Prevalence and Factors Associated with High Risk for Coronary Events in the Brazilian Population: Evidence from Two Household Surveys

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Abstract

Circulatory system diseases are the main causes of death and disability in the world. The aim of this study was to analyze changes in prevalence and factors associated with high risk for coronary events (HRC) over time in the adult Brazilian population. As analytical tools, proportion differences tests and generalized linear models were used considering complex survey samplings, namely NHS 2013 and NHS 2019, to test changes in prevalence of HRC over time and estimate adjusted prevalence ratios for variables sociodemographic, health conditions, and habits and lifestyles. Risk stratification was performed based on the first phase of the I Brazilian Guidelines for Cardiovascular Prevention. There was an increase in the proportion of HRC between surveys (10.05 vs 12.11, $p<0.001$). After adjusting the multiple model, there was a higher prevalence of HRC in residents of the Center-South region of Brazil, with advancing age, male, with regular, poor or very poor health conditions, smoking history, health conditions underlying factors such as hypertension and high cholesterol, overweight/obesity, and abuse of alcohol and ultra-processed foods. The results of this study point to the need for more effective measures, with a longitudinal and comprehensive approach to prevent and care for affected individuals, with the aim of preventing new acute coronary events in the next ten years.

Introduction

Circulatory System Diseases (CSD) represent the main morbidity and cause of death in the world due to population aging, urbanization, and westernization of habits and lifestyles (1, 2). These morbidities are associated with a high degree of limitation and reduced ability to perform daily activities (1–3), in addition to promoting a great socioeconomic impact on society due to the high cost of health and social security, as well as life of families who usually spend resources to treat these morbidities (4–6). Mainly low-income families, who are more exposed to risk factors for chronic non-communicable diseases (CNCD) and who have less access to health services, are being economically impacted. Furthemore, due to the costs associated with the treatment of CNCDs, they reduce the resources to be spent on healthy food, housing and education, feeding back the cycle of poverty associated with chronic diseases (4–6).

In Brazil, CSD represent 31.2% of deaths, with the most prevalent underlying causes being Acute Coronary Syndrome (ACS), Stroke, Unstable Angina and Decompensated Heart Failure. They represent the main causes of death, together with neoplasms and external causes, generating high health costs due to their prolonged treatment, and social security due to disability retirement and withdrawal from treatments (7).

In the last decade, in Brazil, there was a reduction in mortality from CSD due to the expansion of access to health services after the implementation of a universal and free Unified Health System (SUS - Sistema Único de Saúde) that promoted the expansion of Primary Health Care, access to medicines, as well as the improvement of Urgency and Emergency Networks and care for CNCD (8–9). However, the SUS has not been able to correct the historical disparities in the access and quality of health services between Brazilian regions and, thus, the reduction in CNCD mortality rates is greater in the Center-South region of

Brazil, however, Brazilian deaths rates are very high compared to developed countries, with higher rates in individuals aged 40 to 59 years (7, 10).

Faced with this reality and knowing that it is possible to advance in CNCD prevention and control policies, Brazil, in accordance with the 2013–2020 Global Plan to Combat CNCD and the 2030 Agenda of the Sustainable Development Goals, launched the Action Plan Strategies for Coping with CNCD in Brazil (2011–2022) (11). Through this plan, a surveillance system for these morbidities was implemented in the last ten years, which aims to reduce mortality from CSD by 22% by 2022, as well as to decrease the prevalence of smoking, alcohol abuse, sedentary lifestyles, and unhealthy eating habits in the Brazilian population (11). In its axis of surveillance, information, evaluation, and monitoring, some population surveys stand out, such as the National Health Survey carried out in 2013 and 2019. The National Health Surveys (NHS) make it possible to know the health profiles and the distribution of risk factors in a population, with periodic updates and time-sequenced comparisons between geographic areas (12, 13).

Due to the need for continuous surveillance of CNCD, this study aims to carry out an preliminary analysis of temporal changes in the prevalence of high risk for coronary events and associated factors in the Brazilian population based on the first phase of risk stratification of the I Brazilian Guidelines on Cardiovascular Risk (14, 15).

Methods

Study design and data source

This is a cross-sectional study carried out in panels to assess temporal changes in the prevalence of high risk for coronary events (HRC) in Brazil according to the first phase of risk stratification of the I Brazilian Guidelines for Cardiovascular Prevention, based on self-reported information from two national household surveys. Changes in the prevalence of the variable of interest over time (2013 vs 2019) and the influence of sociodemographic factors, eating habits, lifestyles, and health conditions on the prevalence of HRC were evaluated. Data were obtained from the National Health Survey (NHS) in 2013 and 2019 by the Brazilian Institute of Geography and Statistics (IBGE) (12, 13).

The NHS, with a 5-year periodicity, presents the performance of the Brazilian national health system, the health conditions of the Brazilian population, and the surveillance of chronic non-communicable diseases and associated risk factors as main axes. Probabilistic samples consisted of stratification and clustering in three stages (census sectors, households, individuals over 18 years of age) (12, 13).

Study Variables

According to the first stratification phase of the I Brazilian Guidelines on Cardiovascular Prevention (14, 15), the risk stratification for HRC uses the variables related to self-report of diabetes mellitus, history of acute myocardial infarction, angina, stroke, chronic kidney failure, and bypass or stent surgery. In

addition, sociodemographic variables, dietary habits, lifestyle (alcohol consumption, current smoking and past smoking, physical activity, and sedentary lifestyle), self-assessment of health and health conditions (systemic arterial hypertension, altered cholesterol, and limitations for performing daily activities due to the presence of hypertension) were extracted (Table 1). After combining and integrating the common variables in the two surveys through verification of completeness, coding of names, and standardization of response categories, an integrated database was created. The population of interest was composed of individuals participating in the surveys, aged 18 years and older, who were selected and had already carried out the interview.

Table 1
Questions and categorization of sociodemographic variables, habits and lifestyle and self-assessment in health and health conditions, according to National Health Survey, 2013 and 2019

Variables	Categories
I Brazilian Guidelines on Cardiovascular Prevention risk stratification	
A doctor ever given you a diagnosis of diabetes?	Yes No
A doctor ever diagnosed you with a heart disease such as a heart attack?	Yes No
A doctor ever diagnosed you with a heart disease such as Angina Pectoris?	Yes No
Has a doctor ever given you the diagnosis of a stroke?	Yes No
A doctor ever given you a diagnosis of chronic kidney failure?	Yes No
Have you had any bypass surgery, stent placement or angioplasty?	Yes No
High risk for coronary event	Yes, for at least one of these questions
Sociodemography Variables	
Sex	Male Female
Age range (Years)	18 to 24 25 to 39 40 to 59 60 years or more
Race/color	White Non- White

Consumption on weekdays: Low consumption (None); Average consumption (up to 5 days) and high consumption (more than 5 days)

[b]The variable rate of life living with was obtained using the formula, and cutoff points were obtained using quartilhes

Variables	Categories
Marital status	Living with a partner
	Living without a partner
Education	None and pre-primary school
	High School
	University Education
Região geográfica	Central-West
	Northeast
	North
	Southeast
	South
Zone	Rural
	Urban
Do you have health insurance?	Yes
	No
Household registered in the Family Health Strategy (FHS)?	Yes
	No
Do you work?	Yes
	No
Eating habits	
Fresh or minimally processed foods	
Consume beans (days/week)	[a] None
	Up to five days
	More than five days

Consumption on weekdays: Low consumption (None); Average consumption (up to 5 days) and high consumption (more than 5 days)
[b]The variable rate of life living with was obtained using the formula, and cutoff points were obtained using quartilhes

Variables	Categories
Consume salad (days/week)	[a] None Up to five days More than five days
Consume fruit (days/week)	[a] None Up to five days More than five days
Consume red meat (days/week)	[a] None Up to five days More than five days
Consume chicken (days/week)	[a] None Up to five days More than five days
Consume salad (days/week)	[a] None Up to five days More than five days
Ultra-processed food	
Consume soda (days/week)	[a] None Up to five days More than five days
Consume sweet food (days/week)	[a] None Up to five days More than five days
Salt consumption	Not high High

Consumption on weekdays: Low consumption (None); Average consumption (up to 5 days) and high consumption (more than 5 days)

[b]The variable rate of life living with was obtained using the formula, and cutoff points were obtained using quartilhes

Variables	Categories
Health conditions	
Health self-assessment	Very good/good Regular Bad/Very Bad
Hypertension?	Yes No
Limitation due to hypertension?	Yes No
High cholesterol?	Yes No
Proportion of lifetime with hypertension [b]	< = 7% 7% –| 22% 22% –| 32% > 32%
BMI [c]	Low to Normal Overweight Obesity
Habits and Lifestyle	
Currently smokes	Yes No
Smoked in the past	Yes No
Excessive alcohol consumption in 30 days*	Yes (men with 5 doses or more of alcoholic beverages at once and for women 4 doses or more of drinks) No

Consumption on weekdays: Low consumption (None); Average consumption (up to 5 days) and high consumption (more than 5 days)
[b]The variable rate of life living with was obtained using the formula, and cutoff points were obtained using quartilhes

Variables	Categories
Alcohol consumption (days/week)	None Up to five days More than five days
Physical activity practice	Yes (adults who have reached at least 150 minutes per week of physical activity considering leisure, work and displacement) No
Hours watching TV	Up to 3 hours Up to 6 hours More than 6 hours
Consumption on weekdays: Low consumption (None); Average consumption (up to 5 days) and high consumption (more than 5 days)	
[b]The variable rate of life living with was obtained using the formula, and cutoff points were obtained using quartilhes	

$$\frac{(ageatinterview - agewhoreportedthediagnosis) * 100}{ageatinterview}$$

[c]The variable body mass index (BMI) was obtained through self-reported weight and height, and individuals were classified as eutrophic, overweight and obesity according to the criteria of the World Health Organization (WHO, 2000).

The dependent variable of this study, high risk for a coronary event (yes/no), was defined according to the recommendations of the first stratification phase of the I Brazilian Guidelines on Cardiovascular Prevention (14, 15) (Table 1). In the first phase of stratification, individuals at high risk for coronary events in the following ten years were considered, individuals who present at least one of the conditions that characterize a significant atherosclerotic disease or its equivalent: type 1 or 2 diabetes mellitus; chronic kidney disease; or coronary artery, cerebrovascular or peripheral obstructive atherosclerotic disease with clinical manifestations (cardiovascular events) or a history of cerebrovascular accidents (CVA) or acute myocardial infarction (AMI) or Angina Pectoris; and arterial revascularization procedures (14, 15).

There are several approaches for estimating cardiovascular risk (CVR), however, there is no consensus on the best strategies to be used, and a specific cardiovascular risk calculator for the Brazilian population has not been developed. Thus, the I Brazilian Guidelines on Cardiovascular Prevention, which was published in 2013 and revised in 2019, developed its risk stratification using the Global Risk Score and Lifetime Score, based on the Framingham calculator (14, 15).The main differences observed between the

strategies for cardiovascular risk stratification are related to the sociodemographic characteristics of the population that gave rise to them (gender, age, and race/color), the presence of preventive measures for risk factors for existing cardiovascular diseases in the countries that gave rise to them, in addition to the cardiovascular morbidities predicted by each calculator, for the next ten years (14–17).

The I Brazilian Guidelines on Cardiovascular Prevention risk stratification consists of four phases. Phase one assesses health history, and phases two to four require laboratory tests and blood pressure measurements (14, 15). Considering that the surveys used in this study do not present data on blood pressure measurements nor laboratory test results for all adults that were interviewed (18), only the first phase of the stratification was used to identify the prevalence of high risk for coronary events in the following ten years in the total number of adults that were interviewed in NHS 2013 (n = 62,202) and NHS 2019 (n = 88,531).

Due to the high statistical correlation between the variables related to food consumption: fresh or minimally processed foods and ultra-processed foods (Table 1), and due to the impossibility of carrying out the factor analysis for polydichotomous variables in the survey library of the R software. We have chosen a score to assess the variables that are part of each set of food types based on Souza Filho et al. (19). Fresh or minimally processed foods were divided into three blocks, based on the fundamentals of the Food Guide for the Brazilian Population (20) and the stratification of frequency of food consumption was based in the NHS questionnaires (2013 and 2019) (12, 13). Thus, block one consisted of the consumption of beans, red meat, and chicken during the week; block two consisted of the consumption of vegetables, fruits, and fish during the week; and block three consisted of the consumption of ultra-processed foods (soda, sweet foods, and sweets) during the week. Based on the frequency of reported consumption during the week, a score was created for each block of variables, attributing 1 point to the answer “never”; 2 points for a response “up to 5 days a week”; and 3 points for answering “more than 5 days a week”. The individual's total score in each of the blocks was obtained by adding the score received for each food in the block (19).

Statistical Analyses

The first step of the statistical analysis was to assign the sampling design using the weights and design effects of the two surveys, now in a single and integrated database, of which the sampling plan considers an interaction term between the sampling stratum and the observation period, in addition to the particularities of each individual drawing (21).

The prevalence of HRC and of the independent variables and respective 95% confidence intervals, were estimated in the survey periods. The differences between these prevalences were tested using Pearson's chi-square test with the Rao Scott correction, which considers sample weights and design effects in the calculations (22). The significance of the differences was evaluated through the p-values of these tests, and not through the overlapping of confidence intervals between the categories of variables, a practice

that can lead to erroneous conclusions since there is an increase in the probability of detecting false differences (Type I Error).

Subsequently, the HRC Prevalence Ratios (PR) and 95% Confidence Intervals (CI) to time effect were estimated using Generalized Linear Models (GLM) with Poisson probability distribution (23). The sociodemographic variables, habits and lifestyle, and health conditions were used for adjustment. We also evaluated the significance of the terms of the interaction of these explanatory variables with the year of the survey in order to assess changes in associations with the prevalence of HRC over time. All point and interval estimates, tests of differences in proportions, and regression models considered the sample weights and correction for design effects (23) through the Survey package (24) of the statistical software R (25).

Multiple models were adjusted using as a predictor the potential factors pointed out in the univariate analyses. Variables with a value of $p \leq 0.20$ were the initial candidates to compose the final model using a non optimized stepwise-forward method (26). The candidate variables that would make up the final model were all sociodemographic variables with the exception of the health insurance variable ($p > 0.20$), eating habits (block 1 scores, block 2 scores, and block 3 scores), and all variables related to health, and habits and lifestyle.

After inclusion and exclusion of added variables in the order of greatest to least significant with the outcome, the significance of interactions between variables that remained throughout the process was tested. The comparison of the fit of the models was performed using the Akaike Information Criterion (AIC) (27). The choice of the final model considered epidemiological and biological plausibility, in addition to a statistical significance at the 5% level, with estimates of associations based on adjusted PR and CI (26).

Ethical Considerations

The 2013 and 2019 National Health Survey was carried out by the Brazilian Institute of Geography and Statistics in partnership with the Ministry of Health, which provide microdata from the surveys without identifying the participants at the following website (https://www.ibge.gov.br/estatisticas/social/saude/9160-pesquisa-nacional-de-saude.html?=&t = microdados). The data used in this research are secondary data of universal access in which there is no identification of the subjects, and thus it was not submitted to the Research Ethics Committee of the Federal University of Rio Grande do Norte (CEP/UFRN), according to Resolution 196/96 of the National Health Council.

Results

There was an increase in the prevalence of HRC in the Brazilian population between the years 2013 and 2019 (10.05 vs 12.11, $p < 0.001$). The health conditions with the highest burdens on the prevalence of HRC were diabetes mellitus (DM), Stroke (STK), and chronic renal failure (CRF). It is noteworthy that in

both periods there was a significant increase among all health conditions that are part of the risk stratification, with the exception of chronic renal failure and angina(Suplementar Material 1).

Between 2013 and 2019, there was an increase in the prevalence of Brazilians classified with HRC who reported two and three or more morbidities that were part of the risk stratification (1.19 vs 1.64; 0.46 vs 0.69): CVA, DM, angina, acute myocardial infarction, bypass surgery, and chronic renal failure. On the other hand, there was no significant difference between the proportion of life with chronic renal failure and Proportion of life with stroke (Suplementar Material 1).

Individuals classified as being at high risk for coronary events mostly lived in regions with greater socioeconomic development in Southeast, South, and Central-West of Brazil. Residents in the Southeast and South regions had a higher prevalence of HRC, and residents in the North region had a lower prevalence when compared to the geographical reference region of the Northeast. Residents of urban areas had a higher prevalence of HRC compared to residents of rural areas. (Table 2).

Regarding the sociodemographic variables adjusted for the year the survey was carried out, there was a progressive increase in the prevalence of HRC with advancing age. Men, people with higher education levels, non-whites, and people who did not live with a partner were less likely to be classified as being at high risk for coronary events, as well as individuals who reported being in a labour activity. On the other hand, having the household registered in the Family Health Strategy (FHS) increased the probability of HRC (Table 2).

Table 2
Prevalence estimates and PR with the HRC outcome adjusted for the year of the survey (with 95% confidence intervals) of the sociodemographic variables. Featured estimates in bold were considered significant at 5% significance.

Variables	HRC YES (CI95%)	HRC NO (CI95%)	ADJUSTED PR (CI95%)
Geographic Region			
Northeast	9.70 (9.29–10.11)	90.30 (89.89–90.71)	
Central-West	10.97 (10.31–11.62)	89.03 (88.38–89.69)	1.13 (1.05–1.21)
North	8.09 (7.57–8.62)	91.91 (91.38–92.43)	**0.83 (0.77–0.90)**
Southeast	12.10 (11.59–12.60)	87.90 (87.40-88.41)	**1.25 (1.17–1.32)**
South	12.47 (11.82–13.12)	87.53 (86.88–88.18)	**1.29 (1.20–1.38)**
Zone			
Rural	9.16 (8.66–9.65)	90.84 (90.35–91.34)	
Urban	11.44 (11.14–11.75)	88.56 (88.25–88.86)	**1.25 (1.18–1.33)**
Age range (Years)			
18 to 24	1.68 (1.33–2.03)	98.32 (97.97–98.67)	
25 to 39	3.3 (3.01–3.58)	96.70 (96.42–96.99)	**1.96 (1.56–2.45)**
40 to 59	12.04 (11.53–12.54)	87.96 (87.46–88.47)	**7.13 (5.76–8.83)**
60 years or more	28.56 (27.74–29.38)	71.44 (70.62–72.26)	**16.87(13.68–20.80)**
Sex			
Female	12.06 (11.67–12.44)	87.94 (87.56–88.33)	
Male	10.07 (9.66–10.48)	89.93 (89.52–90.34)	**0.84 (0.79–0.88)**
Race/color			

Variables	HRC YES (CI95%)	HRC NO (CI95%)	ADJUSTED PR (CI95%)
White	11.73 (11.29–12.16)	88.27 (87.84–88.71)	
Non-white	10.63 (10.29–10.97)	89.37 (89.03–89.71)	**0.90 (0.86–0.94)**
Education			
None and pre-primary school	15.43 (14.90-15.95)	84.57 (84.05–85.10)	
High school	6.98 (6.59–7.37)	93.02 (92.63–93.41)	**0.45 (0.42–0.48)**
University education	10.84 (10.35–11.32)	89.16 (88.68–89.65)	**0.71 (0.67–0.75)**
Marital status			
Living with a partner	13.3 (12.84–13.77)	86.7 (86.23–87.16)	
Living without a partner	9.41 (9.09–9.72)	90.59 (90.28–90.91)	**0.71 (0.67–0.74)**
Household registered in the Family Health Strategy (FHS)?			
No	10.17 (9.75–10.6)	89.83 (89.4-90.25)	
Yes	11.81 (11.44–12.17)	88.19 (87.83–88.56)	**1.15 (1.09–1.21)**
Do you work?			
No	16.89 (16.41–17.37)	83.11 (82.63–83.59)	
Yes	6.77 (6.45–7.08)	93.23 (92.92–93.55)	**0.40 (0.38–0.42)**
Do you have health insurance?			
No	11.15 (10.83–11.47)	88.85 (88.53–89.17)	
Yes	11.06 (10.54–11.58)	88.94 (88.42–89.46)	0.99 (0.94–1.05)

Regarding the consumption of fresh or minimally processed foods, two patterns were observed. About the frequency of consumption on weekdays, it was found that individuals who reported medium and high consumption of all foods in block 1 (beans, red meat, and chicken) had a lower prevalence of HRC (Table 3). Inversely, the assessment of the consumption of foods in block 3 (salad, fruits, and fish) showed a higher prevalence of HRC in individuals who reported medium and high consumption of these

foods per week (up to five days and more than five days) compared to those who reported low consumption (not even once a week) (Table 3).

Individuals with HRC reported a greater proportion of not consuming ultra-processed foods such as soft drinks, sweet foods, and sweets during the week, in both surveys. A similar result was observed in relation to salt intake, as individuals classified as having HRC showed a lower prevalence of high salt intake (Table 3).

Table 3
Prevalence estimates and PR with the HRC outcome adjusted for the year of the survey (with 95% confidence intervals) of the food consumption variables. Featured estimates in bold were considered significant at 5% significance.

Variables	ARC YES (95%)	ARC NO (CI95%)	ADJUSTED PR (CI95%)
Eating habits			
Fresh or minimally processed foods			
Consume beans (days/week)			
None	12.16 (10.71–13.61)	87.84 (86.39–89.29)	
Up to 5 days	10.47 (10.03–10.90)	89.53 (89.10-89.97)	**0.86 (0.76–0.98)**
More than 5 days	11.40 (11.04–11.76)	88.60 (88.24–88.96)	0.95 (0.84–1.07)
Consume red meat (days/week)			
None	18.53 (17.17–19.89)	81.47 (80.11–82.83)	
Up to 5 days	10.84 (10.52–11.16)	89.16 (88.84–89.48)	**0.59 (0.54–0.64)**
More than 5 days	9.98 (9.40-10.56)	90.02 (89.44–90.60)	**0.55 (0.50–0.61)**
Consume chicken (days/week)			
None	13.02 (11.86–14.19)	86.98 (85.81–88.14)	
Up to 5 days	10.80 (10.50-11.09)	89.20 (88.91–89.50)	**0.83 (0.76–0.91)**
More than 5 days	12.89 (11.85–13.92)	87.11 (86.08–88.15)	0.98 (0.87–1.11)
Block 1 score (food consumption score of beans, red meat, and chicken on weekdays)			**0.95 (0.92–0.97)**
Consume salad (days/week)			

Variables	ARC YES (95%)	ARC NO (CI95%)	ADJUSTED PR (CI95%)
None	8.63 (7.73–9.53))	91.37 (90.47–92.27)	
Up to 5 days	9.91 (9.54–10.28)	90.09 (89.72–90.46)	**1.15 (1.03–1.28)**
More than 5 days	12.76 (12.33–13.2)	87.24 (86.8-87.67)	**1.48 (1.33–1.65)**
Consume fish (days/week)			
None	10.67 (10.26–11.08)	89.33 (88.92–89.74)	
Up to 5 days	11.58 (11.21–11.96)	88.42 (88.04–88.79)	**1.10 (1.05–1.16)**
More than 5 days	11.30 (9.69–12.91)	88.70 (87.09–90.31)	1.07 (0.92–1.24)
Consume fruit (days/week)			
None	8.37 (7.62–9.11)	91.63 (90.89–92.38)	
Up to 5 days	9.41 (9.05–9.76)	90.59 (90.24–90.95)	**1.12 (1,02 – 1,23)**
More than 5 days	14.60 (14.10-15.11)	85.40 (84.89–85.9)	**1.73 (1,57 – 1,90)**
Block 2 score (food consumption score of vegetables, fish, and fruits on weekdays)			**1.19 (1.17–1.22)**
Ultra-processed food			
Consume soda (days/week)			
None	15.38 (14.91–15.85)	84.62 (84.15–85.09)	
Up to 5 days	8.55 (8.17–8.94)	91.45 (91.06–91.83)	**0.56 (0.53–0.59)**

Variables	ARC YES (95%)	ARC NO (CI95%)	ADJUSTED PR (CI95%)
More than 5 days	7.36 (6.59–8.13)	92.64 (91.87–93.41)	**0.49 (0.43–0.55)**
Consume sweet food (days/week)			
None	16.98 (16.43–17.53)	83.02 (82.47–83.57)	
Up to 5 days	8.23 (7.89–8.56)	91.77 (91.44–92.11)	**0.49 (0.46–0.52)**
Mais de 5 dias	7.45 (6.80–8.10)	92.55 (91.90–93.20)	**0.45 (0.41–0.49)**
Consume sweets (days/week)			
None	12.72 (12.37–13.07)	87.28 (86.93–87.63)	
Up to 5 days	7.55 (7.10–7.99)	92.45 (92.01–92.90)	**0.61 (0.57–0.67)**
More than 5 days	11.37 (9.58–13.16)	88.63 (86.84–90.42)	0.94 (0.80–1.10)
Block 3 score (food consumption score of soft drinks, sweet foods, and sweets on weekdays)			**0.72 (0.70 0-.74)**
Salt consumption			
Not high	11.53 (11.24–11.83)	88.47 (88.17–88.76)	
High	8.49 (7.79–9.18)	91.51 (90.82–92.21)	**0.74 (0.68–0.81)**

Regarding alcohol consumption (number of days/week) there was a lower prevalence of HRC in individuals who reported consuming alcohol up to 5 days per week as compared to non-consumers. Likewise, people who reported alcohol abuse (men who had 5 doses or more at a time and women who had 4 doses or more at a time) were less likely to be classified as having HRC (Table 4). As for smoking, there was no difference in the prevalence of HRC between smokers and non-smokers, however, there was a higher proportion of ex-smokers among individuals classified with HRC (Table 3). In relation to a sedentary lifestyle, there was a lower prevalence of physical activity in individuals classified with HRC. In

line with this, it was observed that a greater proportion of individuals at high risk for a coronary events were watching television for up to 6 hours a day (Table 4).

A greater proportion of Brazilian residents who were at high risk for a coronary event, self-rated their health status as regular, bad or very bad (Table 4). Yet, there was a higher prevalence of systemic arterial hypertension (SAH), high cholesterol, overweight, and obesity in individuals with HRC (Table 4). A gradient of increased prevalence of HRC with lifetime living with hypertension was observed. The lifetime with SAH showed a high proportion of individuals with HRC who live more than 17% of their lives with the diagnosis of this chronic disease, and the prevalence of HRC increased with the increase in the lifetime with SAH (Table 4). Furthermore, individuals with HRC had a higher prevalence of limitations due to SAH (Table 4)

Table 4
Prevalence estimates and PR with HRC outcome adjusted for the year of survey (with 95% confidence intervals) for lifestyle and behavioural variables, and health condition variables. Featured estimates in bold were considered significant at 5% significance

Variables	HRC YES (CI95%)	HRC NO (CI95%)	ADJUSTED PR (CI95%)
Eating habits			
Habits and Lifestyle			
Alcohol consumption (days/week)			
None	12.63 (12.31–12.96)	87.37 (87.04–87.69)	
Up to 5 days	6.04 (5.59–6.49)	93.96 (93.51–94.41)	**0.47 (0.44–0.51)**
More than 5 days	13.54 (11.23–15.85)	86.46 (84.15–88.77)	1.08 (0.90–1.28)
Excessive alcohol consumption in 30 days*			
No	12.14 (11.83–12.44)	87.86 (87.56–88.17)	
Yes	5.58 (5.08–6.08)	94.42 (93.92–94.92)	**0.45 (0.41–0.50)**
Physical activity practice			
No	12.85 (12.49–13.21)	87.15 (86.79–87.51)	
Yes	8.19 (7.78–8.59)	91.81 (91.41–92.22)	**0.62 (0.59–0.66)**
Hours watching TV			
Up to 3 hours	10 (9.68–10.32)	90 (89.68–90.32)	
Up to 6 hours	13.38 (12.82–13.95)	86.62 (86.05–87.18)	**1.32 (1.26–1.40)**
More than 6 hours	14.37 (12.71–16.03)	85.63 (83.97–87.29)	**1.63 (1.43–1.85)**
Currently smokes			
No	11.23 (10.93–11.52)	88.77 (88.48–89.07)	
Yes	10.49 (9.69–11.30)	89.51 (88.70-90.31)	0.94 (0.87–1.02)
Smoked in the past			
Yes	9.34 (9.05–9.63)	90.66 (90.37–90.95)	
No	17.39 (16.68–18.09)	82.61 (81.91–83.32)	**1.83 (1.74–1.93)**
Health conditions			
Health self-assessment			
Very good/good	5.47 (5.23–5.72)	94.53 (94.28–94.77)	
Regular	19.75 (19.08–20.42)	80.25 (79.58–80.92)	3.61 (3.41–3.82)

Variables	HRC YES (CI95%)	HRC NO (CI95%)	ADJUSTED PR (CI95%)
Bad/very bad	33.81 (32.23–35.38)	66.19 (64.62–67.77)	6.18 (5.79–6.60)
Hypertension			
No	5.69 (5.45–5.92)	94.31 (94.08–94.55)	
Yes	28.84 (28.04–29.64)	71.16 (70.36–71.96)	**5.04 (4.80–5.30)**
Limitation due to hypertension			
No	9.15 (8.88–9.41)	90.85 (90.59–91.12)	
Yes	40.23 (38.59–41.87)	59.77 (58.13–61.41)	**4.41 (4.19–4.64)**
Proportion of lifetime with hypertension			
< = 7%	19.03 (17.6-20.45)	80.97 (79.55–82.4)	
7% –| 17%	26.05 (24.46–27.64)	73.95 (72.36–75.54)	**1.37 (1.24–1.50)**
17% –| 32%	32.21 (30.53–33.89)	67.79 (66.11–69.47)	**1.68 (1.54–1.84)**
> 32%	38.66 (36.84–40.49)	61.34 (59.51–63.16)	**2.82 (1.84–2.21)**
High cholesterol			
No	8.42 (8.15–8.68)	91.58 (91.32–91.85)	
Yes	28.33 (27.26–29.41)	71.67 (70.59–72.74)	**3.35 (3.18–3.52)**
BMI			
Low to Normal	7.99 (7.61–8.36)	92.01 (91.64–92.39)	
Overweight	11.90 (11.39–12.42)	88.10 (87.58–88.61)	**1.48 (1.39–1.58)**
Obesity	17.47 (16.63–18.31)	82.53 (81.69–83.37)	**2.17 (2.03–2.32)**

Among the surveys and after estimating the multiple model, an increase in the prevalence of high risk for a coronary events was observed with advancing age. Likewise, there was a higher prevalence of high risk in men (PR = 1.15) compared to women and in the Southeast, South, and Midwest regions compared to the Northeast region, and in those who reported a history of smoking, who evaluated their health as regular, bad or very bad, and who reported limitations in their day-to-day activities due to the presence of systemic arterial hypertension (Table 5). On the other hand, there was a lower prevalence of high risk for a coronary event among the surveys in individuals who reported that they are working. There was an interaction between the BMI (Body Mass Index) variables and change in cholesterol, presence of hypertension, and abusive alcohol consumption and the score of consumption of ultra-processed foods during weekdays (soda, sweets and sweets) and high cholesterol (Table 5).

The effect of the interaction between BMI and high cholesterol between the surveys increased the prevalence of high risk for a coronary events, with the PR of the interaction effect being 1.41 for overweight individuals and 1.60 for individuals with obesity. The interaction between the score of consumption during weekdays of ultra-processed foods and changes in cholesterol also increased the prevalence of HRC among the surveys carried out (PR = 1.22), as well as the interaction of the hypertension and excessive alcohol consumption variables (PR = 1.76). It is noteworthy that the effect of the interaction on the outcome is obtained by multiplying the PR of each individual effect of the variables involved with the PR of the interaction.

Table 5
Factors associated with high risk for a coronary event in the multiple model, according to the I Brazilian Guidelines on Cardiovascular Prevention, based on data from the National Health Survey, Brazil, 2013 and 2019.

Variables	Gross PR (IC95%)	Adjusted PR (IC95%)
Sociodemographic Variables		
Age group (years)		
18–24	1	
25–39	1.96 (1.56–2.45)	1.51 (1.18–1.93)
40–59	7.13 (5.76–8.83)	3.27 (2.59-4,14)
60 or older	16.87 (13.68–20.80)	4.87 (3.85–6.15)
Sex		
Female	1	
Male	0.84 (0.79–0.88)	1.15 (1.09–1.21)
Geographic region		
North East	1	
North	1.13 (1.05–1.21)	1.03 (0.96–1.11)
Southeast	0.83 (0.77–0.90)	1.40 (1.32–1.48)
South	1.25 (1.17–1.32)	1.40 (1.31–1.50)
Midwest	1.29(1.20–1.38)	1.34 (1.25–1.44)
Do you work ?		
No	1	
Yes	0.40 (0.38–0.42)	0.81 (0.76–0.86)
Health conditions		
Self-assessment of health condition		
Very good/good	1	

Variables	Gross PR (IC95%)	Adjusted PR (IC95%)
Regular	3.61 (3.41–3.82)	2.05 (1.92–2.18)
Bad/very bad	6.18 (5.79–6.60)	2.63 (2.44–2.85)
Diagnosis of high blood pressure		
No	1	
Yes	5.04 (4.80–5.30)	1.82 (1.70–1.95)
High cholesterol		
No	1	
Yes	3.35 (3.18–3.52)	1.31 (1.08–1.60)
Limitation due to hypertension		
No		
Yes	4.41 (4.19–4.64)	1.31 (1.08–1.60)
Body mass index		
Low to Normal	1	
Overweight	1.48 (1.39–1.58)	1.21 (1.12–1.31)
Obesity	2.17 (2.03–2.32)	1.42 (1.32–1.56)
Eating habits		
Score of ultra-processed food consumption	0.72 (0.70 0-.74)	0.88 (0.86–0.91)
Habits and Lifestyle		
Smoked in the past		
No	1	
Yes	1.83 (1.74–1.93)	1.12 (1.06–1.17)
Excessive alcohol consumption in 30 days*		
No		

Variables	Gross PR (IC95%)	Adjusted PR (IC95%)
Yes	0.45 (0.41–0.50)	0.71 (0.61–0.82)
Interactions		
High Cholesterol (Yes) : BMI		
High Cholesterol (Yes): Overweight		0.89 (0.79–1.01)
High Cholesterol (Yes): Obesity		0.85(0.75–0.96)
Excessive alcohol consumption in 30 days (Yes): High blood pressure (Yes)		1.36 (1.12–1.63)
High cholesterol (Yes): food consumption score of ultra-processed foods		1.06 (1.02–1.11)

Declarations

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Discussion

There was an increase in the prevalence of adult Brazil residents classified as being at high risk for a coronary events (HRC) between 2013 and 2019, and the prevalence of at least one of the conditions that characterize a significant atherosclerotic disease or its equivalent was greater than 10%, highlighting diabetes mellitus, chronic renal failure, and history of stroke in two periods analyzed. These findings show that more than 10% of Brazilian adults have at least 20% of risk for an acute coronary event in the next ten years if there are no more effective measures with a longitudinal and integral approach to prevent and care for individuals with CNCD (14, 15). Also considering that in this study it was only possible to carry out the first phase of risk stratification, it is believed that the prevalence of HRC in the Brazilian population may be higher than that observed in the present study as evidenced by studies carried out with the 2013 HNS subsample, which found a prevalence of 38.1% of HRC in the adult population between the ages of 45 and 64 years according to the I Brazilian Guidelines on Cardiovascular Prevention (16), and 19.4% according to the Framingham score, being 8.7% in women and 21.6% in men (17). It is noteworthy that studies, the stratification of cardiovascular risk was performed with a subsample of the National Health Survey (2013), in which laboratory tests and measurement of blood pressure were measured.

These results are related to the accelerated population ageing that occurred in Brazil in the last five decades which is associated with urbanization, industrialization, and westernization of habits and

lifestyles (1, 7, 27–28), which has contributed to the increase in the incidence, prevalence, and mortality of non-communicable diseases. They can also be evaluated as a positive indicator of access to health services necessary for the diagnosis of a disease (DM, angina, chronic renal failure, and acute myocardial infarction) and/or for performing surgical procedures for performing a bypass graft and/or placement of stents (8, 29).

It is believed that the greater access of Brazilians to clinical and laboratory diagnostic tests due to the implementation of the universal and free SUS, contributed to the increase in the longevity of individuals affected by CNCD (9). Confirmation of this hypothesis can be seen by comparing three Brazilian population surveys carried out between 2008 and 2019, which show an increase in the proportion of medical appointments in the last year and an increase in the coverage of the family health strategy, characterizing increased access to services among individuals with some CNCD (30).

Despite the advances observed after the implementation of the SUS, there are still weaknesses in reducing exposure to risk factors, creating environments that make them accessible and encourage healthy choices, in addition to weaknesses in the provision of a line of care with the ability to detect early conditions of intermediate health care for a coronary events, promote timely treatment and reduce sequelae and deaths, especially in geographic regions of greater socioeconomic vulnerability (11, 31).

In the present study, the highest prevalence of high risk for coronary events was observed in residents of the Center-South region of Brazil and this finding may be related to the fact that this region has an older population and is in a more advanced stage of the demographic transition, where there are higher rates of incidence, prevalence and mortality from CNCDs (7, 10, 27, 30, 32). In addition, these locations have the most organized Health System and greater access to health services at all levels of care complexity, reducing the lethality of CNCDs and increasing the prevalent cases of these morbidities (9, 30–31). Thus, these findings may be related to the survival bias present in cross-sectional studies.

In addition to the geographic region of residence, other socioeconomic and demographic variables that remained related to high risk for a coronary event swere the male gender, age, and being in a labour activity at the time of the interview.

The higher prevalence of HRC in men can be associated greater exposure to factors risk for chronic non-communicable diseases, especially with regard to smoking, alcohol abuse and non-adherence to the treatment of CNCDs that predispose them to get sick and die from these diseases (10, 16, 33–34).

The association between high risk for a coronary events and advancing age was an expected result since aging generates greater stiffening of the arteries and peripheral vascular resistance, a physiological situation that, associated with prolonged exposure to risk factors for CNCD, increases the incidence and prevalence of cardiovascular diseases (1–2, 4, 6–7, 17, 28), as well as related disabilities to these diseases. Therefore, the higher prevalence of HRA observed among individuals who self-rated their health as regular, bad or very bad, was not surprising and was similar to that verified by a study that estimated cardiovascular risk in the Brazilian population in ten years, according to the Framingham score (17). The

incapacities generated by complications of CNCDs and by changes related to advancing age may also explain the fact that there is a higher prevalence of HRC among those who reported limited activity due to the presence of arterial hypertension (1–4, 6–7, 17, 28).

In addition, the lower prevalence of HRC in individuals who reported work activities at the time of the surveys can be explained by the fact that the comorbidities used in the first stage of risk stratification of the I Brazilian Guidelines for Cardiovascular Prevention are more prevalent in the elderly and are related to disabilities that make it impossible to work (3), and thus, possibly, many of the individuals at high risk for a coronary event would already be retired due to age or disability, or on sick leave for health treatment in the context of the surveys.It is noteworthy that the incapacity to work related to CNCDs and their sequelae cause a great financial impact on the Health System, social security, income and quality of life of individuals and their families (1–2, 5–6). Studies have shown that the reduction in income associated with the presence of CNCDs increases the exposure of these families to risk factors for these morbidities at the same time reducing access to health services and adoption of preventive measures, contributing to the vicious cycle of poverty-related to CNCDs (1–2, 5–6).

In the present study among the risk factors for CNCDs, we highlight the history of smoking in the past, the score of consumption of ultra-processed foods (sweets, soft drinks and sweets) and the abusive consumption of alcohol, which remained associated with high risk for a coronary event after adjusting the multiple model.

It is believed that the association between past smoking history and HRC e and the non-association with current smoking, may be related to the survival bias present in prevalence studies. Thus, individuals with comorbidities used in risk stratification, who maintain the habit of smoking, are more likely of complications and death in relation to individuals who no longer smoke.

Regarding the food consumption, results from the bivariate analysis differed from other studies (4, 10, 33, 35), as there was a lower prevalence of high risk for a coronary event (HRC) in Brazilians with medium and high consumption of ultra-processed foods. This result does not mean that ultra-processed foods are important determinants of high risk for a coronary event. In contrast, a higher prevalence was observed in individuals with medium and high consumption of fruits, vegetables and fish. A profile similar to that observed in relation to high salt consumption and alcohol abuse.

These results may be related to survival bias, as individuals at high risk for a coronary event who maintained poor eating habits and alcohol abuse are at higher risk of complications and death (4, 10, 35). Furthermore, these findings may be associated with reverse causality that may appear in cross-sectional studies, as it is not possible to determine the temporality between the dependent variable and the independent variables. It is important to highlight that after multiple analyses and investigation of possible interactions between the variables, the contradictory results were not maintained. There was a significant interaction term between alcohol abuse and the diagnosis of hypertension, increasing the prevalence of high risk for a coronary events as well as between BMI and high cholesterol, and between the score of consumption of ultra-processed foods and high cholesterol.

The relationship between alcohol consumption and cardiovascular risk is still controversial. There are studies that prove the benefits of moderate consumption, but heavy consumption has been associated with increased cardiovascular risk, increased blood pressure, increased risk of diabetes mellitus and stroke (36–38).

The excess of weight, represented by overweight and obesity, is also considered one of the main risk factors for diseases of the circulatory system and predisposes individuals to other risk factors such as physical inactivity, hypertension, diabetes mellitus and dyslipidemia. Therefore, it is expected that the interaction between dyslipidemia and overweight would increase the probability of a coronary events (4, 10, 14, 35, 39).

The interaction between the consumption of ultra-processed foods and high cholesterol reflects the nutritional transition, driven by the process of urbanization and westernization of habits and lifestyle, which has intensely changed food consumption in various locations, due to greater access to ultra-processed foods, in addition to the high cost of fresh foods such as fruits and vegetables. This context has increased the risk of circulatory system diseases, especially in low-income and vulnerable populations (7, 40–41). This fact may also be related to the increased prevalence of high risk for a coronary events when there was an interaction between the consumption of ultra-processed foods and high cholesterol since the cardiovascular risk associated with the medium and high consumption of ultra-processed foods is related to a high intake of cholesterol, lipids and saturated fatty acids, which associated with low fibre consumption, participate in the aetiology of dyslipidemia, obesity, diabetes and arterial hypertension (40–41).

The results of the present study should be carefully evaluated, as its data sources are cross-sectional surveys in which information on health history can be associated with differentiated access to health services, in addition to survival bias and reverse causality. In addition, this is a study of initial screening of high risk for a coronary events, in which only the first step of stratification of the Global Risk Score (GRS) was performed. However, it makes a great contribution to the monitoring of Non-Communicable Diseases, as it is a study whose surveys are nationally representative, with internal validity of the information (13, 42), signalling for the increase in the prevalence of high risk for a coronary event among population surveys, with more than 12% of the adult Brazilian population in 2019.

It is believed that this prevalence may increase in the coming years, due to the effect of the fiscal adjustment period implemented in 2016 through Constitutional Amendment 95 associated with the economic and health crisis promoted by the COVID-19 pandemic (43–45). Studies have shown an increase in exposure to unhealthy eating, sedentary lifestyle, alcohol abuse, and smoking in Brazilians during the pandemic, with a higher prevalence of exposure among Brazilians living with CNCD (45). And if collective health actions are not implemented to ensure access to protective factors and health services, especially for low-income Brazilians, Brazil may not achieve the goals established in the "Strategic Action Plan for Confronting CNCDs in Brazil, 2011–2022" and in the Sustainable Millennium Development Goals. As an increase in the prevalence and mortality due to CNCDs is expected due to the

increase in risk factors, reduction in the search for preventive exams, the difficulty of SUS in meeting demand related to the pandemic together with the care of users with CNCDs (43–46).

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