International Journal of Public Health (2019) 64:821–830
https://doi.org/10.1007/s00038-019-01242-z

ORIGINAL ARTICLE

Clusters of risk behaviors for noncommunicable diseases in the Brazilian adult population

Dyene Aparecida Silva[1] · Ana Elisa Madalena Rinaldi[1,2] · Catarina Machado Azeredo[1,2]

Received: 22 May 2018 / Revised: 1 April 2019 / Accepted: 5 April 2019 / Published online: 6 May 2019

Abstract

Objectives To identify clusters of risk behaviors among Brazilian adults, by sex, and to associate clusters with sociodemographic factors and self-perception of health.

Methods We assessed 46,785 adults from the Brazilian National Health Survey. The risk behaviors were low consumption of fruits and vegetables—LFV (< 5 times/week), physical inactivity—PI (< 150 min/week), smoking (yes/no) and excessive consumption of alcohol—EA (5 doses for male, 4 doses for female). We used Venn diagram, cluster analysis and multinomial regression models.

Results We found 9 clusters. The cluster of four risk behaviors was more common in males (3.2% vs. 0.83%). Despite a greater potential for aggregation of behaviors in females (*O*/*E* = 2.48) than in males (*O*/*E* = 1.62), the women were less likely to have all risk behaviors jointly (OR 0.24, 95% CI 0.19; 0.31), and this was found for the other clusters. In general, Brazilian black/brown, younger, with low education level and who had a self-perception of bad health, were more likely to engage in clusters of risk behaviors.

Conclusions The prevalence of Brazilian adults engaging in clusters of risk behaviors is high, mainly among males, those who reported a bad health and with low socioeconomic status.

Keywords Health-related behaviors · Health risk behaviors · Noncommunicable disease · Cluster · Venn diagram

Introduction

Noncommunicable diseases (NCDs) are the main causes of morbidity and mortality in the world, and all of them share four main risk behaviors: low consumption of fruits and vegetables, physical inactivity, smoking and excessive consumption of alcoholic beverages (WHO 2014; Benziger et al. 2016). These risk behaviors are often individually analyzed, although they do not occur in isolation, which limits a comprehensive understanding of all health risk burden (Barreto and Figueiredo 2009; Dumith et al. 2012). In addition, the simultaneous exposure to more than one risk behavior can jeopardize health more than the sum of the individual risks (Yusuf et al. 2004; Poortinga 2007; Silva et al. 2013).

Cluster analysis is a reliable method to jointly identify risk behaviors and groups with common characteristics (Dumith et al. 2012). In an integrated way, this analysis allows verifying greater exposure to risk or protective behaviors (Stenholm et al. 2016).

A study conducted in Brazil between 2002 and 2008, with 47,886 industry workers, showed that the cluster "low consumption of fruits and vegetables, physical inactivity, smoking and excessive consumption of alcoholic beverages" presented greater potential for aggregation in females (Del Duca et al. 2012). In another study conducted in England with a sample of 11,492 individuals aged 16–64, the results were similar to the Brazilian one

✉ Catarina Machado Azeredo
catarina.azeredo@ufu.br

Dyene Aparecida Silva
dyene.nutriufu@hotmail.com

Ana Elisa Madalena Rinaldi
anarinaldi@ufu.br

[1] Postgraduate program in Science of Health, School of Medicine, Federal University of Uberlandia, Uberlândia, MG, Brazil

[2] Nutrition Course, School of Medicine, Federal University of Uberlandia, Uberlândia, MG, Brazil

(Poortinga 2007). In 2003, it was observed that in 6052 Australian adults between 28 and 72 years old, the *cluster* "smoking, excessive consumption of alcoholic beverages and physical inactivity" presented greater potential for aggregation in females and among younger individuals (Morris et al. 2016).

The behavioral differences between the genders are generally justified by social, structural and psychosocial determinants that are considered more important for the female and the behavioral issues for the male (Denton et al. 2004). However, gender differences in these associations are still poorly reported (Faleiro et al. 2017). According to the literature, males are more exposed to risk behaviors and have lower use of health services (Broom 2009).

Although some studies in Brazil present the prevalence of risk behaviors, they are not representative of the Brazilian population (Tassitano et al. 2010; Del Duca et al. 2012; Costa et al. 2013; Loch et al. 2015; Cruz et al. 2017). Brazil is a country with continental dimensions that has different social, economic and health conditions of life. For example, the life expectance in Santa Catarina (state from south region) is 79.1 years of life and in Maranhão (state from northeast region) is 70.6 years of life (IBGE 2018). The conditions of life from south and southeast regions do not represent the conditions from north and northeast regions. These differences have reflects in behaviors. A survey in all Brazilian state capitals found that the prevalence of smoking ranged from 14.3 to 19.5% for males and 11.0 to 18.0% for females. For heavy alcohol consumption the prevalence ranged from 23.9 to 31.7% for male and 15.3 to 21.2% for females (Brasil 2018). Our study fulfills a gap in the Brazilian literature, because it was conducted using a representative sample from Brazilian adult/elderly population.

Thereby, the objectives of the present study were to identify *clusters* of risk behaviors related to NCDs in the Brazilian adult population and to associate them with sociodemographic factors and self-perception of health.

Methods

Data source and sampling

The data used came from the National Health Survey (PNS) (2013), whose objectives were to evaluate the performance of the national health system, the health conditions of the Brazilian population, the surveillance of chronic noncommunicable diseases and associated risk behaviors (Malta et al. 2008).

The PNS was carried out in partnership with the Brazilian Institute of Geography and Statistics (IBGE), which has a home base and national scope, being part of the Integrated System of Home Surveys (SIPD) and has a periodicity of 5 years. The PNS sample had geographic coverage and was comprised by the census sectors of the Geographical Operational Base of the Demographic Census 2010, except for those with a very small number of households and the special sectors (military barracks, military bases, accommodations, camps, boats, prisons, retirement homes, orphanages, convents and hospitals).

The PNS was designed to represent Brazilian adults and elderly population resident in permanent private households, all five geographic regions and urban and rural settings. The Brazilian Institute of Geography and Statistics (IBGE in Portuguese) developed a Master Sample of the Integrated Household Surveys System (SIPD) from demographic census that has been applied in all household surveys carried out in Brazil. The sample of PNS is a subsample of the Master Sample that is composed by clusters of cities (metropolitan cities, medium-size and small-size cities). The selection of cluster (census tracts) is proportional to their size. The sample was defined using clustering and stratification in three stages. The primary sample unit was composed by clusters (census tracts) selected by simple random sampling; the second sample unit was composed by a fixed number of permanent private households in each second sample unit. The number of household by second sample unit was 10 out of 14 depending on the dissemination domain, and the third sample unit was composed by an adult/elderly resident from household by simple random sampling (equiprobability of selection). It is possible to access the sample size by state from Brazil in the manuscript from Souza-Júnior et al. (2015). The minimum sample of households selected for the survey was 23% higher to consider all losses, nonresponse rate and rate of misclassification of units in the records (Damacena et al. 2015). The total number of households visited was 81,167, but 69,994 were occupied. The number of interviews was 64,348, and the total number of a selected household with complete interview was 60,202. The response rate was 91.9% (Malta et al. 2015). For the purpose of this study, we have assessed data of Brazilian adults (n = 46,785), therefore, excluding those adolescents (< 20 years) and elderly (> 60 years).

Collection and measurement instrument

The present study used questions related to the individual questionnaire of the selected resident and the area of residence (urban or rural) from the household questionnaire. Thematic modules that constituted the questionnaire were composed of general information (sociodemographic characteristics), self-perception of health status, safety (accidents and violence), diet, physical activity, tobacco use, alcohol, diagnosis of chronic diseases (diabetes

mellitus, systemic arterial hypertension, hypercholesterolemia, asthma or asthmatic bronchitis, arthritis or rheumatism, chronic spinal problem, work-related musculoskeletal disorder, depression, mental illness, lung diseases, renal and cancer), anthropometry and laboratory tests. The interviews were conducted using personal digital assistance (PDA).

Risk behaviors

The delimitation of the variables of interest present in the PNS questionnaire (2013) was based on the theoretical reference of risk behaviors for the onset of NCDs, such as low consumption of fruits and vegetables (LFV), physical inactivity (PI), smoking and excessive consumption of alcoholic beverages (WHO 2014).

Fruits and vegetables consumption was considered low when it occurred less than five times in the last week for both (WHO 2014). It was considered excessive consumption of alcoholic beverages when the intake was more than five doses per week in males and more than four doses per week in females (Gunzerath et al. 2004), being a "dose" the equivalent to a can of beer, a glass of wine or a dose of cachaça, whiskey or any other distilled drink. The practice of physical activity was measured based on responses to a questionnaire consisting of questions on the frequency and duration of physical activity in different domains (leisure, work and displacement). For each of the domains evaluated, scores of activity practice were constructed by multiplying the weekly frequency by time duration on the days when the activity was performed. We considered physical inactive, adults who did not reach at least 150 weekly minutes of physical activity considering leisure, work and displacement activities (Mielke et al. 2015). Individuals who reported smoking some tobacco product at the time of the interview were classified as smokers (Del Duca et al. 2012).

The following sociodemographic variables were evaluated: gender (male and female), age (20–29; 30–39; 40–49; 50–59 years old), education level (incomplete elementary school, complete elementary school, complete high school and complete higher education), and color/race. The color/race was assessed based on individuals self-report, following the recommendation of Brazilian government and the Brazilian Institute of Geography and Statistics, and the options were: white, black, brown, yellow (Asian) or indigenous (Brasil 2011). We assessed the employment situation (employed or unemployed) and the area of residence (urban or rural). We also assessed the self-perception of health status. This variable was measured by the question: "In general, how do you evaluate your health? Very good, good, regular, bad or very bad?" The answers were grouped into two categories: "Good" (including those who answered "very good" and "good") and "Bad" (including those who answered "regular," "bad" and "very bad"), according to Esteban y Peña et al. (2010).

Statistical analysis

Cluster analysis was performed, to explore clusters of risk behaviors, by aggregating the individuals into subgroups (Stenholm et al. 2016). Each variable of the risk behaviors was categorized as "0 (−)"—the absence of risk behavior—and "1 (+)"—the presence of risk behavior, and the *cluster* was formed from these variables. In this way, the final score ranged from 0 to 4, 0 being the absence of risk behavior and 4 the presence of all risk behaviors, according to the distribution observed in the sample.

Clusters were defined by combining the prevalence of observed and expected behaviors. The expected prevalence in the combination was calculated by multiplying the individual's prevalence of each individual observed in the survey. The cluster was calculated taking into account the observed/expected risk. It was considered a cluster when the observed/expected result was higher than 1 (Schuit et al. 2002; Barreto and Figueiredo 2009). The higher the result, the greater the aggregation potential of the cluster was, which is related to the interaction of risk behaviors when they occur.

The observed and expected prevalence was made with 16 possible combinations for the four risk behaviors. Clusters were constructed according to gender, in order to identify whether there are distinct patterns between genders.

The analysis was performed in two stages. In the first stage, we identified clusters according to gender and their respective prevalence. Subsequently, the clusters found were used to elaborate a noun variable classifying adults as: "not engaged in any risky behaviors" (0); "engaged in alcohol cluster" (1); "engaged in alcohol and smoking cluster" (2); "engaged in LFV and PI cluster" (3); "engaged in LFV, Alcohol and smoking cluster" (4); "engaged in alcohol, smoke and PI" (5); "engaged in the four risk behavior cluster" (6). This variable was the dependent variable in a multinomial regression model to test associations with sociodemographic variables and self-perceived health, having the group "not engaged in any risk behaviors" as reference. Thus, it was possible to identify vulnerable subgroups to each cluster of risk behaviors. The significance level was 5%.

In order to represent the coexistence of risk behaviors in males and females, the Venn diagram was used. This method made possible to compare and visualize the data set based on the intersection of graphical forms to show the overlap of common characteristics (Ferreira et al. 2017).

All statistical analyses were performed on Stata SE software version 13.1.

Ethical aspects

The National Health Survey project was approved by the National Research Ethics Committee of the National Health Council (CNS) in June 2013. The data used in this study are available on the IBGE Web site, without containing information that may identify the subjects of the research.

Results

A total of 46,785 individuals participated in this study, of which 52.1% were female. The majority was aged between 20 and 29 years old (31.8%), white (46.1%) and brown (43.2%), with complete high school (41.9%) and good health self-perception (70.8%). When analyzed in isolation, the most frequent risk behaviors were physical inactivity (56.8%) and low consumption of fruits and vegetables (68.0%) (Table 1).

According to the Venn diagram, it was found that the coexistence of 4 risk behaviors was more common in males (3.23% vs. 0.82% in females). Low consumption of fruits and vegetables and physical inactivity were the most prevalent risk behaviors, in both males (33.7%) and females (40.0%). The absence of risk behaviors was more common in females (15.75%) than in males (8.79%) (Fig. 1).

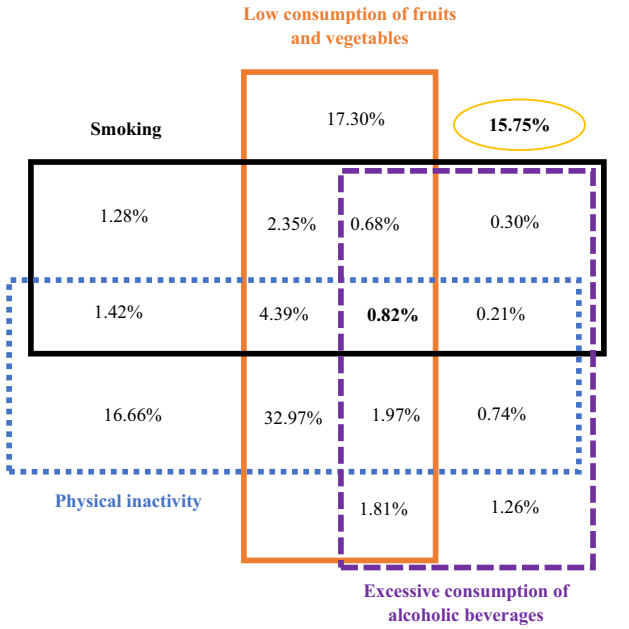
The prevalence of observed, expected and the ratio observed/expected (*O*/*E*) for the 16 possible combinations of risk behaviors by gender are described in Table 2. We found 10 clusters, and 7 were found for both sexes. The cluster of four and three risk behaviors occurred in both genders. For four risk behaviors, there was higher aggregation potential in females (*O*/*E* = 2.48) than in male sex (*O*/*E* = 1.62). The clusters of three risk behaviors, "LFV, alcohol and smoking" (*O*/*E* = 3.00) presented greater potential for aggregation in females, while "alcohol, smoking and PI," presented similar potential for aggregation in both sexes (*O*/*E* = 1.13 in male; *O*/*E* = 1.05 in female). The cluster of "FLV, smoking and PI" was found among women (*O*/*E* = 1.12).

The most common combination was "low consumption of fruits and vegetables and physical inactivity" for both genders (male: 26.21%, female: 32.97%), according to Venn diagram; however, this cluster presented low aggregation potential (*O*/*E* = 1.08 in males; *O*/*E* = 1.09 in females). The cluster "alcohol and smoking" also presented a higher aggregation potential in females (*O*/

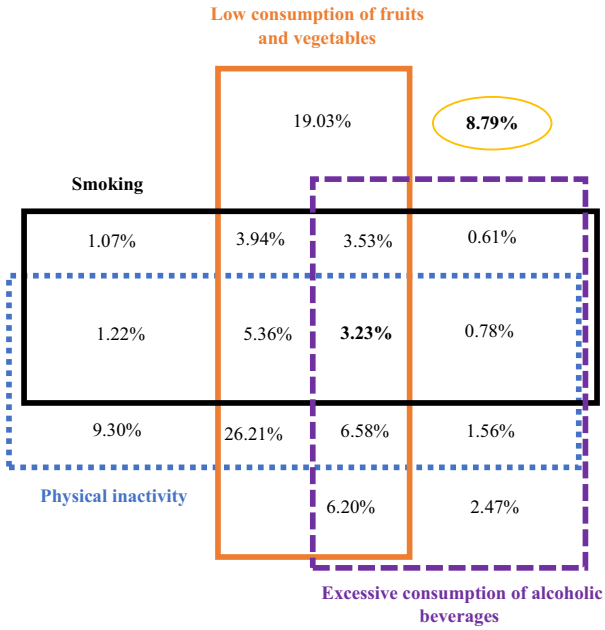
Table 1 Sociodemographic characteristics and risk behaviors in the Brazilian adult population according to sex

Variable	Males 47.8% (%)	Females 52.1% (%)	Total %
Age range (years)			
20–29	32.9	30.7	31.8
30–39	26.2	26.4	26.3
40–49	21.0	22.9	22.0
50–59	19.7	19.7	19.7
Color			
White	45.6	46.6	46.1
Black	9.7	8.6	9.1
Yellow	0.7	1.0	0.8
Brown	43.3	43.2	43.2
Indigenous	0.4	0.5	0.4
Education level			
Incomplete elementary school	12.2	12.2	12.2
Complete elementary school	31.6	26.9	29.2
Complete high school	41.3	42.6	41.9
Complete higher education	14.8	18.1	16.5
Self-perception of health			
Good	74.7	67.1	70.8
Bad	25.2	32.8	29.1
Risk behaviors			
Low consumption of fruits and vegetables	74.1	62.3	68.0
Excessive consumption of alcoholic beverages	25.0	7.8	16.0
Smoking	19.8	11.5	15.4
Physical inactivity	54.3	59.2	56.8

Brazilian National Health Survey (Pesquisa Nacional de Saúde PNS), Brazil 2013



(a) Coexistence of risk behaviors among females



(b) Coexistence of risk behaviors among males

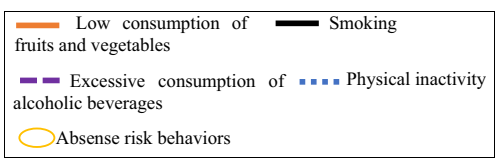


Fig. 1 Coexistence of risk behaviors in Brazilian adult individuals according to sex, Brazilian National Health Survey (Pesquisa Nacional de Saúde PNS), Brazil 2013

E = 2.22 females; O/E = 1.06 males). The cluster "LFV and alcohol" (O/E = 1.03) occurred only in females.

The analysis of sociodemographic factors associated with clusters of risk behaviors for both sexes is shown in Table 3. All clusters were less likely to occur in females (OR 0.13, 95% CI 0.10–0.17), among those with higher education (OR 0.29, 95% CI 0.17–0.50), aged between 50 and 59 years (OR 0.41, 95% CI 0.27–0.63) and employed (OR 0.66, 95% CI 0.48–0.90) and higher probability of occurring in black adults (OR 1.54, 95% CI 1.03–2.31) and with poor self-perception (OR 1.64, 95% CI 1.21–2.21). The same tendency was observed, in general, for the cluster of three and two risk behaviors.

Table 4 shows the analysis of sociodemographic factors and self-perceived health associated with the risk behavior *clusters* occurring in different sexes. In females, the probability of adherence to the cluster "low consumption of fruits and vegetables and excessive consumption of alcoholic beverages" was lower among those aged 50–59 years (OR 0.09, 95% CI 0.04–0.18) and higher probability of occurring in black adults (OR 2.03, 95% CI 1.17–3.54). The "low fruit and vegetables, smoking and physical inactivity" was lower in females with higher education (OR 0.12, 95% CI 0.08–0.19) and employed (OR 0.47, 95% CI 0.37–0.60) and higher in females who live in rural area (OR 1.59, 95% CI 1.15–2.20) and with poor self-perception (OR 1.54, 95% CI 1.17–2.02). In males, the probability of adherence to the cluster "physical inactivity" was lower among those employed (OR 0.40, 95% CI 0.28–0.55) and higher in males with 50–59 years old (OR 1.54, 95% CI 1.17–2.02), with poor self-perception (OR 1.40, 95% CI 1.08–1.81).

Discussion

In the present study 10 clusters of the four risky behaviors were observed. Males presented higher number of clusters, and 70% of all clusters were the same for both genders. The potential aggregation of clusters of risk factors was higher for females. In general, females, individuals aged higher than 40 years and higher education were less likely to present clusters of health behaviors, and self-reported brown and black and those self-perceived their health as bad were more likely. The clusters "LFV and alcohol" and "LFV, smoking and PI" were aggregated only for females and "physical inactivity" only for males.

Clusters of four and three risk behaviors had greater potential for aggregation in females. Although similar results are reported in the literature, it is not clear what factors could explain this finding (Del Duca et al. 2012). However, despite the greater potential for aggregation in females, males had higher probability of adherence in all common clusters. Studies among Brazilian adults support our finding (Del Duca et al. 2012; Cruz et al. 2017), and the

Table 2 Description of *cluster* (grouping) of risk behaviors in the Brazilian adult population according to sex

Number of risk behaviors	Presence of risk behaviors				Males (47.1%)			Females (52.9%)		
	Low consumption of fruits and vegetables	Excessive consumption of alcoholic beverages	Smoking	Physical inactivity	% *O*	% *E*	*O*/*E*	% *O*	% *E*	*O*/*E*
4	+	+	+	+	3.23	1.99	**1.62**	0.82	0.33	**2.48**
3	+	+	+	−	3.53	1.67	**2.11**	0.68	0.22	**3.00**
	+	+	−	+	6.58	8.06	0.82	1.97	2.56	0.77
	+	−	+	+	5.36	5.97	0.90	4.39	3.91	**1.12**
	−	+	+	+	0.78	0.69	**1.13**	0.21	0.20	**1.05**
2	−	−	+	+	1.22	2.08	0.59	1.42	2.36	0.60
	+	+	−	−	6.20	6.78	0.91	1.81	1.76	**1.03**
	−	+	+	−	0.61	0.58	**1.06**	0.30	0.13	**2.22**
	+	−	−	+	26.21	24.21	**1.08**	32.97	30.11	**1.09**
	−	+	−	+	1.56	2.81	0.55	0.74	1.54	0.48
	+	−	+	−	3.94	5.02	0.79	2.35	2.69	0.87
1	−	−	−	+	9.33	8.45	**1.10**	16.66	18.19	0.92
	−	−	+	−	1.07	1.75	0.61	1.28	1.62	0.79
	−	+	−	−	2.47	2.37	**1.04**	1.26	1.06	**1.18**
	+	−	−	−	19.03	20.36	0.93	17.30	20.73	0.83
0	−	−	−	−	8.79	7.11	**1.24**	15.75	12.52	**1.26**

Brazilian National Health Survey (Pesquisa Nacional de Saúde PNS), Brazil 2013

+, presence of risk behavior; −, absence of risk behavior; O, observed; E, expected. The *O*/*E* in bold indicates a significant clustering of risk behaviors

explanation could be that there is less health concern and greater acceptance social behavior of risk behaviors by men than by women (Brasil 2009; Moura et al. 2012).

The oldest adults (50–59 years) were less likely to present clusters of behaviors, which is in accordance with other studies (Poortinga 2007; Silva et al. 2013). This result may be related to the fact that young people are less concern about NCDs and therefore engage in more risky behaviors, since these diseases tend to develop later in life (Barreto and Figueiredo 2009).

It was observed that, in general, those with lower socioeconomic status were more likely engaged in clusters of risky behaviors. For example, the higher the level of education, the lower the probability of presenting clusters of risk behaviors, and the same of found for those employed. In the literature, the low education level is associated with several combinations of risk behaviors (Loch et al. 2015) as well as the smaller access to resources, available information and the use of health services (Del Duca et al. 2012; Muniz et al. 2012). In addition, it is directly related to the low income (Senger et al. 2011) that may reflect the adoption of risk behaviors. The literature also shows that the engagement in risky behaviors is more common among those unemployed (Poortinga 2007). Moreover, self-reported black individuals were more likely to adhere to risk behaviors, which is corroborated in a previous study (Silva et al. 2013). In Brazil, there have been advances in income distribution, but social inequality still remains (IPEA 2011). According to PNAD (2016), the black self-declaring population in Brazil represents 8.9% of the population. Studies on social exclusion and health conditions of black individuals (Araújo et al. 2010) show greater exposure to worse working conditions, lower wages and more restrictions on access to health services (IPEA 2011; Malta et al. 2015). Low levels of education and illiteracy are more frequent among blacks. In 2009, only 8.3% of blacks had higher education, 6.9% were men, and 9.9% were women. Thus, all these issues may favor adherence to unhealthy behaviors (IPEA 2011).

Brazilian adults with poor self-rated health were more likely to engage in most clusters of behaviors. We found no studies exploring associations between clusters of behaviors and self-rated health. However, we found studies that assessed isolated behaviors and self-rated health. Among Brazilians, smoking > 20 cigarettes/day, lack of regular physical activity in leisure time and low weight or obesity were associated with poor self-rated health in both sexes. A

Table 3 Description of sociodemographic characteristics and self-perception of health associated with clusters of risk behaviors for chronic noncommunicable diseases in the Brazilian adult population

Variable	Cluster 1[a]	Cluster 2[a]		Cluster 3[a]		Cluster 4[a]
	Alcohol	Alcohol and smoke	Low fruit and vegetables and physical inactivity	Low fruit and vegetables; alcohol and smoking	Alcohol; smoke and physical inactivity	All behaviors jointly
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex						
Male	1.00	1.00	1.00	1.00	1.00	1.00
Female	**0.29 (0.21; 0.39)**	**0.33 (0.20; 0.52)**	**0.61 (0.54; 0.69)**	**0.11 (0.08; 0.15)**	**0.15 (0.09; 0.27)**	**0.13 (0.10; 0.17)**
Age (years)						
20–29	1.00	1.00	1.00	1.00	1.00	1.00
30–39	1.01 (0.73; 1.38)	1.38 (0.81; 2.37)	0.86 (0.74; 1.01)	**0.52 (0.37; 0.73)**	0.79 (0.35; 1.75)	0.85 (0.60; 1.21)
40–49	**0.62 (0.44; 0.89)**	0.71 (0.37; 1.36)	**0.60 (0.51; 0.71)**	**0.29 (0.21; 0.41)**	0.78 (0.38; 1.62)	**0.61 (0.42; 087)**
50–59	**0.59 (0.39; 0.91)**	0.53 (0.27; 1.05)	**0.49 (0.42; 0.59)**	**0.21 (0.14; 0.31)**	0.74 (0.33; 1.63)	**0.41 (0.27; 0.63)**
Color						
White	1.00	1.00	1.00	1.00	1.00	1.00
Black	1.77 (1.19; 2.62)	1.28 (0.69; 2.39)	1.22 (0.9; 1.54)	**2.73 (1.76; 4.23)**	1.71 (0.74; 3.95)	**1.54 (1.03; 2.31)**
Yellow	1.43 (0.46; 4.47)	0.18 (0.02; 1.38)	0.87 (0.47; 1.59)	0.97 (0.23; 4.03)	0.84 (0.15; 4.75)	0.58 (0.21; 1.59)
Brown	1.46 (1.11; 1.94)	1.26 (0.81; 1.97)	**1.29 (1.13; 1.47)**	**1.83 (1.37; 2.45)**	1.58 (0.94; 2.67)	**1.36 (1.03; 1.79)**
Indigenous	0.50 (0.16; 1.60)	8.4 e−10 (4.28e−10; 1.65 e−09)	1.00 (0.52; 1.91)	2.70 (0.54; 13.35)	0.97 (0.12; 8.11)	0.97 (0.34; 2.75)
Education level						
Incomplete elementary school	1.00	1.00	1.00	1.00	1.00	1.00
Complete elementary school	1.44 (0.79; 2.64)	1.16 (0.56; 2.42)	**0.78 (0.63; 0.97)**	1.09 (0.75; 1.58)	1.28 (0.53; 3.10)	0.96 (0.63; 1.45)
Complete high school	1.37 (0.75; 2.51)	0.50 (0.23; 1.10)	**0.52 (0.42; 0.65)**	**0.30 (0.19; 0.46)**	0.53 (0.20; 1.38)	**0.46 (0.29; 0.72)**
Complete higher education	1.60 (0.84; 3.06)	0.59 (0.27; 1.30)	**0.35 (0.27; 0.45)**	**0.23 (0.14; 0.39)**	0.45 (0.16; 1.26)	**0.29 (0.17; 0.50)**
Employment						
Unemployed	1.00	1.00	1.00	1.00	1.00	1.00
Employed	1.00 (0.69; 1.44)	**2.35 (1.31; 4.22)**	**0.63 (0.55; 0.71)**	1.47 (0.91; 2.38)	0.87 (0.45; 1.68)	**0.66 (0.48; 0.90)**
Area						
Urban	1.00	1.00	1.00	1.00	1.00	1.00
Rural	0.76 (0.49; 1.16)	0.61 (0.30; 1.26)	**1.61 (1.34; 1.94)**	0.90 (0.63; 1.28)	0.66 (0.30; 1.46)	0.79 (0.56; 1.10)
Self-perception of health						
Good	1.00	1.00	1.00	1.00	1.00	1.00
Bad	0.77 (0.57; 1.05)	1.11 (0.70; 1.78)	**1.26 (1.10; 1.43)**	**1.41 (1.08; 1.83)**	1.17 (0.67; 2.05)	**1.64 (1.21; 2.21)**

Brazilian National Health Survey (Pesquisa Nacional de Saúde PNS), Brazil 2013

OR odds ratio, 95% *CI* confidence interval

[a]Models were adjusted for all variables

Table 4 Description of sociodemographic characteristics and self-perception of health associated with clusters of risk behaviors for chronic noncommunicable diseases in the Brazilian adult population

Variable	Cluster 1[a] (male) Physical inactivity OR (95% CI)	Cluster 2[a] (female) Low fruit and vegetables and alcohol OR (95% CI)	Cluster 3[a] (female) Low fruit and vegetables, smoking and physical inactivity OR (95% CI)
Age (years)			
20–29	1.00	1.00	1.00
30–39	**1.60 (1.18; 2.16)**	0.68 (0.46; 1.02)	0.84 (0.59; 1.18)
40–49	**1.58 (1.17; 2.13)**	**0.32 (0.22; 0.48)**	0.82 (0.58; 1.16)
50–59	**1.72 (1.24; 2.39)**	**0.09 (0.04; 0.18)**	0.78 (0.53; 1.14)
Color			
White	1.00	1.00	1.00
Black	0.89 (0.58; 1.37)	**2.03 (1.17; 3.54)**	1.36 (0.88; 2.12)
Yellow	0.47 (0.18; 1.22)	1.93 (0.39; 9.50)	1.14 (0.30; 4.30)
Brown	0.85 (0.66; 1.09)	**1.80 (1.20; 2.71)**	1.25 (0.97; 1.60)
Indigenous	0.93 (0.30; 2.84)	3.22 (0.94; 10.98)	1.77 (0.51; 6.08)
Education level			
Incomplete elementary school	1.00	1.00	1.00
Complete elementary school	1.08 (0.71; 1.63)	1.18 (0.60; 2.33)	0.75 (0.55; 1.03)
Complete high school	0.90 (0.59; 1.35)	0.91 (0.44; 1.86)	**0.17 (0.12; 0.26)**
Complete higher education	0.85 (0.53; 1.34)	0.64 (0.30; 1.38)	**0.12 (0.08; 0.19)**
Employment			
Unemployed	1.00	1.00	1.00
Employed	**0.40 (0.28; 0.55)**	1.09 (0.74; 1.62)	**0.47 (0.37; 0.60)**
Area			
Urban	1.00	1.00	1.00
Rural	0.98 (0.71; 1.37)	0.96 (0.40; 2.31)	**1.59 (1.15; 2.20)**
Self-perception of health			
Good	1.00	1.00	1.00
Bad	**1.40 (1.08; 1.81)**	0.87 (0.61; 1.23)	**1.54 (1.17; 2.02)**

Brazilian National Health Survey (Pesquisa Nacional de Saúde PNS), Brazil 2013

OR odds ratio; *CI* confidence interval

[a]Models were adjusted for all variables

study among adult Colombian found that low levels of leisure time physical activity were associated with regular and poor self-perceived health status in women, although this relationship was not observed in men (Romero and Urbina 2017). On the other hand, among Saudi adults, smoking, obesity and physical inactivity were not associated with self-reported health (Moradi-Lakeh et al. 2015). Since the associations seem to be inconsistent, other studies should explore them.

The *cluster* of "LFV and alcohol" was found only among females, and it was associated with black and older woman (50–59 years). Excessive consumption of alcoholic beverages may be associated with consumption of snack foods such as processed and canned foods, for example, which could replace fruits and vegetables in the diet and result in low consumption of fruits and vegetables (Senger et al. 2011); however, further research is needed. Although in Brazil the availability and diversity of fruits are large, the consumption of these foods is still low. According to data from surveillance of risk factors and protection for chronic diseases by telephone survey (VIGITEL), only 40.7% of women consume fruits and vegetables $\geq$ 5 times a week (Brasil 2017).

The general prevalence of low consumption of fruit and vegetables (68.0%) and the physical inactivity (56.8%) was high among Brazilian adults. Similar results have been reported previously (Brasil 2017; De Rezende et al. 2015). Only one out of three Brazilian adults consumes regularly (5 or more times a week) fruit and vegetables (Brasil 2017), and only one out of five Brazilian population reported to practice physical activity (De Rezende et al. 2015). When addressing these two risky behaviors at population level, we have to take into consideration the social determinants, including cultural, demographic,

differences in access to goods and services; low levels of education; and differences in access to information. A recent study in Brazil showed that among natural food, the vegetables were the most expensive; in addition, the high convenience and massive marketing promoting ultra-processed food in Brazil favors the replacement of fruit and vegetables for ultra-processed food consumption (Claro et al. 2016). For physical activity the scenario is similar; policy makers should invest in health promotion strategies, transport, socioeconomic development, education, sport and leisure, to decrease the high prevalences of physical inactivity (De Rezende et al. 2015).

This study has some limitations. The first is that non-differential information bias could have occurred, influencing the prevalence of the behaviors evaluated. In addition, for the consumption of fruits and vegetables, it was not possible to know the amount consumed daily, in order to compare with the daily recommendation by the World Health Organization. In addition, the restrictions we made to investigate only four risk behaviors may have limited outcomes. However, the four behaviors chosen are the major modifiable risk factors for NCDs (WHO 2014).

The positive aspects of the study include the use of a representative sample of the Brazilian population and the high response rate. These positive points minimize the possibility of selection bias and allow a better understanding of the co-occurrence of risk behaviors in the Brazilian population. In addition, cluster analysis allowed us to work with clusters, not just with each risk behavior in isolation.

Our results showed that the isolated presence of risk behaviors is very low and that the more vulnerable to adopt clusters of risk behaviors are males, younger, black color individuals, with lower socioeconomic status and which have a bad perception of their health status. Thus, it is extremely important to investigate the causes that lead to the adoption of clusters of risk behaviors considering the current health status of the population and its reflection in the NCDs. The Strategic Action Plan for Coping with NCDs in Brazil (2011–2022), prepared by the Ministry of Health, has as a positive point to appoint the four risk behaviors together, since the actions advocated in this plan should be implemented jointly.

Acknowledgements The present research received financial support from Brazilian National Council of Scientific and Technological Development (CNPq), 404905/2016-1, awarded to Catarina Machado Azeredo.

Compliance with ethical standards

Conflict of interest The authors declare that there are no conflicts of interest.

Ethical approval The National Health Survey project was approved by the National Research Ethics Committee (CONEP) of the National Health Council (CNS) in June 2013. The data used in this study are available on the IBGE Web site, without any information that may identify the subjects of the research.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

AdeM Souza, Pereira RA, Yokoo EM, Levy RB, Sichieri R (2013) Most consumed foods in Brazil: National Dietary Survey 2008–2009. Revista de Saúde Pública 47(Suppl. 1):190s–199s. https://doi.org/10.1590/S0034-89102013000700005

Araújo EM, Costa MCN, Noronha CV, Hogan VK, Vines AI, Araújo TM (2010) Inequalities in health and race/skin color: literature review of Brazil and the United States (1996–2005). Saúde Coletiva 7(40):116–121

Barreto SM, Figueiredo RC (2009) Chronic diseases, self-perceived health status and health risk behaviors: gender differences. Revista de Saúde Pública 43:38–47

Benziger CP, Roth GA, Moran AE (2016) The global burden of disease study and the preventable burden of NCD. Glob Heart 11(4):393–397

Brasil (2009) Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento de Ações Programáticas e Estratégicas. Política Nacional de Atenção Integral à Saúde do Homem: princípios e diretrizes/Ministério da Saúde, Secretaria de Atenção à Saúde, Departamento de Ações Programáticas e Estratégicas—Brasília: Ministério da Saúde. 92

Brasil (2011) Instituto Brasileiro de Geografia e Estatística—IBGE. Censo demográfico 2010. Características da população e dos domicílios. Resultados do universo. Rio de Janeiro

Brasil (2017) Ministério da Saúde. Secretaria de Vigilância em Saúde. Departamento de Vigilância de Doenças e Agravos não Transmissíveis e Promoção da Saúde. Vigitel Brasil 2016: vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico: estimativas sobre frequência e distribuição sociodemográfica de fatores de risco e proteção para doenças crônicas nas capitais dos 26 estados brasileiros e no Distrito Federal em 2016/Ministério da Saúde, Secretaria de Vigilância em Saúde, Departamento de Vigilância de Doenças e Agravos não Transmissíveis e Promoção da Saúde—Brasília: Ministério da Saúde

Brasil (2018) Ministério da Saúde. Datasus—Tecnologia da informação a serviço do SUS. Disponível em: http://tabnet.datasus.gov.br/cgi/deftohtm.exe?vigitel/vigitel10.def. Acesso em 25 de setembro de 2018

Broom DH (2009) Men's health and women's health—deadly enemies or strategic allies. Crit Public Heath 19(3–4):269–277

Claro RM, Maia EG, Costa BVdeL, Diniz DP (2016) Food prices in Brazil: prefer cooking to ultra-processed foods. Cadernos de Saúde Pública 32(8):e00104715. https://doi.org/10.1590/0102-311X00104715

Costa FF, Benedet J, Leal DB, Assis MAA (2013) Clustering of risk factors for noncommunicable diseases in adults from Florianopolis, SC. Revista Brasileira de Epidemiologia 16(2):398–408

Cruz MF, Ramires VV, Wendt A, Mielke GI, Martinez-Mesa J, Wehrmeister FC (2017) Simultaneity of risk factors for chronic non-communicable diseases in the elderly in Pelotas, Rio Grande do Sul State, Brazil. Cadernos de Saúde Pública 33(2):e00021916

Damacena GN, Szwarcwald CL, Malta DC et al (2015) The development of the national health survey in Brazil, 2013. Epidemiologia e Serviços de Saúde 24(2):197–206

De Rezende LFM, Rabacow FM, Viscondi JYK, OdoC Luiz, Matsudo VKR, Lee IM (2015) Effect of physical inactivity on major noncommunicable diseases and life expectancy in Brazil. J Phys Activity Health 12(3):299–306. https://doi.org/10.1123/jpah.2013-0241

Del Duca GF, Silva KS, Garcia LMT, Oliveira ESAO, Nahas MV (2012) Clustering of unhealthy behaviors in a Brazilian population of industrial workers. Prev Med 54:254–258

Denton M, Prus S, Walters V (2004) Gender differences in health: a Canadian study of the psychosocial, structural and behavioural determinants of heath. Soc Sci Med 58:2585–2600

Dumith SC, Muniz LC, Tassitano RM, Hallal PC, Menezes AMB (2012) Clustering of risk factors for chronic diseases among adolescents from Southern Brazil. Prev Med 54:393–396

Esteban y Peña MM, Hernandez Barrera V, Fernández Cordero X, Gil de Miguel A, Rodríguez Pérez M, Lopez-de Andres A, Jiménez-García R (2010) Self-perception of health status, mental health and quality of life among adults with diabetes residing in a metropolitan area. Diabetes Metab 36(4):305–311

Faleiro JC, Giatti L, Barreto SM, Camelo LV, Griep RH, Guimarães JMN (2017) Lifetime socioeconomic status and health-related risk behaviors: the ELSA-Brazil study. Cadernos de Saúde Pública 33(3):e00017916

Ferreira NL, Claro RM, Mingoti SA, Lopes ACS (2017) Coexistence of risk behaviors for being overweight among Brazilian adolescents. Prev Med 100:135–142

Gunzerath L, Faden V, Zakhari S, Warren K (2004) National institute on alcohol abuse and alcoholism report on moderate drinking. Alcohol Clin Exp Res 28(6):829–847

IBGE (2018) Expectativa de vida do brasileiro sobre para 75.8 anos. Disponível em https://agenciadenoticias.ibge.gov.br/agencia-noticias/2012-agencia-de-noticias/noticias/18469-expectativa-de-vida-do-brasileiro-sobe-para-75-8-anos. Acesso em 25 de setembro de 2018

Loch MR, Bortoletto MSS, Souza RKT, Mesas AE (2015) Simultaneity of health risk behaviors and associated factors in a population-based study. Cadernos Saúde Coletiva 23(2):180–187

Malta DC, Leal MC, Costa MFL, Neto OLMN (2008) National Health Surveys: accumulated experience and proposal for the Brazilian health survey. Revista Brasileira de Epidemiologia 11:159–167

Malta DC, Stopa SR, Szwarcwald CL, Gomes NL, Júnior JBS, Reis AAC (2015) Surveillance and monitoring of major chronic diseases in Brazil—National Health Survey, 2013. Revista Brasileira de Epidemiologia 2:3–16

Mielke GI, Hallal PC, Rodrigues GBA, Szwarcwald CL, Santos FV, Malta DC (2015) Prática de atividade física e hábito de assistir à televisão entre adultos no Brasil: Pesquisa Nacional de Saúde 2013. Epidemiologia e Serviços de Saúde 24(2):277–286

Moradi-Lakeh M, Bcheraoui CE, Tuffaha M et al (2015) Self-rated health among Saudi adults: findings from a National Survey, 2013. J Community Health 40(5):920–926

Morris LJ, D'Este C, Sargent-Cox K, Anstey K (2016) Concurrent lifestyle risk factors: clusters and determinants in an Australian sample. Prev Med 84:1–5

Moura et al (2012) Profile of the health situation of man in Brazil. Oswaldo Cruz Foundation - Fernandes Figueira Institute, Erly Moura./Rio de Janeiro

Muniz LC, Schneider BC, Silva ICM, Matijasevich A, Santos IS (2012) Accumulated behavioral risk factors for cardiovascular diseases in Southern Brazil. Revista de Saúde Pública 46(3):534–542

Pesquisa de orçamentos familiares (2008–2009). Análise do consumo alimentar pessoal no Brasil/IBGE, Coordenação de Trabalho e Rendimento. Rio de Janeiro: IBGE, 2011

Pesquisa nacional por amostra de domicílios: síntese de indicadores 2015/IBGE, Coordenação de Trabalho e Rendimento. Rio de Janeiro: IBGE, 2016

Poortinga W (2007) The prevalence and clustering of four major lifestyle risk factors in an English adult population. Prev Med 44:124–128

Retrato das desigualdades de gênero e raça/Instituto de Pesquisa Econômica Aplicada [et al.]. 4ª ed. Brasília: Ipea, 2011

Romero DM, Urbina A (2017) Leisure time physical inactivity and self-perception of health status in colombian adults from 18 to 64 years old (2017). Arch Med Deporte 34(5):260–266

Schuit AJ, van Loon AJM, Tijhuis M, Ocké MC (2002) Clustering of lifestyle risk factors in a general adult population. Prev Med 35:219–224

Senger AEV, Ely LS, Gandolfi T, Schneider RH, Gomes I, De Carli GA (2011) Alcoholism and smoking in the elderly: relation to dietary intake and socioeconomic aspects. Revista Brasileira de Geriatria e Gerontologia 14(4):713–719

Silva DAS, Peres KG, Boing AF, González-Chica DA, Peres MA (2013) Clustering of risk behaviors for chronic noncommunicable diseases: a population-based study in southern Brazil. Prev Med 56(1):20–24

Souza-Júnior PRB, Freitas MPS, Antonaci GA, Szwarcwald CL (2015) Sampling design for the national health survey, Brazil 2013. Epidemiologia e Serviços de Saúde 24(2):207–216

Stenholm S, Pulakka A, Kawach I, Oksanen T, Halonen JI, Aalto V, Kivimäki M, Vahtera J (2016) Changes in physical activity during transition to retirement: a cohort study. Int J Behav Nutr Phys Activity 13:51

Tassitano RM, Feitosa WMN, Júnior GLS, Tenório MCM (2010) Simultaneity of health risk behaviors and associated factors in a population-based study. Revista Brasileira de Atividade Física e Saúde 15(1):180–187

World Health Organization (2014) Global status report on noncommunicable diseases. World Health Organization, Geneva

Yusuf S, Hawken S, Ôunpuu S et al (2004) Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. Lancet 364(9438):937–952