Original Article

Food consumption patterns, overweight and cardiovascular risk: a cross-sectional analysis of the *Pró-Saúde* Study, Brazil, 2013*

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Abstract

Objective: To identify food consumption patterns and association between overweight and risk of cardiovascular disease. **Methods:** This was a cross-sectional study with staff of the Universidade do Estado do Rio de Janeiro, Brazil, who took part in the Pró-Saúde Study. Food consumption was investigated using a food frequency questionnaire. Association between dietary patterns (exposure) and overweight and cardiovascular risk (outcomes) was estimated using linear regression. **Results:** Among the 520 staff assessed, four dietary patterns were found: 'ultra-processed', 'healthy', 'meat' and 'traditional'. After adjustment, the 'meat' pattern was inversely associated with waist circumference (ß=-1.52 – 95%CI -2.66;-0.39), body mass index (ß=-0.56 – 95%CI -1.01;-0.11), and the Framingham Risk Score (ß=-0.36 – 95%CI -0.64;-0.09). **Conclusion:** In view of excess weight, risk of cardiovascular disease and inverse association between the 'meat' food consumption pattern and BMI, it is important to conduct further investigations, with non-working groups, with the aim of gaining greater understanding of the health-disease process related to food consumption.

Keywords: Eating; Cardiovascular Diseases; Risk Factors; Overweight.

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Introduction

Obesity is growing in Brazil and worldwide, and is considered a global epidemic, a great challenge for public health.[1] According to the Brazilian National Health Survey published in 2019, the proportion of obesity among adult individuals had reached 26.8%. Regarding overweight, the prevalence found in adults was 63.3% for women and 60.0% for men.[2]

> *Isolated investigations of nutrients underestimate the possibility of interaction between nutrients and other food intake components.*

A larger reserve of fat in the body, specifically in the trunk, predisposes the occurrence of conditions such as glucose intolerance, plasma lipid profile alterations, and in particular hypertension, all of which are considered risk factors for cardiovascular disease (CVD).[3]

Diagnostic imaging methods, considered the gold standard for assessing adiposity, are expensive and difficult to implement in epidemiological studies. Among the most adopted anthropometric indicators, the World Health Organization (WHO) recommends the body mass index (BMI) for defining general obesity. However, BMI does not provide information about fat distribution in the body. Waist circumference provides more accurate estimates of intra-abdominal visceral fat. Furthermore, as it is a simple and practical measure it has become widely used in determining abdominal obesity and is capable of predicting cardiovascular risk.[3]

Because of the need to quantify the effect of each risk factor and to estimate the severity of cardiovascular-related disease, risk scores and guidelines have been developed for CVD prevention and treatment. The Framingham Risk Score (FRS), for example, is widely used to assess an individual's risk of having a coronary event within the next ten years.[4]

Hypertension, smoking and hypercholesterolemia, risk factors used to calculate this score, are frequent in the Brazilian population, and have prevention as their primary focus, aiming to achieve improved quality of life, change in eating habits, and physical activity. A diet based on fresh and minimally processed foods, as well as regular physical exercise, play this important preventive role, especially in adults with CVD risk factors.[5]

On the other hand, a diet high in total fat, sugars, synthetic oils, sodium, additives and emulsifiers, and low in fiber, omega-3 and antioxidant nutrients such as vitamin A, C, D and E is associated with higher risk of CVD.[6] Studies highlight the relationship between higher carbohydrate intake and increased risk of death, while higher saturated fat intake is associated with decreased occurrence of strokes.[7] Indeed, isolated investigations of nutrients underestimate the possibility of interaction between nutrients and other food intake components.[8]

Several studies have been conducted in order to assess the relationship between food consumption patterns and the risks of developing CVD.[8] It is recognized that a dietary pattern rich in fruit, vegetables, fish, and whole grains (defined as the 'healthy' pattern), DASH diet (Dietary Approaches to Stopping Hypertension)[9] and the so-called 'Mediterranean diet'[10] reduce the risk of DCV. In turn, patterns of food consumption characterized by high fat and sugar content, or a meat-based diet, especially processed meat, have harmful effects related to increased risk of obesity, type 2 diabetes mellitus and CVD.[11]

In Brazil, few studies have investigated the relationship between dietary pattern, adiposity measured by dual-energy X-ray absorptiometry and cardiovascular risk factors.[12] Inverse association has been found between diabetes mellitus and a dietary pattern characterized by dairy products, as well as the DASH diet associated with metabolic syndrome.[12] The typically Brazilian traditional pattern of food consumption has been associated with higher BMI and waist circumference, higher levels of total cholesterol and its LDL-cholesterol and HDL-cholesterol fractions, as well as higher systemic blood pressure.[13] Another study found that three out of four patterns, referred to as 'traditional', 'cafeteria' and 'atherogenic', were associated with CVD risk factors.[14]

Considering that food consumption patterns can be a determining factor in the development of overweight and chronic diseases, the present study aimed to verify association between food consumption patterns, overweight and risk of CVD.

Methods

Study design

This was a cross-sectional study within the larger context of a cohort study called the *Pró-Saúde* Study.

Context

The *Pró-Saúde* Study is conducted with technical-administrative staff of the Universidade do Estado do Rio de Janeiro (UERJ), and its main objective is to investigate the role of markers of social position and other dimensions related to health in Brazilian adult populations.[15]

Participants

The *Pró-Saúde* Study began in 1999 and in 2012-2013 a fourth wave of data collection was conducted with a sample of 520 study participants, this being about 1/5 of the study's baseline population. This sample was randomly selected from within strata relating to sex, age (in years: <50; ≥50), and schooling (<high school education; ≥high school education). The size of the strata corresponded to the proportions observed among baseline participants, while the sample size obeyed the project's budgetary constraints. Administrative technicians who had retired and those who had moved out of Rio de Janeiro state were excluded. The data were investigated through standardization, and data collection took place between July 2012 and July 2013, carried out by interviewers and technicians who had been trained beforehand.

Variables

Outcomes:

a) Adiposity, assessed according to total body mass, height and BMI, as well as total fat mass, android and gynoid fat mass;
b) Cardiovascular risk, measured by waist circumference and the Framingham Risk Score (FRS).

The covariables investigated were socioeconomic profile, represented by age, schooling, and per capita family income.

Data source and measurement

Dietary assessment was based on a validated semi-quantitative food frequency questionnaire (FFQ),[16] covering 82 food items or food groups, in previously stipulated quantities and based on household measures or units of food items. Participants were asked to report the frequency of food consumption in the previous 6 months, divided into eight categories, ranging from ≥3 times/day to never or almost never; and the mean amount, which was variable according to each type of food.

Total body fat, total fat mass and android and gynoid region fat mass measurements were taken by means of Dual-Energy X-ray Absorptiometry (DXA), using iDXA Lunar equipment (GE, Health Care) and EnCoRe 2008 software, version 12.20. The scans were performed by the same professional and the equipment was calibrated daily, according to the manufacturer's instructions. During the session, participants were instructed to wear light clothing with no metallic components.

The android region was defined by the upper limit above the cut-off point of the pelvis, at 20% of the distance between the pelvis and the lap cut-off points. The gynoid region was defined by the upper limit below the pelvis line, with a cut-off point 1.5 times the height of the android region.

Android fat mass (AFM) and gynoid fat mass (GFM) were expressed as a percentage of total fat mass (TFM%), obtained via DXA. The android fat mass/gynoid fat mass ratio was expressed in terms of percentage android fat mass divided by percentage gynoid fat mass: AFM%/GFM%.

Waist circumference (WC) was measured in centimeters. Assessment of risk of metabolic alterations associated with obesity followed the criteria proposed by the WHO, based on WC measurement according to sex,17 classified as follows: high risk, where WC is ≥94cm in men and ≥80cm in women; and very high risk, where WC is ≥102cm in men and ≥88cm in women.

Height was measured in meters, using a stadiometer, on which individuals stand barefoot, in an erect position, with their heads positioned according to the Frankfurt plane. Height was measured taking a 90 degree angle to the scale. Total body mass (in kg) was measured using digital weighing scales (Filizola brand). BMI was calculated by the ratio between total body mass (in kg) and height squared (in meters), adopting the cut-off points proposed for adults and for those over 60 years old.

The FRS was used to assess cardiovascular risk. It is based on an algorithm, associating multiple factors in order to estimate the risk of cardiovascular events happening within ten years among individuals not already diagnosed as having coronary disease.[18]

The risk factors adopted to estimate the SRF were age, sex, presence of dyslipidemia (total cholesterol and HDL-cholesterol), systemic blood pressure, and smoking. Each variable received a rating, and the final sum represented low (less than 10%), medium (10 to 20%), or high (more than 20%) cardiovascular risk. Individuals with a history of diabetes mellitus and CVD were classified as having high risk (more than 20%).

The presence of diabetes mellitus, CVD, and cigarette consumption were assessed by the answers to the questionnaire used in wave 4 of the present study.

Blood pressure was measured using an OMRON® monitor, duly calibrated by the manufacturer. All blood pressure measurements were taken on the right arm, after a five-minute rest, using an armband; they were taken three times, with a two-minute interval between each one, taking the mean of the three measurements.

In order to determine total cholesterol and HDL-cholesterol levels, blood samples were subsequently collected from participating UERJ employees who had fasted for 12 hours. The samples were collected by a trained professional, who used vacutainer® (Becton, Dickinson & Company do Brasil) tubes containing EDTA-Na as an anticoagulant, and tubes without anticoagulant to obtain serum. The sample processing and biochemical analyses were performed at the Laboratório de Lípides (LabLip). Cut-off values established for total cholesterol (<190 mg/dl) and HDL-cholesterol (>40 mg/dl) levels were used.

Bias

The following covariables were analyzed with the aim of minimizing possible biases:

a) Age categorized in years: under 35; 35-44; 45-49; 50-54; 55-59; 60 or over;
b) Sex (female; male);
c) Schooling categorized into: up to complete elementary education (including incomplete junior and middle school); complete high school education (including incomplete higher education); complete higher education or above;
d) *Per capita* family income calculated from the midpoint of the reported net income category, divided by those dependent on the income; this quotient was divided by the minimum wage in effect at the time (BRL 622.00) and the resulting value was stratified into 3 categories: less than 3 minimum wages; 3 to 6 minimum wages; more than 6 minimum wages.

Statistical methods

Food consumption pattern

Dietary patterns were identified using principal component analysis (PCA). The food items listed in the FFQ were grouped together according to nutritional similarities or culinary preparations (Box 1). The premises for applying PCA were tested using the Kaiser-Meyer-Olkin (KMO) sample adequacy test, resulting in a value of 0.752 (>0.6 is considered adequate), and the Bartlett sphericity test. The null hypothesis was rejected when the latter test was performed (p<0.001), indicating that the data were adequate for the use of the method. Varimax orthogonal rotation was adopted, and factor loadings equal to or greater than 0.30 were considered as belonging to the patterns. After performing PCA, a standardized variable was predicted (continuous, symmetrical), indicating how much each individual adhered to each pattern identified.

The continuous variables were expressed in means and standard deviations (SD); while the categorical variables were expressed in percentages.

Among the variables, only TFM% and AFM% reached a 5% significance level when the Shapiro Wilk normality test was applied. However, since distribution was similar to the normal histogram and the sample size was large, linear models were considered for all variables. A linear regression model was estimated for each response variable (TFM%; AFM%; GFM%; AFM%/GFM%; WC; BMI; FRS), in relation to the crude and adjusted explanatory variables (dietary patterns: ultra-processed; healthy; meat; traditional). The explanatory variables were adjusted by the sociodemographic variables (sex; age; schooling; per capita income) and total energy. The model parameters were estimated using the least square model. 95% confidence intervals (95%CI) were used.

STATA version 13 was used in all stages of the analysis.

Box 1 – Food groups according to nutritional similarity, used to identify dietary patterns, Pró-Saúde Study, Rio de Janeiro, 2012-2013

Food groups	Food items
Rice	Rice
Pasta	Spaghetti, lasagna, gnocchi or ravioli
Bread and salted biscuits	Mini baguette or loaf of bread and salted biscuits
Fruit	Orange or tangerine, banana, papaya, apple, water melon, melon, pineapple, mango, lime, passion fruit, grapes
Fresh greens and vegetables	Lettuce, kale, cabbage, cauliflower or broccolis, tomato, cucumber, choko, zucchini, pumpkin, carrot, beetroot, okra, French beans, garlic, onion and sweet pepper
Conserved vegetables	Palm hearts, olives, maize
Beef and offal	Beef, tripe, liver, gizzard, heart and barbecue
Pork	Pork
Processed meat and fish	Meat or fish conserved in salt, bacon or pork crackling, tinned sardines or tuna
Ultra-processed meat	Hamburger, hot dog sausage, sausage, mortadella, luncheon meat, ham and salami
Fresh fowl and fish	Fresh fish and chicken
Milk and milk products	Cheese, milk, yoghurt and cream cheese
Eggs	Eggs
Beans	Beans
Fat	Butter or margarine and mayonnaise
Confectionary	Cake, filled biscuit, sweet biscuit, ice cream, candies, milk-based confectionary, fruit-based confectionary, bar of chocolate or bonbon, powdered chocolate and sugar
Savories and pizzas	Pizza, rissole-type savories, deep fried savories
Coffee and infusions	Coffee, tea and matte
Soda drinks	Cola-based soda drinks and other soda drinks
Natural fruit juice	Fruit juice or pulp
Alcoholic drinks	Beer, wine and other alcoholic drinks
Snacks	French fries, potato crisps or straws, packet snacks, packet peanuts
Pulses	Lentils, peas, chickpeas
Cereals	Polenta or corn mash
Root vegetables and products	Potato or mashed potato, cassava and cassava flour

Ethical aspects

The Research Ethics Committee of the Instituto de Medicina Social, Universidade do Estado do Rio de Janeiro approved the study project in its opinion on Certificate of Submission for Ethical Appraisal No. 0041.0.259.000-11. Its opinion was issued on October 18th 2011. The UERJ staff participated voluntarily. All participants signed a free and informed consent form.

Results

There was no loss of participants during the data collection stages. Of the total individuals studied (n=520), 51.9% were female, 24.6% were between 50 and 54 years old, 54.3% reported having complete higher education or above, and 70.0% had a per capita income of less than three minimum wages (Table 1).

Table 2 shows variables related to adiposity. Among the participants, mean BMI was 27.8 kg/m^2 (SD=5.0), TFM was 36.2% (SD=8.3), and the AFM%/GFM% ratio was 0.6 (SD=0.2).

Risk of cardiometabolic diseases, according to WC, was identified for 77.9% of the study population, while 66.6% were overweight or obese. However, according to the FRS, 68.5% of participants had low risk and

31.5% had intermediate or high risk of developing CVD within 10 years.

Four food consumption patterns were found and referred to as 'ultra-processed', 'healthy', 'meat' and 'traditional'. The latter pattern included characteristics of a traditional Brazilian diet: ultra-processed (pasta; bread and salted biscuits; fat; confectionary; savories and pizzas; soda drinks; snacks; ultra-processed meat); healthy (fruit; fresh greens and vegetables; fresh fowl and fish; milk and milk products; coffee and infusions; natural fruit juice; pulses); meat (conserved vegetables; beef and offal; pork; processed meat and fish; alcoholic drinks); and traditional (rice; beans; cereals; roots, root vegetables and products). Total variance explained by the four patterns was 37.3% (Table 3).

Table 4 shows the crude and adjusted coefficients to find association between the food consumption patterns and each of the outcomes. In the bivariate analysis, inverse association was found between the 'ultra-processed' pattern and the Framingham Risk Score (ß=-0.52 - 95%CI -1.01;-0.02), and between the 'meat' pattern and waist circumference (ß=-1.33 - 95%CI -2.42;-0.24) and body mass index (ß=-0.44 - 95%CI -0.87;-0.01). After adjustment, the 'meat' pattern was inversely associated with waist circumference (ß=-1.52 - 95%CI -2.65;-0.38), body mass index (ß=-0.56 - 95%CI -1.00;-0.10) and Framingham Risk Score (ß=-0.36 - 95%CI -0.63;-0.09). As for the other patterns, no association was identified with any of the outcomes assessed.

Discussion

The analyses revealed four food consumption patterns, referred to as 'ultra-processed', 'healthy', 'meat' and 'traditional', as well as association between the 'meat' consumption pattern and overweight, and risk of developing CVDs according to the FRS.

Although food consumption is influenced by regional and cultural factors, similar food consumption patterns to those we identified have been described by other authors in France,[19] China,[20] the United States[21] and also in Brazil.[22] In general, patterns usually recognized as traditional reflect those foods that are most consumed by the population that is being studied and usually cost less.[22]

The 'meat' pattern, comprised of beef and pork, processed meat and fish, conserved vegetables and alcoholic beverages, was inversely associated with WC, BMI and FRS. This finding contrasts with the literature, which indicates that so-called healthy or prudent patterns are protective against obesity. However, it has been found that the protein content of the diet results in a reduction of carbohydrates, generating a calorie deficit of approximately 6%, which is favorable to weight loss or maintenance.[23]

Some potential explanatory mechanisms are related to the fact that the consumption of protein-rich foods promotes a negative fat balance, and consequently a reduction in body fat stores. One of these mechanisms is related to the thermal effect of protein, which is greater than that of carbohydrate or fat. In addition, protein generally exerts a greater satiety effect than other macronutrients, partially mediated by a synergistic effect of the sociogenic hormones (glucagon-like peptide-1 [GLP-1] and peptide YY [PYY]) released in the small intestine. Other mechanisms involve reduction of orexigenic hormone secretion (ghrelin) and protein-induced changes in gluconeogenesis, improving glucose homeostasis.[24]

We found that alcoholic beverage consumption was present in the 'meat' pattern and this is worthy of note. The literature shows that habitual light to moderate alcohol consumption (1 to 2 doses/day) is associated with lower risk of total mortality from diabetes mellitus or CVD. These findings may be related to the action of ethanol in reducing platelet aggregation and its effect in increasing high density lipoproteins (HDL-c), besides the antioxidant action of some beverages.[25] However, excessive alcohol consumption (>4 doses/day) is associated with a higher risk of death and presence of CVD.[25]

The effect of alcohol consumption in relation to body composition is controversial. In a systematic review of studies on the subject, some studies reported that individuals with low to medium alcohol consumption had lower weight, compared to those who never drank and also to those with heavy alcohol consumption, while other studies showed a positive effect of alcohol on BMI.[26]

An investigation carried out earlier with the same population taking part in the present study showed low alcohol consumption: 41% reported not consuming any type of alcoholic drinks, 41% reported consuming up to one dose per day and 18% reported consuming

Table 1 – General characteristics of technical and administrative staff (n=520) at a university in the state of Rio de Janeiro, *Pró-Saúde* Study, Rio de Janeiro, Brazil, 2012-2013

Variables	n	%
Sex		
Female	270	51.9
Male	250	48.1
Age (years)		
<35	29	5.6
35-44	71	13.7
45-49	115	22.1
50-54	128	24.6
55-59	82	15.8
≥60	95	18.2
Schooling		
Up to complete elementary education	49	9.4
Complete high school education	184	35.3
Complete higher education or above	283	54.3
***Per capita* income (minimum wages)**		
<3	364	70.0
3-6	128	24.6
>6	28	5.4
Waist circumference		
No risk	114	21.1
At risk	406	77.9
BMI[a]		
Underweight	20	3.8
Normal	154	29.6
Overweight	346	66.6
Framingham Risk Score (rating)		
High	51	9.8
Intermediate	113	21.7
Low	356	68.5

a) BMI: body mass index.

more than one dose per day.[27] Those results corroborate the understanding of the associations we found related to the increase in BMI.

Dietary patterns identified as healthy or prudent include foods such as fruit, vegetables, fresh greens and vegetables, and cereals, associated with better health outcomes. In turn, the so-called processed, or 'western', patterns reflect higher consumption of sugars, fat, sodium and energy, which are inversely associated with health outcomes.[28]

Studies with the Brazilian population have found a relationship between a traditional dietary pattern (rice and beans) and metabolic complications,[22,29] although the present study did not detect this association. A survey of baseline participants of the 2008-2010 Brazilian Longitudinal Study of Adult

Table 2 – General description of the study population (n=520), according to adiposity, *Pró-Saúde* Study, Rio de Janeiro, Brazil, 2012-2013

Variables	Mean	Standard deviation
Total mass (kg)	77.6	15.3
Total fat mass (%)	36.2	8.3
Android fat mass (%)	9.3	1.8
Gynoid fat mass (%)	16.9	3.1
AFM%/GFM% ratio[a]	0.6	0.2
BMI (kg/m^2)[b]	27.8	5.0
Waist circumference (cm)	97.2	12.4
Framingham Risk Score (rating)	6.5	7.0

a) AFM%/GFM% ratio: android fat mass %/gynoid fat mass %; b) BMI: body mass index.

Table 3 – Distribution of food consumption pattern factor loadings (n=520), *Pró-Saúde* Study, Rio de Janeiro, Brazil, 2012-2013

Food groups	Factors (dietary patterns) identified			
	Ultra-processed	Healthy	Meat	Traditional
Pasta	0.57	0.03	0.05	0.08
Bread and salted biscuits	0.42	0.25	-0.23	0.25
Fat	0.46	0.06	0.15	0.31
Confectionary	0.64	0.09	-0.14	0.04
Savories and pizzas	0.69	-0.09	0.18	-0.06
Soda drinks	0.54	-0.26	0.14	0.07
Snacks	0.58	0.03	0.21	-0.01
Ultra-processed meat	0.58	-0.07	0.35	0.04
Fruit	-0.09	0.69	0.10	0.16
Fresh greens and vegetables	-0.16	0.70	0.24	0.17
Fresh fowl and fish	0.08	0.32	0.04	0.08
Milk and milk products	0.17	0.62	-0.22	0.16
Coffee and infusions	0.14	0.45	0.29	0.00
Natural fruit juice	0.04	0.32	-0.20	0.17
Pulses	0.05	0.48	0.16	-0.15
Conserved vegetables	0.13	0.27	0.44	-0.15
Beef and offal	0.18	-0.03	0.56	0.25
Pork	0.14	-0.08	0.64	0.08
Processed meat and fish	0.21	0.15	0.48	0.13
Alcoholic drinks	0.01	0.07	0.49	-0.10
Rice	0.01	-0.09	0.02	0.74
Beans	-0.45	-0.01	-0.01	0.78
Cereals	0.15	0.21	-0.01	0.38
Roots, root vegetables and products	0.26	0.18	0.10	0.41

a) KMO: Kaiser-Meyer-Olkin Measure of Sampling Adequacy.

To be continue

Continuation

Table 3 – Distribution of food consumption pattern factor loadings (n=520), *Pró-Saúde* Study, Rio de Janeiro, Brazil, 2012-2013

Food groups	Factors (dietary patterns) identified			
	Ultra-processed	Healthy	Meat	Traditional
Eigenvalues	2.99	2.41	1.99	1.93
Explained variance (%)	11.95	9.63	7.97	7.73
Total explained variance (%)	37.3			
KMO[a]	0.752			
Bartlett sphericity	0.001			

a) KMO: Kaiser-Meyer-Olkin Measure of Sampling Adequacy.

Table 4 – Association between dietary patterns and each of the outcomes assessed (n=520), *Pró-Saúde* Study, Rio de Janeiro, Brazil, 2012-2013

Variables	Non-adjusted β	95%CI[a]	p-value	Adjusted β[b]	95%CI[a]	p-value
Total fat mass (%)						
'Ultra-processed' pattern	0.64	(-0.08;1.37)	0.082	0.06	(-0.84;0.96)	0.890
'Healthy' pattern	0.38	(-0.34;1.11)	0.303	0.06	(-0.70;0.83)	0.871
'Meat' pattern	-0.22	(-0.95;0.50)	0.551	-0.42	(-1.17;0.33)	0.275
'Traditional' pattern	0.70	(-0.02;1.43)	0.055	0.23	(-0.61;1.07)	0.586
Android fat mass (%)						
'Ultra-processed' pattern	0.06	(-0.09;0.22)	0.439	-0.02	(-0.21;0.17)	0.833
'Healthy' pattern	0.08	(-0.06;0.24)	0.271	0.06	(-0.10;0.23)	0.461
'Meat' pattern	-0.10	(-0.26;0.04)	0.173	-0.14	(-0.31;0.01)	0.083
'Traditional' pattern	-0.10	(-0.26;0.04)	0.177	-0.15	(-0.33;0.03)	0.101
Gynoid fat mass (%)						
'Ultra-processed' pattern	-0.11	(-0.38;0.15)	0.415	-0.22	(-0.56;0.10)	0.183
'Healthy' pattern	0.11	(-0.15;0.38)	0.394	0.02	(-0.25;0.31)	0.848
'Meat' pattern	0.17	(-0.08;0.44)	0.191	0.15	(-0.12;0.43)	0.279
'Traditional' pattern	0.22	(-0.04;0.49)	0.104	0.04	(-0.26;0.36)	0.761
AFM%/GFM% ratio[c]						
'Ultra-processed' pattern	0.01	(-0.07;0.02)	0.281	0.01	(-0.01;0.02)	0.496
'Healthy' pattern	0.01	(-0.01;0.01)	0.792	0.01	(-0.01;0.20)	0.733
'Meat' pattern	-0.01	(-0.02;0.02)	0.169	-0.01	(-0.02;0.01)	0.132
'Traditional' pattern	-0.01	(-0.03;0.02)	0.071	-0.01	(-0.03;0.01)	0.162
Waist circumference						
'Ultra-processed' pattern	0.43	(-0.66;1.52)	0.430	0.06	(-1.29;1.42)	0.924
'Healthy' pattern	0.79	(-0.29;1.88)	0.151	0.69	(-0.46;1.85)	0.235
'Meat' pattern	-1.33	(-2.42;-0.24)	0.012	-1.52	(-2.65;-0.38)	0.009
'Traditional' pattern	-0.25	(-1.34;0.84)	0.656	-0.41	(-1.67;0.85)	0.522

a) 95%CI: 95% confidence interval; b) Least square linear regression, adjusted for sex, schooling, *per capita* income, age and energy (total calorie intake); c) AFM%/GFM% ratio: android fat mass %/gynoid fat mass %; d) BMI: body mass index.

To be continue

Continuation

Table 4 – Association between dietary patterns and each of the outcomes assessed (n=520), *Pró-Saúde* Study, Rio de Janeiro, Brazil, 2012-2013

Variables	Non-adjusted β	95%CI[a]	p-value	Adjusted β[b]	95%CI[a]	p-value
BMI[d]						
'Ultra-processed' pattern	0.20	(-0.22;0.63)	0.351	0.10	(-0.43;0.64)	0.709
'Healthy' pattern	0.29	(-0.13;0.72)	0.182	0.23	(-0.22;0.69)	0.308
'Meat' pattern	-0.44	(-0.87;-0.01)	0.043	-0.56	(-1.00;-0.10)	0.015
'Traditional' pattern	-0.10	(-0.54;0.32)	0.638	-0.20	(-0.70;0.29)	0.427
Framingham Risk Score						
'Ultra-processed' pattern	-0.52	(-1.01;-0.02)	0.040	0.11	(-0.21;0.44)	0.483
'Healthy' pattern	-0.24	(-0.73;0.25)	0.341	0.25	(-0.02;0.52)	0.072
'Meat' pattern	-0.00	(-0.50;0.49)	0.982	-0.36	(-0.63;-0.09)	0.009
'Traditional' pattern	-0.09	(-0.58;0.40)	0.724	0.16	(-0.13;0.46)	0.280

a) 95%CI: 95% confidence interval; b) Least square linear regression, adjusted for sex, schooling, *per capita* income, age and energy (total calorie intake); c) AFM%/GFM% ratio: android fat mass %/ gynoid fat mass %; d) BMI: body mass index.

Health (Estudo Longitudinal de Saúde do Adulto – ELSA-Brasil), identified that the traditional Brazilian dietary pattern (beans, white rice, processed and fresh meat, and beer) was related to greater diagnosis of diabetes mellitus and metabolic syndrome. It is noteworthy that that survey also identified four food patterns, similar to those identified in this study.[29] However, authors have observed an inverse association between this traditional pattern and overweight/obesity in women.[22] Traditional dietary patterns represent particular characteristics of the populations studied, although the 'traditional' pattern is mostly represented by the Western pattern associated with the prudent or healthy pattern.

This study identified a 'healthy' pattern, consisting of foods such as fruit, fresh greens and vegetables, fresh fowl and fish, milk and milk products, coffee and infusions, natural fruit juice and pulses. Other studies have revealed an inverse association of the healthy pattern with cardiovascular events.[8-10] Among Chinese men, an intake pattern characterized by fruit and milk was inversely associated with hypertension. The same pattern was associated with lower blood pressure levels, diabetes mellitus, and lower CVD risk among adults, and with a lower risk of hypertension for women on a DASH diet.[30]

Quality of food and an active lifestyle are two fundamental conditions for preventing and controlling modifiable risks of CVD and obesity.[1] Therefore, knowing the main dietary patterns related to protection or risk of these morbidities is of utmost importance in public health strategies.

The main limitation of this study is its cross-sectional design, which weakens inferences, of a causal nature, regarding associations between food intake patterns, overweight and cardiovascular risk. The participants of the *Pró-Saúde* Study are civil servants, which makes the occurrence of healthy worker bias possible, given the better conditions of this population for maintaining their health and keeping to a diet, compared to the average population. It should be noted that the instrument used to evaluate food consumption is subject to errors, since it is a retrospective instrument, dependent on the memory of the interviewee, on individual choices, in addition to the quantification and classification of foods, even though it is a validated instrument.[16]

Although more precise methods may be used to assess abdominal fat, waist circumference should be considered to be a good predictor of cardiometabolic risk, in view of it being a practical and low cost measure, in addition to the use of the FRS for predicting cardiovascular risk.[18]

This was the first study in Brazil to use a food intake pattern and which, by adopting a food frequency questionnaire related to body composition data, such as total fat mass, android and gynoid fat mass, measured via DXA, the gold standard for anthropometric measurement, overcame limitations of previous studies that used double indirect anthropometry. Observational analyses were performed between consumption patterns and sex; however, the directions of association were unchanged.

Given the high prevalence of overweight and risk of CVD, as well as the inverse association found related to 'meat' dietary pattern and BMI, it is important to conduct further prospective investigations to help understand the role of diet in the development of cardiovascular disease.

Authors´ contributions

Rocha TF contributed to the concept and design of the study, analysis and interpretation of the results, drafting and critically reviewing the contents of the manuscript. Curioni C contributed to the study design, analysis and interpretation of the results, drafting and critically reviewing the contents of the manuscript. Verly-Junior E, Bezerra F and Faerstein E contributed to data analysis and interpretation, drafting and critically reviewing the contents of the manuscript. All the authors have approved the final version of the article and are responsible for all aspects thereof, including the guarantee of its accuracy and integrity.

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