; [e]Adjusted sex, maternal education and weight status.

Corroborating these results, the Household Budget Survey held in Brazil in 2008-2009 showed that people with higher income consumed more processed and packaged foods, while the traditional Brazilian diet (consisting of rice and beans) was more common among the low-income population (37).

The silent pattern included two important NCDs risk behaviors, insufficient physical activity and skipping breakfast, both associated with overweight in adolescents. Other adolescent studies also found an association between skipping breakfast and low physical activity levels (38,39). In this study, the silent pattern was associated with female gender, higher maternal education, and overweight. Confirming these findings, studies conducted in different countries including Brazil have shown an association of female gender with the lower level of physical activity (40) and skipping breakfast (41). Girls might seek skipping breakfast rather than physical activity as a form of weight control.

Differently from the literature, higher maternal education was positively associated with the silent pattern in this study. Maternal education, in this case, might be reflecting economic level, since higher income is associated with skipping breakfast (39) and lower levels of physical activity among adolescents (42). It is expected that parents' education as an education level marker shows an inverse association with skipping breakfast and low levels of physical activity, as observed in other studies (40,41). If there is a direct correlation between maternal education and economic level, it is possible that adolescents whose mothers have higher education levels have greater purchasing power to buy snacks. A Brazilian study also found that higher maternal education was associated with adolescents' consumption of unhealthy foods, including soft drinks, fried foods, fast foods, chips, artificial juices, and canned foods (36).

Regarding physical activity, it is likely that low-income adolescents commute to school actively, such as walking and cycling, more often than those from higher economic levels. Silva et al. (43) found that Brazilian adolescents of higher economic levels had a higher prevalence of passive displacement to school than those from lower economic levels. In addition, greater purchasing power can contribute to more time in sedentary activities, which in turn reduces the time spent on leisure activities, since sedentary behavior is also associated with higher maternal education and higher economic level in this population. Dias et al. (31) observed that adolescents with more time in sedentary activities were also less physically active.

Although other studies have identified behavioral patterns in adolescents, the comparison of results is impaired by the diversification of the assessed behaviors and mainly by differences in the patterns identified. It is noteworthy that differences in the statistical approaches used to identify patterns also make comparisons difficult. However, the method used in this study showed patterns of NCDs risk factors and not only the simultaneity of behaviors which has been a focus in most previous adolescent studies.

A limitation of this study refers to its cross-sectional design, not allowing causal inference between variables; however, longitudinal studies (9,44) have found similar associations. In addition, the instrument used to estimate food consumption, the FFQ, has some limitations, such as the overestimation of food consumption.

This study confirmed the hypothesis that the main NCDs risk behaviors tend to occur simultaneously in adolescents and are associated with sociodemographic, economic, and body weight status. Two major dietary markers (skipping breakfast and diet quality), vaguely explored as risk pattern components to date, were considered in this study. The identification of behavior patterns and associated factors provides an important tool for the development of intervention strategies in this age group, with an emphasis on integrated approaches that can promote health and prevent disease.

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