Clustering of risk factors for chronic noncommunicable diseases among adolescents: prevalence and associated factors

Simultaneidade dos fatores de risco para doenças crônicas não transmissíveis em adolescentes: prevalência e fatores associados

Simultaneidad de los factores de riesgo para enfermedades crónicas no transmisibles en adolescentes: prevalencia y factores asociados

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ABSTRACT

Objective: To determine the prevalence and clustering patterns of risk factors for chronic noncommunicable diseases, according to the socioeconomic level and age of adolescents.

Methods: School-based cross-sectional study with 1,675 adolescents (females – 53%) aged 11 to 17 years-old, randomly selected from private and public schools. Behavioral variables were defined as tobacco and alcohol consumption, high consumption of fat in the diet, and low physical activity level. Biological risk factors were defined as high waist circumference and blood pressure, and low cardiorespiratory fitness. Multinomial logistic regression was applied to identify variables associated with clustering of risk factors for chronic noncommunicable diseases.

Results: 62 and 31% of adolescents presented low cardiorespiratory fitness and high fat intake, respectively. Two out of ten adolescents had two or more unhealthy behaviors, and one-third had at least two risk factors for noncommunicable diseases. A total of 62% of adolescents had at least two risk factors for noncommunicable diseases, with more frequent clustering among older teenagers. Analysis with both behavioral and biological variables showed that the older age was associated with the presence of two or more risk factors for noncommunicable diseases (males: OR 2.10; females: OR 5.74).

Conclusions: Six out of ten adolescents had at least two noncommunicable diseases risk factors. There was an association of clustered factors with age, regardless of gender. Thus, interventions aiming at reducing clustering of risk factors for noncommunicable diseases at older ages must begin early in life.

Key-words: risk factors; risk-taking; adolescent; chronic disease.

RESUMO

Objetivo: Estimar a prevalência e os padrões dos fatores de risco para doenças crônicas não transmissíveis segundo o nível socioeconômico e a idade dos adolescentes.

Métodos: Estudo transversal de base escolar envolvendo 1.675 adolescentes (53% do sexo feminino), com idades de 11 a 17 anos, de escolas públicas e privadas. O consumo de tabaco e álcool, o alto consumo de gordura na dieta e o baixo nível de atividade física constituíram as variáveis comportamentais. Circunferência da cintura e pressão arterial elevada, assim como e baixa aptidão cardiorrespiratória compuseram as variáveis biológicas. Regressão logística

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multinomial foi realizada para identificar variáveis associadas à simultaneidade dos fatores de risco para doenças crônicas não transmissíveis.

Resultados: Dos adolescentes, 62 e 31% apresentaram baixa aptidão cardiorrespiratória e elevado consumo de gordura, respectivamente. Dois em cada dez adolescentes tinha dois ou mais comportamentos de risco, e um terço deles tinham pelo menos dois fatores de risco biológicos para doenças crônicas não transmissíveis. No total, 62% dos adolescentes tinham pelo menos dois fatores de risco para doenças crônicas não transmissíveis, com maior frequência nos estudantes mais velhos. Na análise simultânea de todas as variáveis, observou-se que o aumento da idade esteve associado ao acúmulo de dois ou mais fatores de risco (sexo masculino com OR 2,10, e feminino com OR 5,74).

Conclusões: Seis em cada dez adolescentes tinham pelo menos dois fatores de risco, enquanto a proporção do agrupamento desses fatores aumentou com a idade. Portanto, quanto mais precoce forem as intervenções, provavelmente menos adolescentes estarão acometidos por agravos à saúde em idades mais avançadas.

Palavras-chave: fatores de risco; comportamento de risco; adolescente; doença crônica.

RESUMEN

Objetivo: Estimar la prevalencia y los estándares de los factores de riesgo para enfermedades crónicas no transmisibles, según el nivel socioeconómico y la edad de los adolescentes de Caxias do Sul, en Rio Grande do Sul, Brasil.

Métodos: Estudio transversal de base escolar, involucrando a 1.675 estudiantes (53,2% del sexo femenino), con edades entre 11 y 17 años, de escuelas públicas y privadas. El consumo de tabaco y alcohol, el alto consumo de grasa en la dieta y el bajo nivel de actividad física constituyeron las variables comportamentales. Circunferencia de la cintura y presión arterial elevada y baja aptitud cardiorrespiratoria compusieron las variables biológicas. Se realizó regresión logística multinominal para identificar variables asociadas a la simultaneidad de los factores de riesgo para enfermedades crónicas no transmisibles.

Resultados: De los adolescentes, el 61,6 y el 31,2% presentaron baja aptitud cardiorrespiratoria y elevado consumo de grasas, respectivamente. Dos en cada diez adolescentes tenían dos o más comportamientos de riesgo y un tercio de ellos tenía al menos dos factores de riesgo biológico para enfermedades crónicas no transmisibles. En total, el 62,0% de los adolescentes tenían al menos dos factores de riesgo para enfermedades crónicas no transmisibles, con mayor frecuencia en los estudiantes mayores. En el análisis simultáneo de todas las variables, se observó que el aumento de la edad estuvo asociado a la acumulación de dos o más factores de riesgo (sexo masculino con OR 2,10 y femenino con OR 5,74).

Conclusiones: Seis en cada diez adolescentes tenían al menos dos factores de riesgo, mientras que la proporción del agrupamiento de esos factores aumentó con la edad. Por lo tanto, cuanto más temprano tienen lugar las intervenciones, probablemente menos adolescentes serán acometidos por problemas de la salud en edades más avanzadas.

Palabras clave: factores de riesgo; comportamiento de riesgo; adolescente; enfermedad crónica.

Introduction

The prevalence of risk factors of chronic non-communicable diseases (CNCD) has been studied in groups of adolescents so that health complications may be prevented in the short and long terms. The goals defined by the World Health Organization for 2008 to 2013 include the reduction of CNCD risk factors because these diseases account for up to 60% of global mortality, an this rate may reach 77% in the next decade[1].

Observational studies showed that the exposure to behavioral and biological CNCD risk factors is associated with socioeconomic status[2-6]. A study conducted with data retrieved from the US Youth Risk Behavior Survey found that smoking, excessive alcohol consumption and sedentary lifestyles were more prevalent among adolescents with a lower income or whose parents or guardians had little education, whereas the consumption of fat-rich foods was lower among adolescent girls whose parents had a higher level of education[2]. Another study conducted in the state of Santa Catarina, Brazil, found that higher consumption of fruit and vegetables and lower use of illicit drugs were associated with higher family income[6], whereas another study, conducted in the same geographical area, did not find any associations between socioeconomic status and CNCD risk factors[7].

Socioeconomic factors play an important role in adolescent quality of life, health and lifestyle[8], but little is known about the association between socioeconomic status and CNCD risk factors. Moreover, it is important to investigate how risk

factors combine and are distributed in different socioeconomic classes. Such data may support interventional strategies to reduce health problems among young individuals.

Studies in the literature have explored the clustering patterns of CNCD risk factors and have included up to five variables in their analyses[9-10]. The aim of this study was to investigate clustering of behavioral and biological risks among young individuals and to describe their clustering patterns. Such findings may improve our understanding of which risk factors tend to combine and which subgroups are more susceptible to interventions, and these data may support decision making and the definition of strategies for this population.

This study investigated socioeconomic factors associated with the prevalence of behavioral and biological CNCD risk factors and their clustering patterns.

Method

This study was part of a school-based epidemiological survey about "Cardiovascular risk factors in adolescents in Caxias do Sul, Brazil". Data were collected from May to July 2007 in a group of adolescents aged 11 to 17 years. Caxias do Sul, with about 420,000 inhabitants, is the second largest town in the state of Rio Grande do Sul, Brazil. The study was approved by the Ethics Committee on Research with Human Beings of Universidade Federal de Santa Catarina (UFSC). An informed consent term was handed out to students to be taken home and signed by their parents or guardians and collected one day later.

The study enrolled boys and girls studying in elementary and secondary schools. According to the Department of Education in the State of Rio Grande do Sul, there were 41,534 students (84% in public schools) enrolled in 117 schools (98 public and 19 private schools), distributed into the nine urban zones of Caxias do Sul. Sampling was conducted in two stages: 12 schools in four zones of the city were chosen by random drawing; after that, 75 classes were randomly chosen to reach the number of individuals defined in the sample size calculation, stratified according to type of school (public and private) and level (elementary and secondary).

To estimate sample size, we assumed a 95% confidence interval, population size, 60% prevalence of physical inactivity, 3% error margin and alpha equal to 5%[11]. As clustering (schools and classes) was used, 50% was added to account for the sampling method, and the minimum sample size was estimated at 1,500 students. Because of possible losses or refusals to participate, another 20% was added, and the final sample size was 1,800. In the classes chosen, there were 1,835 adolescents, 69 refused to participate or did not hand back the questionnaires, and 91 were not 11 to 17 years old, The final sample comprised 1,675 adolescents (girls: 53.2%).

Data were collected in a period of 73 days, at three time points. On the first day, students were told about the study objectives and received the informed consent term. On the following day, after the term was collected, adolescents filled out, in the classroom, a questionnaire about demographic, socioeconomic and behavioral variables (30 to 40 minutes), and their blood pressure was measured. On the third day, anthropometric measurements were made and the cardiorespiratory fitness test was applied (60 minutes). Data were collected by the main author, physical education students and teachers and a nurse.

Socioeconomic status was assessed using the economic classification criteria of the Brazilian Association of Survey Companies (ABEP)[12]: level of education of the head of the family, number of household devices, family cars and bathrooms in the house. Economic classes range from A (the richest) to E (the poorest), and socioeconomic status was classified as low (C, D, E), middle (B) and high (A).

Using a questionnaire based on the US Youth Risk Behavior Survey, the adolescents answered questions about their consumption of alcohol and smoking. Smoking was defined as one or more cigarettes in the last 30 days, and alcohol consumption, as drinking at least one dose of any alcoholic beverage in the last 30 days.

A dietary recall of usual eating habits was used to evaluate total calorie and fat intake. Adolescents were asked to describe portion sizes of the foods eaten in the last 15 days. The software DietWin Clínico[13] 3.0 (Brubins Comércio de Alimentos e Supergelados, Porto Alegre, Brazil) was used to calculate macronutrient energy intake and the total and relative contribution of fat in their diets. A fat percentage equal to or higher than 30% of the total calorie intake was classified as high dietary fat intake[14].

To measure the level of physical activity (PA), we use an adaptation[15] of the self-record instrument described by Bouchard *et al*[16]. The adolescents filled out an instrument in which they recorded the PA performed on three days of the last week: one day on the weekend (Sunday) and two weekdays (one with more and one with less activity). Each day was divided into 36 intervals of 30 minutes each, from 6 am to midnight. The intensity of the activity performed

was recorded at each 30-minute slot using a scale from 1 to 9: 1 indicated sleeping/lying down; 2, sitting; 3, activities performed while standing up; 4, light walk; 5, light physical work; 6, leisure activities and recreational sports; 7, manual work at a moderate pace; 8, leisure activities and non-competitive sports; and 9, heavy physical work and competitive sports. Total energy expenditure was calculated by multiplying time spent in each period by the corresponding metabolic equivalent task (MET), which ranges from 0.52 to 4.00kcal/kg/30 min[16]. The 1st quintile of energy expenditure (kcal/kg/day) was used to define less physically active individuals.

Cardiorespiratory fitness was measured using the Progressive Aerobic Cardiovascular Endurance Run (PACER)[17], which has shown to have good reproducibility and validity[18-19]. The speed in the shuttle run test, using sound signals, increased progressively at each stage (about one minute) for a fixed distance of 20m. The test finished when the student stopped due to exhaustion or could not keep the speed required for three runs. The number of runs completed was used to classify fitness as low or adequate/high, according to the criteria for sex and age described in the FITNESSGRAM manual issued by the Cooper Institute for Aerobics Research[17].

Waist circumference (WC) was measured at the midpoint between the lowest rib and the upper edge of the iliac crest. Using the mean of two measurements, WC was classified as normal or elevated according to sex, age and skin color (white and non-white)[20]. We chose to use WC as an index of obesity because it measures abdominal fat and, as well as the body mass index (BMI), has been a good predictor to identify risk factors, such as elevated blood pressure (BP), dyslipidemia[20] or cardiovascular risk factor clustering[21]. In our sample, the agreement between elevated BMI and elevated WC was 88.1%. A calibrated sphygmomanometer was used to measure BP twice in the right arm while the individual was sitting and after resting for five minutes. Adolescents with systolic or diastolic BP above the 90th percentile for sex, age and height[22] or that had a BP above 120/80 were classified as having elevated BP.

A chi-square test was used to compare the rates of socioeconomic variables and risk factors between sexes. The possible clustering of behavioral and biological CNCD risk factor was defined according to observed and expected prevalence. In addition, we calculated the observed-to-expected (O/E) prevalence ratios and their respective 95% confidence intervals. Expected prevalence was calculated assuming the independence of the different risk factors and by multiplying the individual probability of each factor in the population under study.

A multinomial logistic regression was used to evaluate the association between socioeconomic status (socioeconomic class and parents' education) and biological or behavioral CNCD risk factors: outcome 1: one risk factor; outcome 2: two or more risk factors; reference category: no risk factor. Moreover, we tested the association between socioeconomic status and risk factor clustering (behavioral plus biological) in the same model. All analyses were conducted using the Statistical Package for the Social Sciences (SPSS) 15.0. The level of statistical significance was set at 5%.

Results

Almost 50% of the students were middle class (49.7%), and 39.0% of the parents had 12 or more years of education. Less than 10% of the adolescents were smokers (6.2%), 21.0% had drunk less than one dose of alcoholic beverage in the previous month, and 31.0% had a high fat intake in their diets. The analysis of biological risk factors revealed that about 28.0% had elevated WC and BP, and 62.0% had a low level of cardiorespiratory fitness (Table 1).

None of the risk behaviors were found in 42.0% of the adolescents; 39.0% had one risk factor, and 19.0% had two or more unhealthy behaviors. At the same time, 24.0% had no biological risk factor, 44.0% had one factor, and 32.0 had two or more CNCD risk factors. Additionally, when the behavioral and biological factors were analyzed as clusters, 12.0% of the adolescents had no CNCD risk factors, 26.0% had one risk factor and 62.0% had two or more CNCD risk factors (Table 2).

The prevalence of clustering of smoking and alcohol consumption was 4.1 times greater among boys and 2.2 greater among girls when compared with the expected values for this population. For smoking, alcohol consumption and elevated dietary fat intake, it was 4.7 times greater than expected among boys and 3.5 times among girls. Clustering of all risk behaviors was 4.2 times greater than expected among girls (Table 2).

The analysis of biological risks revealed that the clustering of elevated WC and BP and low level of cardiorespiratory fitness was greater than expected for 85% of the boys and 69% of the girls. In contrast, the rates of elevated WC among boys and elevated BP and low level of cardiorespiratory fitness among girls were below the expected prevalence.

Table 1 - Distribution of age and socioeconomic, behavioral and biological variables according to sex

	n	Total		Boys (n=784)		Girls (n=891)		*p*-value
		n	%	n	%	n	%	
Age (years)	1,675							0.032
11–13		708	42.3	353	45.0	355	39.8	
14–17		967	57.7	431	55.0	536	60.2	
Socioeconomic status	1,347							0.588
(classes C, D and E)		450	33.4	197	32.0	253	34.6	
(class B)		670	49.7	312	50.6	358	49.0	
(class A)		227	16.9	107	17.4	120	16.4	
Parental education (years)	1,526							0.667
0 to 8		537	35.2	256	36.4	281	34.2	
9 to 11		395	25.9	180	25.6	215	26.2	
≥12		594	38.9	268	38.1	326	39.7	
Risk behaviors								
Smoking	1,580	98	6.2	32	4.3	66	7.9	0.004
Alcohol consumption	1,599	356	22.3	161	21.5	195	23.0	0.471
Elevated dietary fat intake	1,566	488	31.2	224	31.0	264	31.3	0.887
Little physical activity	1,634	326	20.0	153	20.0	173	19.9	0.983
Risk factors								
Elevated BP	1,653	469	28.4	224	29.0	245	27.8	0.587
Elevated WC	1,662	460	27.7	169	21.7	291	32.9	<0.001
Low CRF	1,598	985	61.6	401	53.0	584	69.4	<0.001

Smoking: all smokers; alcohol consumption: at least one dose in previous month; elevated dietary fat intake: intake of 30% or more of total energy intake; little physical activity: lowest calorie expenditure (1st quintile); elevated BP: blood pressure above 90th percentile; elevated WC: waist circumference according to sex, age and skin color[20]; low CRF: low cardiorespiratory fitness according to PACER (FITNESSGRAM)[17];

Table 2 - Clustering of risk factors of chronic non-communicable diseases among adolescents

Nº	S	PA	F	A	Boys			Girls		
					O	E	O/E (95%CI)	O	E	O/E (95%CI)
4	+	+	+	+	0.2	0.1	4.06 (0.08–17.00)	0.5	0.1	4.20 (1.19–11.21)
3	+	-	+	+	0.9	0.2	4.74 (1.74–10.34)	1.6	0.5	3.48 (1.76–5.95)
3	+	+	-	+	0.0	0.1	0.0	0.7	0.3	2.73 (0.82–5.92)
3	+	+	+	-	0.2	0.2	1.02 (0.02–4.29)	0.1	0.4	0.26 (0.01–1.90)
3	-	+	+	+	0.8	1.3	0.63 (0.19–1.39)	1.6	1.4	1.12 (0.57–1.91)
2	+	-	-	+	1.7	0.4	4.13 (2.01–7.19)	2.2	1.0	2.22 (1.30–3.58)
2	+	+	-	-	0.0	0.4	0.0	0.5	0.8	0.61 (0.17–1.62)
2	-	-	+	+	4.8	4.9	0.99 (0.68–1.40)	3.8	5.5	0.69 (0.46–0.99)
2	+	-	+	-	0.2	0.8	0.27 (0.01–1.11)	0.7	1.9	0.47 (0.14–1.03)
2	-	+	+	-	6.6	5.0	1.32 (0.96–1.78)	5.9	4.6	1.28 (0.93–1.71)
2	-	+	-	+	1.8	2.7	0.66 (0.34–1.15)	2.3	3.1	0.75 (0.45–1.20)
1	+	-	-	-	0.8	1.6	0.49 (0.15–1.08)	1.4	3.2	0.44 (0.22–0.81)
1	-	+	-	-	11.1	10.8	1.02 (0.81–1.29)	9.0	9.9	0.91 (0.71–1.15)
1	-	-	+	-	18.0	19.3	0.93 (0.78–1.12)	17.6	17.7	0.99 (0.83–1.18)
1	-	-	-	+	10.1	10.5	0.96 (0.74–1.21)	11.1	11.9	0.93 (0.75–1.15)
0	-	-	-	-	43.0	41.8	1.03 (0.91–1.16)	41.0	38.2	1.08 (0.96–1.20)

S: smoking; PA: little physical activity; F: elevated dietary fat intake; A: alcohol consumption; O: observed prevalence; E: expected prevalence

Table 3 - Clustering of biological risk factors of chronic non-communicable diseases among adolescents

Nº	WC	BP	CRF	Boys			Girls		
				O	E	O/E (95%CI)	O	E	O/E (95%CI)
3	+	+	+	6.2	3.3	1.85 (1.35–2.46)	10.7	6.3	1.69 (1.36–2.08)
2	+	-	+	9.2	8.1	1.15 (0.89–1.45)	14.4	16.5	0.87 (0.72–104)
2	+	+	-	2.0	2.9	0.68 (0.38–1.13)	2.3	2.8	0.82 (0.49–1.28)
2	-	+	+	10.4	12.2	0.85 (0.67–1.06)	8.9	12.9	0.69 (0.54–0.87)
1	+	-	-	4.0	7.1	0.57 (0.38–0.81)	5.5	7.3	0.76 (0.55–1.01)
1	-	+	-	10.7	10.8	0.99 (0.79–1.23)	5.8	5.7	1.01 (0.75–1.35)
1	-	-	+	27.3	29.5	0.93 (0.80–1.06)	35.3	33.6	1.05 (0.93–1.18)
0	-	-	-	30.1	26.0	1.16 (1.01–1.32)	17.1	14.9	1.15 (0.97–1.35)

WC: elevated waist circumference; BP: elevated blood pressure; CRF: low cardiorespiratory fitness; O: observed prevalence; E: expected prevalence

Table 4 - Association of age and socioeconomic variables with risk factor clustering (biological, behavioral and total) for chronic non-communicable diseases among adolescents

	BeRF		BiRF		Total	
	1	≥2	1	≥2	1	≥2
	Boys [OR (95%CI)]					
Age (11 to 13 years)						
14 to 17	1.45 (0.96–2.18)	1.58 (1.02–2.47)	1.55 (1.05–2.31)	1.82 (1.08–3.07)	1.58 (0.88–2.81)	2.10 (1.25–3.55)
(Low) Socioeconomic status						
Middle	0.82 (0.45–1.49)	0.86 (0.44–1.66)	0.66 (0.37–1.18)	0.49 (0.25–1.00)	0.47 (0.78–1.23)	0.43 (0.17–1.04)
High	0.66 (0.33–1.32)	0.73 (0.34–1.57)	0.54 (0.27–1.07)	0.39 (0.16–0.92)	0.96 (0.32–2.93)	0.51 (0.18–1.42)
Parental education (years) (0 to 8)						
9 to 11	1.03 (0.61–1.74)	1.23 (0.69–2.21)	1.03 (0.61–1.73)	1.22 (0.63–2.38)	0.47 (0.22–1.01)	0.75 (0.38–1.46)
≥12	0.87 (0.51–1.51)	1.32 (0.73–2.38)	0.88 (0.52–1.50)	0.83 (0.41–1.69)	0.59 (0.27–1.29)	0.77 (0.38–1.58)
	Girls [OR (95%CI)]					
Age (11 to 13 years)						
14 to 17	2.24 (1.44–3.48)	3.68 (2.28–5.92)	2.32 (1.61–3.34)	7.31 (4.05–13.17)	1.65 (0.82–3.30)	5.74 (2.99–11.00)
(Low) Socioeconomic status						
Middle	1.33 (0.72–2.45)	1.28 (0.65–2.52)	0.61 (0.35–1.05)	0.44 (0.22–0.86)	1.27 (0.48–3.36)	1.09 (0.44–2.70)
High	1.20 (0.59–2.45)	1.56 (0.73–3.36)	0.58 (0.31–1.07)	0.27 (0.12–0.60)	1.23 (0.40–3.74)	1.18 (0.42–3.35)
Parental education (years) (0 to 8)						
9-11	0.70 (0.40–1.21)	1.00 (0.55–1.80)	0.91 (0.57–1.44)	0.94 (0.50–1.74)	0.56 (0.24–1.30)	0.58 (0.26–1.26)
≥12	0.82 (0.46–1.48)	1.16 (0.62–2.16)	0.83 (0.51–1.34)	1.42 (0.76–2.64)	0.77 (0.31–1.91)	0.66 (0.28–1.56)

BiRF: biological CNCD risk factors; BeRF: behavioral CNCD risk factors; Total: biological and behavioral CNCD risk factors; Level of significance: 5%

Finally, there was a slight increase of the observed prevalence in comparison with the expected value for absence of these three biological risk factors among boys (Table 3).

The multinomial logistic regression models were used to test the association between socioeconomic status and CNCD risk factor clustering. Older adolescents had a higher probability of having two or more risk behaviors (boys: OR 1.58; girls: OR 3.68) and biological risk factors (boys: OR 1.82; girls: OR 7.31). Those in the highest socioeconomic classes had a lower chance of having two or more biological risk factors (boys: OR 0.39; girls: OR 0.27). The analysis of factor clustering revealed that only age remained associated with two or more CNCD risk factors (boys: OR 2.10; girls: OR 5.74) when compared to no risk factor (Table 4).

Discussion

This study investigated the clustering patterns of behavioral and biological CNCD risk factors in a sample of students aged 11 to 17 years. The prevalence of individual

behavioral risks was lower than that found in other studies[23,24]. Only 6.2% of the adolescents had smoked in the previous month, in comparison with a prevalence of 19.5% among American adolescents according to the same criterion[23]. The prevalence of alcohol consumption in at least one day of the previous month (10.6%) was also lower than that found in another Brazilian survey (27.3%)[24] and than the one reported in the US Youth Risk Behavior Surveillance System (41.8%)[23]. The level of PA was classified according to the data distribution energy expenditure estimates (example: 1st quartile for low activity); therefore, the prevalence of physical inactivity is not comparable with studies that evaluate the same behavior based on recommendations of PA practice (for example, at least 60 minutes of moderate to vigorous PA every day).

Risk factor clustering was observed and compared with expected values. The clustering pattern of behavioral risk factors had high observed-to-expected ratios when compared with the ratio found for biological risk factors. This indicates that the prevalence of behavioral risk factors is elevated and higher than expected in this population. Some clustering patterns were more prevalent, such as alcohol consumption, smoking and high dietary fat intake of both sexes, as well as risk factor clustering among girls. Such findings suggest that CNCD risk factors tend to cluster. This may be associated with lifestyles, which, in adolescence, are greatly affected by peer pressure, local culture and fashion trends and directly influence the adoption of certain habits.

Although there is growing interest in examining health risk factors among children and adolescents, little is known about this field of study. Our results showed that 10.0% of the students had at least two behavioral risk factors; about one third had two or three biological risk factors, and 60.0% had two or more risk factors according to the analysis of behavioral and biological variables. These findings are similar to those reported in other studies[2,4-5] that analyzed the clustering of behavioral and biological factors.

Among Canadian adolescents, 65.0% had at least two CNCD risk factors, such as physical inactivity, sedentary behavior, smoking and alcohol consumption[4]. Among American adolescents aged 12 to 17 years, two of each three reported having at least two behavioral risk factors, such as cigarette smoking, sedentary lifestyle, insufficient consumption of fruit and vegetables, excessive consumption of foods high in fat, and episodic heavy drinking of alcohol[2]. In a representative sample of students aged 15 to 19 years in a state of Southern Brazil, 65% reported having two or more behavioral factors (physically inactive, sedentary lifestyle, smoking, alcohol consumption and elevated BMI)[6]. In that study, only one in each ten adolescents did not have any of the seven CNCD risk factors, and about 25.0% had at least one. Other studies evaluated four to six risk factors and found similar results: about 10.0% of the adolescents had no risk factors, whereas 25 to 30% had one[2,4,6]. Among Canadian[9] and Iranian adolescents[10], 20.0% had no risk factors, and almost 60% had only one CNCD risk factor.

Clustering of CNCD risk factors was higher among older adolescents. Some studies found that the clustering prevalence of risk factors increases with age[4-6,9]. A study conducted in a city in Southern Brazil found that 17- to 19-year-old adolescents had a 86% greater chance of smoking, and a 3.3 times greater chance of having pre-hypertension or elevated BP when compared with 14- to 16-year-olds[7]. Chances may increase as a result of the daily stresses caused by social relations and the greater exposure to several unhealthy behaviors in this phase of life.

Most studies found that there is an inverse association between social indices (parents' education, family income and possession of goods) and the prevalence and clustering of health risk behaviors[2,4-6]. Our findings showed more biological risk factor clustering among adolescents in poorer families than among those from richer families; however, no association was found for clustering of behavioral and biological CNCD risk factors. Socioeconomic status was assessed according to reports of possession of durable goods (television, car, radio, washing machine, refrigerator and others) and the level of education of the head of the family, an approach that might lead to an assessment bias because of the increase in the buying power of Brazilian families resulting from recent economic and social policies in Brazil. As a result, individuals from different socioeconomic levels might have been classified in the same class.

Some limitations and positive aspects should be taken into consideration when analyzing our results. First, self-reported measures may underestimate the prevalence of behavioral CNCD risk factors because of the social acceptance bias, which may, in turn, lead to an even worse prevalence of unhealthy behaviors. The evaluation of fat intake should be carefully analyzed because the instrument used had some limitations and might not have measured calorie intake accurately. Second, comparisons with data in other studies should be carefully made because there are differences in the number of risk factors selected, as well as in the definitions of variables, cut-off points and age groups. To overcome

such limitations, variables were classified according to well-known definitions and standards to ensure that the interpretation of findings was accurate. This study findings enabled us to explore clustering patterns of behavioral and biological risk factors, and provided insights on how to promote interventions aimed at this population.

Risk factor clustering did not differ according to socioeconomic status, which suggests that interventions may be developed without taking social class into consideration. However, further studies should be conducted to understand the biological risk profile among adolescents with a low socioeconomic status. Health risk factors and behaviors tend to cluster for older adolescents. These findings suggest that it is important to identify the most frequent risk factor clustering patterns, which might motivate investigators to focus on specific clustering patterns.

Health promotion programs for adolescents should be outlined and tested, and two new approaches may be followed: interventions aimed at two or more health risk factors to investigate whether their prevalence decreases; or interventions directed to only one risk behavior to test its possible impact on other combined risk factors. For example, which risk behavior clustering tends to affect other factors? In a group of adolescents with an high dietary fat intake and low PA, would the development of an intervention to increase PA lead, indirectly, to a reduction in fat intake? Such questions raise new issues that should be examined in studies about health promotion in schools.

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