

Aggregation of the four main risk factors to non-communicable diseases among adolescents

Agregamento dos quatro principais comportamentos de risco às doenças não transmissíveis entre adolescentes

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ABSTRACT: *Objective:* To investigate the aggregation of four main risk behaviors (smoking, alcohol, physical inactivity and low consumption of fruits and vegetables) to chronic diseases in a population from Northeastern Brazil. *Methods:* Cross-sectional study with a representative sample (n = 600) of high school students from public schools in Caruaru, Pernambuco, Brazil. The aggregation was evaluated by comparing the observed prevalence with the expected prevalence in all the aggregation possibilities between the behaviors. The logistic regression analysis was performed by grouping three or four behaviors, after adjusting for independent variables. *Results:* With the exception of smoking, other risk behaviors had prevalence rates above 20%. Only 0.3% (95%CI 0.1 – 1.3) of the students presented the four risk behaviors simultaneously, while 15.3% (95%CI 12.3 – 18.2) did not present any of them. Risk behaviors tended to aggregate together, particularly smoking and alcohol consumption, being more pronounced among boys, with physical inactivity and low consumption of fruits and vegetables being higher among girls (p < 0.05). Regression analysis indicated that, among the independent variables, those students who do not have physical education classes were 2.1 times more likely to have three or more aggregated risk behaviors. *Conclusions:* The results of this study allow us to establish the prevalence of aggregated risk behaviors, which may have important implications for health policies and practices. It is suggested that educational and health actions are tested in schools, and physical education classes can be an important context for intervention.

Keywords: Life Style. Cluster. Health behavior. Risk factors. Adolescent. Brazil.

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RESUMO: *Objetivo:* Verificar o agrupamento dos quatro principais comportamentos de risco (fumo, álcool, inatividade física e baixo consumo de frutas, legumes e verduras) relacionados às doenças crônicas não transmissíveis em uma população do Nordeste do Brasil. *Metodologia:* Estudo transversal com uma amostra representativa ($n = 600$) de estudantes do ensino médio da rede pública estadual de Caruaru, Pernambuco. O agrupamento foi avaliado comparando a prevalência observada com a esperada em todas as possibilidades de agrupamento entre os comportamentos. A análise de regressão logística foi realizada agrupando três ou quatro comportamentos, sendo ajustadas para as variáveis independentes. *Resultados:* Com exceção do fumo, os demais comportamentos de risco obtiveram prevalências superiores a 20%. Apenas 0,3% (IC95% 0,1 – 1,3) dos estudantes apresentam os quatro comportamentos de risco de forma agregada, enquanto 15,3% (IC95% 12,3 – 18,2) não apresentaram nenhum. Os comportamentos de risco tenderam ao agrupamento, particularmente o fumo e o consumo de álcool, sendo mais acentuado entre os rapazes, e a inatividade física e o baixo consumo de frutas, legumes e verduras, entre as moças ($p < 0,05$). A análise de regressão indicou que, dentre as variáveis independentes, aqueles estudantes que não fazem aulas de Educação Física têm 2,1 vezes mais chance de apresentar três ou mais comportamentos de risco agregado. *Conclusões:* Os resultados deste estudo permitem o conhecimento da prevalência dos comportamentos de risco de forma agregada, podendo ter implicações importantes para as práticas e políticas de saúde. Sugere-se que ações de educação e saúde sejam testadas nas escolas, e que as aulas de Educação Física podem ser um importante contexto de intervenção.

Palavras-chave: Estilo de vida. Conglomerado. Condutas de saúde. Fatores de risco. Adolescente. Brasil.

INTRODUCTION

Over the last decades, the leading causes of death worldwide have become chronic non-communicable diseases (NCDs), surpassing infectious diseases¹. In 2005, it was estimated that about 60% of all causes of death worldwide were from these diseases, and for the year 2030, for example, it is estimated an increase of 17% in the total number of deaths¹. In addition, in countries with low and middle income, there are coexisting problems related to NCDs and infectious diseases¹.

A recent report published by the World Health Organization (WHO) indicated that more than one third of all deaths worldwide can be attributed to a small group of risk factors¹. Smoking, alcohol, physical inactivity and low consumption of fruits and vegetables were directly responsible for 20.9% of deaths in the world. When considering middle-income countries, this proportion increased to 37.7%¹.

There is a strong concern for adolescents, because although these diseases manifest largely in adulthood, the precursors of their conditions manifest during childhood and adolescence^{2,3}. In addition, evidence indicates that these behaviors tend to co-occur, that

is, there is a link between exposure causes to one behavior and the presence of another⁴⁻¹¹. There has been a significant increase in publications on the knowledge of the prevalence and the factors related to risky behavior in isolation. However, few studies have been published on the prevalence and distribution of multiple behaviors^{4-7,9,11}, especially among younger people^{4,8}. Most studies published in the international literature investigated the clustering of multiple behaviors in adults in developed countries^{4-7,9,11}.

In Brazil, studies have generally investigated the behaviors in combination, most of them being related to the combination of specific risk factors for heart diseases¹²⁻¹⁴ and only one related to the simultaneity of risk behaviors related to general health (smoking, alcohol, physical inactivity and low consumption of fruits and vegetables)¹⁵. No studies investigating the aggregation of risk behaviors to overall health, in both adults and adolescents, were found. Analyses of aggregation of multiple behaviors may help future health promotion programs, since interventions with strategies focusing on multiple behaviors have better impact when compared to interventions with isolated behaviors¹⁶⁻¹⁸. Therefore, the aim of this study was to investigate the aggregation of risk behaviors and associated factors among adolescents in Caruaru, Pernambuco.

METHODOLOGY

This cross-sectional study was approved by the Ethics Committee for research with human beings of *Faculdade ASCES* under protocol no. 44/2007. All ethical guidelines in Resolution 196/96 of the Brazilian Health Council were enforced. This study had the approval of the Department of Education and Culture (SEDUC) of the State of Pernambuco, which, in addition to the logistical support, provided data concerning the school census.

The study was conducted with high school students of state public schools in Caruaru. The municipality of Caruaru is located in the *Agriste* region of Pernambuco, 120 km (74.5 miles) from the state capital, Recife. It is considered the “capital of the *Agriste* of Pernambuco” and, according to the 2007 census, it had 289,086 inhabitants. The municipality is geographically divided into three regions (North, Central, South), where, according to administrative data from SEDUC, there are 15 public schools that offer high school education. The target population consisted of high schoolers (15 – 20 years) from state public schools, with a total of 8,833 students.

To calculate the sample size, the SampleXS software, distributed by WHO to support sample design in cross-sectional studies, was used. The following parameters were used: population ($n = 8,833$); confidence interval of 95%(95%CI) maximum tolerable error of five percentage points; sample design effect of 1.5; and, because it was impossible to precise the extent of the various health risk behaviors in high schoolers in Caruaru, the prevalence was set at 50%. Based on these parameters, the sample size was estimated at 541 subjects. Additionally, predicting any refusals, a decision was made to multiply the sample in 1.2, with a total final sample of

649 subjects. In the sample selection process, the following aspects were considered: (a) the proportion of students distributed by geographic region of the municipality; (b) the size of the school; and (c) period of classes (morning and evening). Students enrolled in the morning and afternoon classes were grouped into a single category (morning class students).

To that end, the sample selection was carried out in two stages and per cluster. In the first stage, the sampling unit was the school, with all state schools that offered high school education in Caruaru being considered eligible for study participation. The selection of schools was random, and the following stratification criteria were considered: (a) density of the school and of students in each microregion; and (b) school size (small, medium and large). The classification adopted to determine the size of the school was: large (500 or more students enrolled), average (between 200 and 499 students) and small (less than 200 students).

In the second stage, all classes (smaller sampling unit) from the selected schools were considered eligible for the study. A simple random sampling was used, and the following stratification criteria were considered: (a) density of classes in each school drawn; and (b) quantity of students enrolled in morning and evening periods. All drawings were made by the Randomizer software, available at www.randomizer.org, which provided random numbers. Based on the 2007 school census, there was an average of 41 students enrolled in each high school class. Therefore, 16 classes from 8 schools were randomly selected (58.6% of total schools).

For data collection, we used the questionnaire entitled “Risk behaviors in adolescents from Santa Catarina (COMCAP)”, which has been already validated and used in other studies with students from the Brazilian public education network^{19,20}. However, a pilot study was conducted in a population of a public school in Caruaru, with the same age range (15 – 20 years), presenting moderate to high reproducibility measures among Caruaru students. The questionnaire covers information related to the lifestyle of adolescents, consisting of a section of general information (sociodemographic and work-related) and five sections related to health (eating habits, physical activity, risk behaviors, preventive behaviors and self-rated health).

For the present study, information regarding the four health-related behaviors (smoking, alcohol, physical activity and frequency of consumption of fruits and vegetables) were used. The scales of measurement and the operational definition of exposure for these variables were as follows:

- Physical activity: The scale used was minutes per day and number of days per week of practice of moderate to vigorous physical activities during a typical week in the four dimensions (leisure, occupation, household and transportation). Adolescents who reported doing less than 300 minutes per week were considered as exposed.
- Alcohol: The scale used was number of days per week that the adolescent consumed alcoholic beverages. Those who reported consuming these beverages in at least one day over the week previous to the study were classified as exposed.

- Smoking: Students were questioned if they currently smoked. Those who reported currently smoking, regardless of the number of daily cigarettes, were considered exposed.
- Fruits and vegetables: The scale used was number of days per week and the number of servings eaten each day. Those who reported a frequency of consumption lower than five servings per day were considered exposed.

The other variables were divided into social and demographic (sex, age, marital status and place of residence), economic (total monthly family income and employment) and school-related (period of classes and Physical Education classes). The response categories were: sex (boys and girls), age (chronological referring to the day of the visit), place of residence (urban and rural), total monthly family income (up to 500 reais, between 501 and 1,000 reais, 1,001 – 2,000 reais and above 2,001 reais, at an exchange rate of 1 real = 1.80 dollars at the time of the study), employment (yes or no), period of classes (morning and evening) and Physical Education classes (attending and not attending).

The procedures adopted for data collection were: (a) previous contact with the school principals for submission of terms of consent and for scheduling the visit and (b) training of data collection procedures among researchers. Data collection occurred during the month of October 2007, with all students in selected classes present on the day ($n = 16$).

To survey the information, the researcher would initially inform about the research objectives, explaining to students that the information provided would be kept confidential, would not influence on their educational performance and would only be used for research purposes. In addition, students were instructed not to identify themselves at any point. Then, after the distribution of the questionnaires, the researcher would read each question, so students would then proceed to answer the questions (collective interview). In case of doubt, the researcher would interrupt their reading and clarify any doubts, as prearranged during their training. The average time for the application of the questionnaire was between 30 and 40 minutes.

The final data tabulation procedure was performed through the Epi Data software, version 3.1. In order to detect errors during entry, data were retyped on another computer. Through the software's "VALIDATE" tool, a file containing information about the typos was generated in order to correct them and guide the review process and database cleansing. After this check, data were exported to analysis software (SPSS, version 15.0). Confidence intervals were calculated using Epi Info (version 6.04d).

In the data analysis plan, some variables were grouped and others were created. The chronological age was transformed into two categories: 15 – 17 and 18 – 20. Total monthly family income was separated into two categories: up to 500 reais and over 500 reais (at an exchange rate of 1 real = 1.80 dollars at the time of the study). Risk behaviors were coded into a binary variable (presence = 1, absence = 0). The prevalence of multiple risk behaviors was estimated from the sum of the behaviors, being ranked from 0 to 4 (0 = no risk factor to 4 = all risk factors), based on the distribution observed in the sample^{7,9,11}.

The analysis of the present study was conducted in three parts and was based on international studies^{7,9,11}. Initially, the aggregation of risk factors was analyzed, with the analysis stratified by sex. Aggregation exists when the observed combination (O) exceeds the expected prevalence factors (E) of the combination. The expected prevalence of each combination of behaviors is calculated by multiplying the individual probability of occurrence of each behavior based on the occurrence observed in the study. If the result of the ratio of observed-to-expected (O/E) is greater than 1, it indicates the existence of aggregation between the behaviors^{7,9,11}.

For example, supposing that the observed prevalence of the four risk behaviors is: physical inactivity = 55%; alcohol exposure = 35%; smoking = 7.5% and low consumption of fruits and vegetables = 45%, then the expected prevalence of all behaviors at the same time is: $= 0.55 \times 0.35 \times 0.075 \times 0.45 = 0.0064$ (0.6%). However, the prevalence expected for physical inactivity, alcohol consumption, low consumption of fruits and vegetables, but absence of smoke is: $0.55 \times 0.35 \times 0.925 \times 0.45 = 0.08$ (8.0%).

Second, the prevalence odds ratio (POR) was used to calculate the aggregation of two behaviors, regardless of exposure to the other two behaviors. The PER represents the estimate that the relative odds of a behavior may have in relation to other risk behavior, which is calculated by the following equation^{9,11}:

$$N_{11} \times N_{00} / N_{10} \times N_{01}$$

Where: N_{11} is the number of individuals exposed to two risk factors, N_{00} is the number of individuals without any risk factor, N_{10} is the number of respondents who show only one of the risk factors and N_{01} represents those who show the other risk factor.

For example, a PER of 1.5 indicates that subjects who exhibit one behavior (e.g. physical inactivity) are 1.5 times more likely to also present the other behavior (e.g. low consumption of fruits and vegetables) when compared to those subjects who are not exposed to the behavior (e.g. physical inactivity).

The third and final analysis was multivariate. Therefore, the Poisson regression was used, taking as an dependent variable the exposure to three or more risk behaviors. For this analysis, the adjusting for all confounding variables was performed, with $p < 0.05$ being adopted for all analyzes as the threshold for statistical significance.

RESULTS

Eight schools and 16 classes were visited. Of all students who were present on the days of collection ($n = 624$), 24 refused to participate (3.8%). The final sample consisted of 600 students (62.5% of girls), with mean age of 17.5 years and standard deviation of 1.6.

With respect to sociodemographic and school-related variables, most students reported being single, with total monthly income exceeding 500 reais, resident in

urban areas and currently employed. There was no significant difference between the sexes according to age, total monthly family income, marital status, place of residence or attendance of Physical Education classes (Table 1). With regard to employment in adolescence and attending classes in the evening, those variables were more frequent among boys in comparison to girls.

The prevalence rates for risky behaviors were: smoking – 3.7% (95%CI 2.4 – 5.4), alcohol consumption - 29.7% (95%CI 25.4 – 32.8), inadequate consumption of fruits and vegetables – 66.7% (95%CI 62.2 – 69.9%) and physical inactivity – 41.7% (95%CI 37.2 – 45.2). There was no difference with regard to sex for smoking or for the low consumption of fruits and vegetables (Table 1).

When counting the number of negative health-related behaviors, there was a ratio of 0.3% (95%CI 0.1 – 1.3) of students who presented the four behaviors, 8.3% (95% CI 6.7 – 11.5) presented three behaviors, 38.7% (95%CI 33.8 – 41.7) presented two behaviors, 37.7% (95%CI 33.2 – 41.0) presented one behavior and 15.3% (95%CI 12.3 – 18.2) did not present any behavior. There were no significant differences according to sex (Table 1).

Table 2 shows the results of the prevalence of observed and expected aggregated factors of the four behaviors, stratified by sex. While no occurrence of the four factors aggregated was observed in boys, the prevalence observed among girls was 0.5% (95%CI 0.1 – 2.1). The absence of the four risk behaviors was similar between the sexes, a prevalence of 16.3% (95%CI 11.9 – 21.9) among boys and 14.7% (95%CI 11.3 – 18.7) being observed among girls. The aggregation ($O/E > 1.0$) of the four risk behaviors was only observed among girls.

Both in boys and girls, the occurrence of smoking appeared aggregated with any risk factor evaluated. For the aggregation of three behaviors, the most noteworthy were smoking, alcohol and physical inactivity among boys ($O/E = 3.4$), and tobacco, alcohol and low consumption of fruits and vegetables among girls ($O/E = 2.4$).

Among males, the highest aggregations of two behaviors observed were between smoking and alcohol consumption (4.6) and smoking and physical inactivity (4.2). Among the girls, for all combinations of two behaviors, with the exception of alcohol consumption and physical inactivity, there was clustering, especially smoking and alcohol consumption, which showed a cluster of 13.4, as shown in Table 2.

Table 3 indicates the prevalence and POR of the combination of two risk behaviors, regardless of exposure to the other two risk behaviors. It is suggested that, among boys, smoking and alcohol consumption are clustered, i.e., the presence of one of the behaviors is determining the presence of the other. Among girls, clustering was observed between physical inactivity and low fruit and vegetable intake.

The association between sociodemographic and school-related variables with the presence of three or more health risk behaviors (smoking, alcohol abuse, physical inactivity and/or low consumption of fruits) was also evaluated (Table 4). Adolescents who were married or had a partner, with a higher family income, who attended classes in the morning and who did not attend Physical Education classes were at risk for exposure to three or more health risk behaviors than their respective reference groups in adjusted analyzes. The other

Table 1. School-related sociodemographic characteristics and health risk behaviors among students from public schools in Caruaru.

Variables	Boys (n = 226)	Girls (n = 374)	p-value*
	%	%	
Risk behaviors			
Smoking	4.9	2.9	0.22
Alcohol abuse (\geq once a week)	38.5	23.3	< 0.001
Inadequate consumption of fruits and vegetables (< 5 portions/day)	65.5	67.1	0.68
Physical inactivity (< 300 minutes/week)	22.8	53.1	< 0.001
Number of risk factors**			
4	0	0.5	0.23
3	8.1	8.4	
2	31.7	42.2	
1	43.9	34.0	
0	16.3	14.7	
Sociodemographic factors			
Age group (years)			
14 – 17	52.7	56.2	0.33
18 – 20	47.3	43.3	
Monthly family income**			
Up to 500 reais	37.3	38.2	0.09
Between 501 and 1,000 reais	30.0	36.5	
Between 1,001 and 2,000 reais	20.5	19.5	
2,001 reais or more	12.3	5.8	
Marital status			
Single	97.3	94.1	0.06
Other	2.7	5.9	
Currently employed			
Yes	70.5	57.8	< 0.001
No	29.5	42.2	
Place of residence			
Rural	11.5	12.0	0.85
Urban	88.5	88.0	
School-related factors			
Physical Education classes			
Attends	72.1	69.3	0.45
Does not attend	27.9	30.7	
Period of classes			
Morning	36.7	49.7	< 0.001
Evening	63.3	50.3	

* χ^2 of heterogeneity; ** χ^2 for tendency.

Exchange rate of at the time of the study: 1 real = 1.80 dollars.

Table 2. Prevalence and clustering of four health risk behaviors, stratified by sex.

Risk factors	Smoking	Alcohol consumption	Low consumption of fruits and vegetables	Physical inactivity	Boys (n = 226)		Girls (n= 374)	
					O (%)	O/E	O (%)	O/E
4	+	+	+	+	*	--	0.5	2.0
3	+	+	+	-	1.2	1.3	0.5	2.4
	+	+	-	+	0.5	3.4	0.2	1.7
	+	-	+	+	0.5	1.1	1.0	1.3
	-	+	+	+	5.9	1.1	6.7	0.8
2	+	+	-	-	2.3	4.6	1.4	13.4
	+	-	-	+	1.0	4.2	1.1	2.8
	+	-	+	-	*	--	1.0	1.4
	-	+	+	-	19.9	1.1	8.1	1.3
	-	+	-	+	0.4	0.1	0.3	0.1
	-	-	+	+	8.1	0.9	30.3	1.1
1	+	-	-	-	0.9	0.1	*	--
	-	+	-	-	6.8	0.7	3.0	0.9
	-	-	+	-	31.2	1.1	20.4	0.9
	-	-	-	+	5.0	1.1	10.6	0.8
0	-	-	-	-	16.3	1.0	14.7	1.3

O = combination observed; E: expected prevalence; O/E: ratio between observed and expected; +Present factor; -Absent factor; *Value = 0.

Table 3 - Odds Ratio Prevalence of two health risk behaviors, stratified by sex.

Combination of risk factors	Boys			Girls		
	P(%)	POR	p-value	P(%)	POR	p-value
Smoking and alcohol consumption	3.5	1.82	*	1.1	1.54	
Smoking and low consumption of fruits and vegetables	1.9	0.54		2.4	1.18	
Smoking and physical inactivity	1.3	1.18		1.6	1.01	
Alcohol consumption and low consumption of fruits and vegetables	26.0	0.75		16.1	0.86	
Alcohol consumption and physical inactivity	9.8	1.15		12.0	0.90	
Physical inactivity and low consumption of fruits and vegetables	13.6	0.76		38.2	1.62	**

POR: Prevalence Odds Ratio; *p < 0.05 – Fisher's exact test; **p < 0.05 – χ^2 .

variables evaluated (sex, age, place of residence and employment) were not associated with the outcome. There was no evidence of effect modification by sex with any variable (interaction p-value > 0.20 in all cases).

Table 4. Crude and adjusted analyses of the association between sociodemographic and school-related variables with the presence of three or more risk behaviors to health.

	n (%)	Crude analysis*	Adjusted analysis*†
		PR (95%CI)	PR (95%CI)
Sex		p = 0.73	p = 0.74
Boys	221 (8.1)	1.00	1.00
Girls	368 (9.0)	1.10 (0.64 – 1.91)	1.10 (0.63 – 1.91)
Age (years)		p = 0.18	p = 0.55
14 – 17	324 (8.0)	1.00	1.00
18 – 19	265 (9.4)	1.18 (0.70 – 1.99)	1.19 (0.67 – 2.10)
Marital status		p = 0.006	p = 0.03
Single	561 (8.0)	1.00	1.00
Married/has a partner	26 (23.1)	2.88 (1.35 – 6.13)	2.34 (1.09 – 5.02)
Monthly family income (reais)		p = 0.006	p = 0.03
Up to 500	246 (4.9)	1.00	1.00
501 or more	343 (11.4)	2.33 (1.25 – 4.36)	2.04 (1.08 – 3.84)
Place of residence		p = 0.14	p = 0.13
Rural	69 (2.9)	1.00	1.00
Urban	520 (9.4)	3.25 (0.81 – 13.09)	3.05 (0.71 – 13.01)
Employment at adolescence		p = 0.09	p = 0.14
Yes	370 (10.3)	1.00	1.00
No	215 (6.1)	0.59 (0.32 – 1.08)	0.63 (0.34 – 1.17)
Period of classes		p = 0.70	p = 0.05
Morning	262 (9.2)	1.00	1.00
Evening	327 (8.3)	0.90 (0.53 – 1.52)	0.58 (0.33 – 1.01)
Attends Physical Education classes		p = 0.12	p = 0.04
Yes	173 (5.8)	1.00	1.00
No	416 (9.9)	1.71 (0.87 – 3.33)	2.14 (1.02 – 4.46)

PR: Prevalence ratio; *Wald's test; †Adjusted analysis to variables with p-value ≤ 0.20. Exchange rate of at the time of the study: 1 real = 1.80 dollars.

DISCUSSION

The aim of this study was to investigate the prevalence, clustering and associated factors of four major risk factors for non-communicable diseases (smoking, alcohol, physical inactivity and low consumption of fruits and vegetables) in high schoolers of state public schools in Caruaru, Pernambuco. The sampling procedure asserts that the size and scale of the sample was representative of the number of schools and students enrolled in the municipality. Data collection followed the planning, respecting the proportion of students enrolled per period and school size, which allows for scaling the results to the population of high schoolers in state public schools in Caruaru.

One of the strengths of this study was to investigate the aggregation of behavioral risk factors for chronic diseases and associated factors, since most studies conducted with adolescents is restricted to evaluate the occurrence of risk factors in isolation. Moreover, no study with adolescents with this type of analysis was found in the national literature.

Despite the innovative approach, this study has some limitations that need to be considered. Extrapolation of the results for adolescents in general should be made with caution, especially for students from private schools and teenagers from other regions of Brazil. Other limitations are the instrument used and the cutoff points adopted. Regarding the instrument, it is important to highlight that the consumption of fruits and vegetables was investigated by the daily frequency of portions reported by students. Therefore, it is not possible to estimate the quantity in grams of consumption, as in the study by Schuit et al.¹¹, or the number of doses, as in the study by Poortinga⁹.

It is also important to stress that information on physical activity, smoking and alcohol consumption was self-reported, which may lead to an overestimation in the case of physical activity and underestimation in the prevalence of other behaviors cited, even if the questionnaire was conducted confidentially. However, this limitation is present among the related studies^{7,9,11}. In addition, studies assessing the aggregation of risk factors for chronic diseases vary widely in the group of factors analyzed, which complicates the direct comparability of findings.

The results showed that, with the exception of smoking, other factors were present in boys and girls, with frequencies exceeding 20%. These results are important because, according to the WHO 2009 report, in developing countries, smoking, physical inactivity, alcohol consumption and low consumption of fruits and vegetables, as isolated factors, are ranked second, fourth, fifth and eighth among the leading causes of death in developing countries, respectively¹.

In Brazil, for example, information about the isolated exposure to these risk behaviors to school health is well documented. Recently, the National Adolescent School-based Health Survey (PeNSE) covered several factors related to the health of Brazilian 9th graders from the 26 state capitals and the Federal District. The present study investigated another segment of education, and observed that two out of three students do not meet recommendations for fruit and vegetable consumption, and that four in ten are physically inactive. There was no significant difference between boys and girls for smoking and consumption of fruits and

vegetables. As for alcohol consumption and physical inactivity, a difference was observed, with alcohol being more prevalent among boys and physical inactivity being more prevalent among girls. These results, regardless of the cutoff points and instrument used, correspond to findings in the literature^{7,9}, except for physical inactivity¹¹.

The simultaneity analysis consisted of grouping the exposure to two or more behaviors and verifying the prevalence found. The low prevalence of the four behaviors aggregated can be explained by this being the case of adolescents and not adults. In other related studies, the prevalence of three and four associated behaviors were higher^{7,9,11,15}.

The aggregation analysis consisted of determining the ratio of an expected and observed combination of behaviors, so that when the ratio is greater than 1, it corresponds to aggregation. In general, the ratio between the observed and the expected prevalence was higher than 1, which indicates that risk factors tend to co-occur.

Some studies⁴⁻¹¹ have shown that the occurrence of behaviors is independent, that is, a person can simultaneously present positive and negative health behaviors. In this study, positive behaviors were observed among girls for consumption of fruits and vegetables and for physical activity, while negative behaviors were observed for alcohol consumption and smoking. The results indicate similarities with other studies, and the clustering tends to occur more frequently as more negative health behaviors are added^{7,9,11}.

The POR estimative indicates how much the presence of one risk factor increases the chance of occurrence of the other behavior. The study revealed that the risk factors tended to aggregation, particularly smoking and alcohol consumption, which were more pronounced among male adolescents, and physical inactivity and low consumption of fruits and vegetables, which were higher among girls ($p < 0.05$). Among boys, a POR of 1.82 was observed, which indicates that the presence of these behaviors increases by 1.82 the occurrence of the other behavior. Among girls, the presence of one behavior, whether it is the low consumption of fruits and vegetables or physical inactivity, increases by 4.65 the occurrence of the other behavior.

In other studies^{7,9,11}, the same trend was observed, which may suggest that smoking and alcohol consumption are characterized as a group of similar behaviors in relation to exposure, and, on the other hand, physical inactivity and inadequate consumption of fruits and vegetables belong to another particular group.

The logistic regression analysis indicated that being married, having a total monthly income that exceeds 500 reais, attending classes in the morning period and not attending Physical Education classes are significant risk factors for the occurrence of three or more risk behaviors. Two of these factors are sociodemographic and socioeconomic, and the other two are school-related. However, from the point of view of intervention programs, a direct intervention can only be made in Physical Education classes.

In the present study, those students who do not attend Physical Education classes had 2.1 times higher chance of presented three or more aggregated risk behaviors. In the national literature, other cross-sectional studies have investigated both attendance in Physical Education classes and the level of physical activity²¹⁻²³, as well as other health-related

behaviors²³. In the study by Hallal et al.²², for example, a substantial part of physical activity practiced by adolescents are from Physical Education classes. On the other hand, in the study by Tassitano et al.²³, participating in Physical Education classes, regardless of the content offered, besides being associated with a higher level of physical activity, is associated with higher consumption of fruits and vegetables and less exposure to television.

The results of this study may have important implications for health policies and practices since the high prevalence of multiple risk factors for NCDs observed reinforces the importance of interventions for its reduction. It is known that interventions that target multiple behaviors have the greatest impact in reducing negative behaviors when compared to interventions in individual behaviors^{10,24}. Given that behavioral risk factors, such as those as investigated in the present study, are modifiable, identifying subgroups at higher risk of presenting multiple factors simultaneously is extremely important to avoid a higher trend of chronic diseases later in life.

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