https://doi.org/10.1590/1678-9865202235e210102

ORIGINAL

Dietary patterns and cardiometabolic risk factors of a federal public institution staff in the northern region of Brazil

Padrões alimentares e fatores de risco cardiometabólicos em funcionários de uma instituição pública federal na região norte do Brasil

Elisama Costa LOPES[1] 0000-0002-6244-3830
Fabiane Aparecida Canaan REZENDE[2] 0000-0002-5617-8778
Renata Junqueira PEREIRA[3] 0000-0001-9487-4013

ABSTRACT

Objective

To identify dietary patterns in an adult population and assess those patterns association with cardiometabolic risk factors.

Methods

Cross-sectional study conducted with 130 workers of a university in *Tocantins*, Brazil, aged 20-59 years. Dietary patterns were identified by principal component analysis based on a food frequency questionnaire. Body mass index, waist circumference, blood pressure, fasting glycemia, triacylglycerols, low-density lipoprotein and high-density lipoprotein cholesterol were measured. Multinomial logistic regression was used to assess the association between dietary patterns and cardiometabolic risk factors.

[1] Universidade Federal do Tocantins, Pró-Reitoria de Pesquisa, Programa de Pós-Graduação em Ciências da Saúde. Palmas, TO, Brasil.
[2] Universidade do Porto, Faculdade de Ciências da Nutrição e Alimentação. Porto, Portugal.
[3] Universidade Federal do Tocantins, Direção do Campus de Palmas, Curso de Graduação em Nutrição. Quadra 109, Av. NS-15, ALCNO-14, Plano Diretor Norte, 77001-090, Palmas, TO, Brasil. Correspondence to: RJ PEREIRA. E-mail: <renatajunqueira@uft.edu.br>.

Article based on the dissertation of EC LOPES, entitled "*Identificação de padrões alimentares em uma população adulta: associação com marcadores de risco cardiometabólicos*". Universidade Federal do Tocantins; 2018.

How to cite this article

Lopes EC, Rezende FAC, Pereira RJ. Dietary patterns and cardiometabolic risk factors of a federal public institution staff in the northern region of Brazil. Rev Nutr. 2022;35:e210102. https://doi.org/10.1590/1678-9865202235e210102

Results

Three dietary patterns were identified that together explained 78.74% of total variance: healthy, western and fit dietary patterns. In the adjusted model, greater adherence to the healthy pattern was associated with lower fasting glucose values (*OR*: 0.89; 95%IC: 0.82-0.97; *p*=0.009) and with higher concentrations of low-density lipoprotein cholesterol (*OR*: 1.02; 95%IC: 1.00-1.04; *p*=0.024); the western dietary pattern was associated with higher fasting glucose values (*OR*: 1.06; 95%IC: 1.00-1.13; *p*=0.05) and the fit pattern was associated with lower concentrations of low-density lipoprotein cholesterol (*OR*: 0.98; 95%IC: 0.97-0.99; *p*=0.048).

Conclusion

Food was an important risk and protective factor for cardiometabolic changes.

Keywords: Adults. Cardiovascular diseases. Food consumption. Risk factors.

RESUMO

Objetivo

Identificar padrões alimentares em uma população adulta e avaliar a associação com fatores de risco cardiometabólico.

Métodos

Estudo transversal realizado com 130 funcionários entre 20 e 59 anos de uma universidade do Tocantins, Brasil. Os padrões alimentares foram identificados por análise de componentes principais com base em um questionário de frequência alimentar. Foram mensurados índice de massa corporal, perímetro da cintura, pressão arterial, glicemia de jejum, triglicerídeos, lipoproteínas de baixa densidade e lipoproteínas de alta densidade. As associações dos padrões com os fatores de risco cardiometabólico foram determinadas por regressão logística multinomial.

Resultados

Três padrões foram identificados que explicaram 78.74% da variância total: saudável, ocidental e fit. No modelo ajustado, a maior adesão ao padrão saudável foi associada com menores valores de glicemia de jejum (OR: 0.89; 95% IC: 0.82-0.97; p=0.009) e com maiores concentrações de lipoproteína de baixa densidade colesterol (OR: 1.02; 95% IC: 1.00-1.04; p=0.024); o padrão ocidental foi associado com maiores valores de glicemia de jejum (OR: 1.06; 95% IC: 1.00-1.13; p=0.05) e o padrão fit foi associado com menores concentrações de lipoproteína de baixa densidade colesterol (OR: 0.98; 95% IC: 0.97-0.99; p=0.048).

Conclusão

A alimentação constituiu um importante fator de risco e de proteção para alterações cardiometabólicas.

Palavras-chave: *Adultos. Doenças cardiovasculares. Consumo alimentar. Fatores de risco.*

INTRODUCTION

Dietary patterns can be defined as a set or group of foods consumed by a given population, and have been increasingly explored in nutritional epidemiology in order to complement the view that previously focused on the effect of foods, nutrients and food components on human health. As they are closer to the actual eating behavior, dietary patterns can provide clearer relationships regarding the risk of diseases and be more useful in the implementation of educational health strategies, as they are more easily interpreted by the general public [1].

Dietary patterns can be identified a *priori* (score or indices that assess the diet quality) or a *posteriori* – through multivariate analysis techniques (*e.g.*, Principal Component Analysis [PCA]). In studies that evaluated the association between a *posteriori* dietary patterns and cardiometabolic risk factors, it was observed that dietary patterns with a predominance of fruits, vegetables, grains, including whole grains, nuts, fish and poultry have a protective effect against general obesity and/or or abdominal obesity changes in the lipid profile, hypertension, diabetes and metabolic syndrome [2-4]. On the other hand, dietary patterns with regular consumption of hamburgers, fast food, desserts, red/processed meats, high-fat dairy products, processed foods, and alcohol are unfavorably associated with cardiometabolic risk [2,3,5,6].

We should be aware that the dietary pattern is very important as a starting point to determine the relationship between food and health, and to establish more effective preventive and/or therapeutic interventions. Many studies on dietary patterns in adult populations have been published; however the different cultures and eating habits influence the dietary patterns which are represented by foods and culinary preparations specific to each population, so it is believed that this study may contribute to understanding the cumulative effect of the diet on human health. This study aims to identify the dietary patterns of a federal public institution staff in the northern region of Brazil and to assess its association with cardiometabolic risk factors.

METHODS

Cross-sectional study carried out between March and December 2017 with 130 workers of a federal public educational institution in *Palmas* (TO), Brazil. The inclusion criteria were: to be an employee of the institution (technical-administrative, teaching or outsourced), of both genders, aged between 20 and 59 years who accepted to participate in the study. Pregnant women, postpartum women, lactating women, the elderly, individuals treated with low-calorie diets, or who reported weight loss in the last six months (allowing a variation of up to 5%) or who participated in nutrition-related research or consultations in the last six months, were excluded. Individuals undergoing chemotherapy, using weight-loss drugs or multivitamin supplements, or with any condition that could affect the anthropometric assessment (edema, amputated limb, wheelchair users, *etc*.) were also excluded. All participants signed the Free and Informed Consent Form. This study was approved by the Ethics Committee for Research on Human Beings of the *Universidade Federal do Tocantins* (UFT, Federal University of Tocantins) under opinion nº 2.161.142).

Anthropometric assessment was performed at the nutrition laboratory, located on the UFT *Palmas* campus, and included weight, height and Waist Circumference (WC) measurements. Body weight was measured on a 300 kg, 50 g division digital scale. Body height was measured with a 2.20 m stadiometer with millimeters division. Nutritional status was classified using the Body Mass Index (BMI), according to the cutoff points of the World Health Organization [7]. The WC was measured twice at the midpoint between the lower margin of the last rib and the iliac crest. When it was not possible to identify the midpoint, the measurement was performed 2 cm above the umbilical scar. The cardiometabolic risk classification was defined according to the World Health Organization cut-off score [7].

The biochemical evaluation included fasting glucose and lipidogram, and was performed by a specialized laboratory after 8 hours fasting. Cardiometabolic risk situations included: being on hypoglycemic and/or hypocholesterolemic drug treatment, self-report of diabetes or alteration in biochemical tests: reduced high-density lipoprotein (HDL-c) (<40 mg/dL for men and <50 mg/dL for women), high triacylglycerols (TG) (≥150 mg/dL for both genders), high fasting blood glucose (FBG) (≥100 mg/dL for both genders) and increased low-density lipoprotein (LDL-c) (≥130 mg/dL for both genders) [8,9]. Metabolic Syndrome (MS) was defined according to the criteria of the International Diabetes Federation (IDF), which include the presence of abdominal obesity (WC >94 cm in men and >80 cm in women) associated with two other of the following criteria: FBG ≥100 mg/dL or diagnosed with diabetes, TG ≥150 mg/dL or being treated for dyslipidemia, HDL <40 mg/dL in men or <50 mg/dL in women, and Systolic Blood Pressure ≥130 mmHg or diastolic blood pressure (DBP) ≥ 85 mmHg or treatment for arterial hypertension [9]. Blood pressure was measured with an aneroid sphygmomanometer, being considered a risk when Systolic Blood

Pressure ≥130 mmHg and/or DBP ≥85 mmHg, or when hypertension was self-reported or in the case of patient's use of antihypertensive drugs. The measurement was performed following the guidelines of the Brazilian Society of Cardiology [10].

The sociodemographic, economic and behavioral variables were age, gender, years of schooling, income (*per capita*), alcohol consumption (number of grams of alcohol/day from the consumption reported in the food frequency questionnaire-FFQ), smoking (never smoked, ex-smoker and smoker) and leisure-time physical activity (<150 minutes/week and ≥150 minutes/week) [11].

Dietary patterns were identified by PCA using a semi-quantitative FFQ validated for the Brazilian population, used in the *Estudo Longitudinal de Saúde do Adulto* (Longitudinal Study of Adult Health) [12]. This instrument was adapted and included typical regional foods, and was presented without prior foods grouping. Participants were encouraged to answer which foods/preparations they had habitually consumed in the last six months (per day, week or month), consumption measures, in addition to reporting seasonal consumption [13].

For the analysis, only the qualitative component of the FFQ was used. Before grouping the 140 foods evaluated, seven foods (*bacaba, siriguela, jambo*, soy, nuts, gherkin stew and polenta) were excluded because they had a consumption frequency of less than 5; the objective was to improve the robustness of the analysis [14]. Foods were categorized into 23 groups according to the similarity of nutrient content (Table 1). The case-to-variable ratio was 5.65 (130 participants/23 variables) [15]. The consumption frequencies of the food groups were summarized in a single value for each individual, according to the methodology represented by the equation [15]:

$$\frac{\text{Summary measure} = \Sigma \text{ of the consumption frequency of foods contained in the food group}}{\text{Number of foods in the group x maximum frequency of consumption indicated in the FFQ}}$$

Table 1 – Matrix of dietary patterns factor loadings. *Palmas* (TO), Brazil, 2018.

1 of 2

Food / Food groups	Food items included	Factor 1	Factor 2	Factor 3
Oatmeal/granola	Oatmeal and granola	**0.5526**	0.1024	0.2777
Cereals/tubers	White rice, brown rice, boiled sweet potatoes, boiled potatoes, cassava, cassava flour, *farofa*, mashed potatoes, couscous, mush, pasta, *pamonha* and *tapioca*	**0.7273**	0.2781	0.0083
Bread/cakes/cookies	Homemade bread, white bread loaf, whole wheat bread, cheese bread, sweet bread, French roll, simple cake, corn cake, rice cake, cracker, salt crackers, social club, cornstarch, maria biscuits, donuts	0.2992	**0.5891**	-0.0460
Fruits	Pineapple, banana, fried plantain, cashew, guava, apple, papaya, mango, watermelon, melon, tangerine/ponkan, grape, *açaí* and *cupuaçu*	**0.7366**	0.0479	-0.0257
Vegetables	Chard, lettuce, cabbage, arugula, pumpkin, zucchini, eggplant, beetroot, broccoli, carrot, chayote, cauliflower, *jiló*, gherkin, soft corn, cucumber, *pequi*, okra, tomato, green beans, vegetable salad (mayonnaise)	**0.6623**	0.0538	0.0477
Legumes	Carioca beans, string beans, black beans, chickpeas, lentils	**0.3192**	0.1133	0.1218
Feijoada	Feijoada	0.0191	**0.3686**	-0.0577
Oilseeds	Cashew nuts, Brazil nuts, peanuts	**0.4628**	0.0428	**0.3948**
Eggs	Eggs	**0.3270**	0.0962	**0.3197**
Whole milk dairy	Whole milk, natural yogurt, fruit yogurt, cottage cheese, mozzarella, fresh Minas cheese	0.0701	**0.5426**	0.2350
Skimmed milk dairy	Semi-skimmed milk, skimmed milk	0.1566	-0.1086	0.0360
Margarine	Margarine	0.1334	0.1669	**-0.5515**

Table 1 – Matrix of dietary patterns factor loadings. *Palmas* (TO), Brazil, 2018.

2 of 2

Food / Food groups	Food items included	Factor 1	Factor 2	Factor 3
Butter	Butter	0.0179	0.0348	**0.6697**
Red meat	Beef, pork, barbecue, *chambari*, pumpkin *quibebe*, *buchada*, offal, beef stroganoff	0.2940	**0.4751**	-0.1777
Chicken/fish	Chicken, fish	**0.5321**	-0.0762	-0.1396
Processed meat	Sausages, bologna, ham, salami, hamburger, bacon	0.0177	**0.6609**	-0.1000
Mixed preparations	Chicken stew, baião de dois, *Maria Isabel*, meat/chicken *escondidinho*, lasagna	**0.4529**	0.2688	-0.0904
Snacks	Hamburger (sandwich), hot dog, fried dishes, fried pastel, savory pie, chips, popcorn, stuffed biscuit and pizza	0.0415	**0.8353**	-0.0254
Honey/*rapadura*	Honey, *rapadura* (brown sugar).	0.2486	-0.1022	**0.3684**
Sweets/desserts	Powdered chocolate-type drink, chocolate bar/bonbon, ice cream, pudding, fruit jam	0.1697	**0.6867**	0.0784
Coffee/infusions	Coffee, herbal tea	0.2049	0.1335	0.1649
Natural juices	*Acerola*, cashew, *cupuaçu*, mango, orange, etc	**0.2971**	0.1693	0.0981
Soft drinks/ industrialized juices	Soda, powdered and bottled juice	-0.0752	**0.3762**	**-0.3178**
% explained variance: 78,74% (accumulated)		32,34%	30,96%	15,43%

Note: Values indicated in bold are factor loadings ≥0.30 that are considered significant.

To define dietary patterns by the PCA, the correlation matrix of the 23 food groups was evaluated, which showed 21 variables with saturation values greater than 0.30. The Kaiser-Meyer-Olkin tests (KMO=0.716), the Bartlett test ($\chi^2(253)=930.62$; $p=0.000$) and the correlation matrix determinant=0.000 indicated good quality of the correlations. The number of factors to be extracted was defined according to the Kaiser criterion (eigenvalues>1.0) which identified four patterns [1]. However, when interpreting each factor, it was found that the meanings of the fourth factor were not very clear, opting for the retention of 3 factors, which explained 78.74% of the variance after rotating the factors (orthogonal varimax). Factor loadings were considered significant when values were ≥0.30. Then, factor scores were derived for each individual, representing the level of adherence for each specific pattern, and subsequently subdivided into tertiles. The patterns were named according to the characteristics of the foods that presented the highest factor loadings.

The linear trend test for continuous variables (expressed as mean±SD) and the chi-square test for categorical variables were used to identify significant differences between the tertile categories of dietary patterns. In order to assess the association of dietary patterns with cardiometabolic risk variables, multinomial logistic regression was used to estimate Odds Ratios (OR) with a 95% confidence interval (95%CI). Logistic models were adjusted for age, gender, physical activity, smoking, years of schooling, BMI, WC, FBG, LDL-c and blood pressure. The variables were included in the final model considering Wald's p value <0.2 in the bivariate analysis. Men and women were combined in the analysis as they did not present differences for the variables studied. For all the analyses, Stata version 13.0 (StataCorp., College Station, US) was used and $p<0.05$ was considered statistically significant.

RESULTS

Three patterns were identified, which together explained 78.74% of the total variance: healthy pattern, which includes fruits, cereals and tubers, vegetables; oatmeal and granola, chicken and fish, oilseeds, mixed dishes, eggs, legumes and natural juices; western pattern, characterized by snacks; sweets and desserts, red meat, processed meat, bread, cakes and cookies, high-fat dairy products, soft drinks and processed juices and *feijoada*; the fit pattern was positively correlated with butter consumption; oilseeds; honey; brown sugar and eggs, and negatively with margarine; soft drinks and processed juices. The fit pattern was named after the individuals in the last tertile who were physically more active (linear trend p=0.045). The matrix with the dietary patterns distribution of factor loadings is shown in Table 2.

Table 2 – Matrix of dietary patterns factor loadings. *Palmas* (TO), Brazil, 2018.

Foods/food groups	Healthy	Western	Fit
Oatmeal/granola	0.5526		
Cereals/tubers	0.7273		
Bread/cakes/cookies		0.5891	
Fruits	0.7366		
Vegetables	0.6623		
Legumes	0.3192		
Feijoada		0.3686	
Oilseeds	0.4628		0.3948
Eggs	0.3270		0.3197
Whole milk dairy		0.5426	
Skimmed milk dairy			
Margarine			-0.5515
Butter			0.6697
Red meat		0.4751	
Chicken/fish	0.5321		
Processed meat		0.6609	
Mixed preparations	0.4529		
Snacks		0.8353	
Honey/brown sugar			0.3684
Sweets/desserts		0.6867	
Coffee/infusions			
Natural juices	0.2971		
Soft drinks / industrialized juices		0.3762	-0.3178
% explained variance: 78.74% (accumulated)	32.34%	30.96%	15.43%

The characteristics of the participants according to the tertiles of the eating patterns scores are presented in Table 3. The participants in the upper tertile of the healthy pattern were more predominantly females (p=0.015) and who revealed lower alcohol consumption (grams/day) (p=0.006) when compared to individuals in the first tertile. Compared with the participants in the first tertile, participants in the third tertile of the Western dietary pattern were significantly younger (p=0.014). Individuals in the third tertile of the fit pattern, compared to those in the first tertile, tended to have more education (p<0.0001), higher *per capita* income (p=0.005), be more physically active (minutes/week) (p=0.045) and with a lower MS frequency (p=0.005).

In models adjusted for gender, age, physical activity, smoking status, years of schooling, BMI, WC, FGA, LDL-c and blood pressure, greater adherence to the healthy pattern was associated with lower FGA concentrations, and with higher LDL-c concentrations. For the Western diet standard, higher scores were associated with higher FBG concentrations. Regarding the fit pattern, greater adherence to this pattern was associated with lower LDL-c concentrations (Table 4).

Table 3 – Characteristics of the participants according to the tertiles of the dietary patterns scores. *Palmas* (TO), Brazil, 2018.

Variables	"Healthy"		$p^{a,b}$	"Western"		$p^{a,b}$	"Fit"		$p^{a,b}$
	T1 (n= 44)	T3 (n= 43)		T1 (n= 44)	T3 (n= 43)		T1 (n= 44)	T3 (n= 43)	
Gender (%)									
Female	47.73	76.74	**0.015**	68.18	51.16	0.267	56.82	55.81	0.628
Male	52.27	23.26		31.82	48.84		43.18	44.19	
Age (years)	33.70±8,83[c]	35.63±8.55	0.246	37.45±8.47	32,74±7.06	0.014	34.20±8.09	33.72±7.15	0.955
Years of education	17.20±4,28[c]	18.98±7.93	0.399	16.84±6.93	18.06±5.39	0.080	15.04±4.73	20.15±6.63	**<0.0001**
Per capita income (R$)	2.659,97± 1.739,99[c]	2.940,48± 2.508,05	0.648	2.421,44± 1.607,44	2.662,84± 1.678,53	0.606	2.009,27± 1.652,66	2.828,94± 1.397,95	**0.005**
Physical activity (minutes/week)	132.16±179.20[c]	149.30±202.88	0.596	125.68± 212.29	105.58± 145.59	0.772	65.91± 107.04	162.33± 226.73	**0.045**
Smoking (%)	13,64	4,65	0.114	6.82	6.98	0.970	11.36	0.00	0.192
Alcohol consumption (grams/day)	7.75±13.68[c]	4.08±12.62	**0.006**	4.43±11.21	5.58±12.25	0.287	3.91±10.22	7.14±13.79	0.197
Metabolic syndrome (%)	23.33	19.35	0.712	20.69	20.00	0.914	36.36	5.88	**0.005**

Note: [a]Chi-square test for categorical variables. [b]P linear trend values between tertiles. [c]Mean ± standard deviation. Values in bold indicate statistical significance (p<0.05).

Table 4 – Adjusted odds ratio and relevant confidence intervals according to variables associated with dietary patterns. *Palmas* (TO), Brazil, 2018.

Variables	Healthy		Western		Fit	
	T1	T3 *OR* (95%CI)	T1	T3 *OR* (95%CI)	T1	T3 *OR* (95%CI)
BMI (kg/m^2)[b]	1.0	0.97(0.83-1.13)	1.0	0.99(0.86-1.14)	1.0	0.98(0.85-1.12)
WC (cm)[a]	1.0	0.99(0.93-1.06)	1.0	1.00(0.95-1.06)	1.0	0.99(0.93-1.05)
FBG (mg/dL)[b]	1.0	0.89(0.82-0.97)*	1.0	1.06(1.00-1.13)*	1.0	0.96(0.90-1.02)
LDL-c (mg/ dL)[a]	1.0	1.02(1.00-1.04)*	1.0	0.99(0.98-1.01)	1.0	0.98(0.97-0.99)*
Normal BP[a]: <130/85 mmHg	1.0	1.45(0.20-10.83)	1.0	0.33(0.06-1.63)	1.0	2.22(0.39-12.61)

Note: *p<0.05. [a]Model 1: age, gender, physical activity; smoking, years of education, WC, FBG, LDL-c and BP. [b]Model 2: age, gender, physical activity, smoking, years of education, BMI, FBG, LDL-c and BP. BMI: Body Mass Index; FBG: Fasting Blood Glucose; LDL-c: Low Density Lipoprotein; BP: Blood Pressure; WC: Waist Circumference.

DISCUSSION

Our main findings showed that individuals who adopted a healthy dietary pattern were less prone to experience changes in FBG concentrations; on the other hand, they were more likely to have abnormal LDL-c values. High adherence to the dietary western pattern was associated with higher values of hyperglycemia, while the fit pattern was associated with lower LDL-c concentrations. The results of this study also revealed that the healthy pattern was more likely to be adopted by women and individuals who consumed less alcohol, while the dietary western pattern was more prevalent in younger individuals, and the fit pattern was preferred by individuals with better socioeconomic levels (income and education) and who were physically more active.

In epidemiological studies carried out with adults and the elderly, who also used PCA and identified healthy patterns (characterized by the consumption of fruits, vegetables, jams and honey, cereals, whole foods, dairy products, fish and nuts), similar to our first pattern, there was an inverse relationship of these patterns with general and abdominal obesity, changes in the lipid profile[2,4] and with the presence of diabetes, hypertension and MS [2,4,3]. In evidence presented in meta-analyses, greater adherence to dietary

 https://doi.org/10.1590/1678-9865202235e210102

patterns labeled as healthy and prudent (with more frequent consumption of fruits, vegetables and whole grains) was associated with a 19% lower chance of central obesity (*OR*: 0.81; 95%CI, 0.66-0.96) and 15% less likely to develop MS (*OR*: 0.85; 95%CI, 0.79-0.91) [16, 17].

The benefits of "healthy" and "prudent" patterns can be attributed to the phytochemicals, antioxidants, fiber and mono- and polyunsaturated fats present in the main foods that make up these dietary patterns [2-4]. The cardioprotective functions of these compounds include the reduction of inflammatory markers and platelet aggregation, improving endothelial function, reducing blood pressure, improving lipid profile and insulin sensitivity, and reducing the risk of abdominal obesity [8].

In this study, the fact that the dietary healthy pattern was associated with higher concentrations of LDL-c, even after adjusting for confounding factors, can be explained by reverse causality, or even by obstacles related to the food survey itself; for example, the survey participants may have responded in a way that they believed acceptable to the interviewer. In addition, this pattern was positively correlated with mixed dishes (*escondidinho*, lasagna, chicken, *baião de dois* and Maria Isabel rice), which are normally high energy and fat density food preparations, which may have contributed to the increase in chances of higher concentrations of LDL-c in the sample assessed. Finally, due to the complexity of dietary patterns nature, the high intake of foods that are markers of healthy eating may not be sufficient to provide beneficial health effects in the situation where the food is prepared in an unhealthy way, for example, with immoderate use of fats.

Higher scores for the dietary Western pattern were associated with higher FBG concentrations in this study, in line with other studies that also identified an unhealthy pattern, characterized by the predominance of red and/or processed meat, butter/margarine, refined cereals, fried foods, snacks, soft drinks and sweets [3,5,6]. An unbalanced diet, typical of the Western pattern, with high energy density and high fat foods, especially with saturated and trans fatty acids, can lead to oxidative/antioxidant imbalance. This imbalance increases the inflammatory response which, in turn, affects hunger and satiety signals in the hypothalamus, leading to overconsumption of calories. The expansion of fat cells, due to excess calories, favors hypoxia and necrosis of adipose tissue, which results in worsening of inflammation and insulin resistance of the fat cell, favoring the development of cardiometabolic alterations [18].

The third dietary pattern identified in this study, called dietary fit pattern, characterized by the high consumption frequency of butter, oilseeds, honey, brown sugar, eggs, and low consumption of margarine, soft drinks and processed juices, possibly points to a broader pattern of life behaviors, as this pattern was found more frequently in physically more active individuals. Dietary patterns tend to be correlated with socioeconomic status and lifestyle, and although statistical adjustments are made, residual confounding can still occur and influence the associations observed. Thus, the analysis of individual behavioral factors may not show an effect on cardiovascular risk, but their combination can lead to significant impacts on human health due to their synergistic action [19]. In this connection, the effects found in the group assessed may be the result of a set of behaviors favorable to health.

This study has limitations. As it has a cross-sectional design, it is not possible to establish a cause and effect relationship. The sample consisted of a public institution's employees thus restricting the extrapolation of the results; however, they can be applied in a cultural context that takes into account the characteristics of the dietary patterns investigated. The use of factor analysis implies some subjectivity that can impact the composition of dietary patterns, thus demanding caution when comparing studies. On the other hand, the FFQ used in this study was validated for the Brazilian population and used without prior grouping, which may reflect positively on the assessment of food consumption.

CONCLUSION

The positive effects of the healthy dietary pattern were not very clear. Although this pattern was associated with lower concentrations of fasting glucose, it was directly associated with LDL-c. Adherence to the dietary Western pattern was associated with higher fasting blood glucose concentrations. The fit dietary pattern was more like the healthy lifestyle pattern, being associated with lower LDL-c concentrations. Younger and male individuals in the sample proved to be priority targets for healthy lifestyle actions. Future well-designed longitudinal studies are suggested, with validated food survey instruments and sufficient sample size. In this way, they will not only provide clearer information, but also more robust analyses, with the inclusion of other confounding factors, such as income, energy intake and alcohol consumption, which were not addressed in this study. Finally, multicenter studies with the inclusion of different cultural and social contexts could possibly clarify the relationships of the effect of diet on cardiometabolic risk.

CONTRIBUTORS

EC LOPES was responsible for the conception and design of this article, as well as collection, analysis and interpretation of data, writing of the article and approval of its final version. FAC REZENDE and RJ PEREIRA contributed to the conception and design of the article, analysis and interpretation of data, critical review and approval of the final version of the article.

REFERENCES

1. Carvalho CA, Fonsêca PCA, Nobre LN, Priore SE, Franceschini SCC. Metodologias de identificação de padrões alimentares a posteriori em crianças brasileiras: revisão sistemática. Cien Saude Colet. 2016;21(1):143-154. https://doi.org/10.1590/1413-81232015211.18962014
2. Angeles-Agdeppa I, Sun Y, Tanda KV. Dietary pattern and nutrient intakes in association with non-communicable disease risk factors among Filipino adults: a cross-sectional study. Nutr J. 2020;19(1):79. https://doi.org/10.21203/rs.3.rs-22947/v2
3. Agodi A, Maugeri A, Kunzova S, Sochor O, Bauerova H, Kiacova N, *et al.* Association of dietary patterns with metabolic syndrome: results from the Kardiovize Brno 2030 Study Nutrients. 2018;10(7):898. https://doi.org/10.3390/nu10070898
4. Silveira BKS, Novaes JF, Reis NA, Lourenço LP, Capobiango AHM, Vieira SA, *et al.* "Traditional" and "Healthy" dietary patterns are associated with low cardiometabolic risk in brazilian subjects. Cardiol Res Pract. 2018;2018:1-11. https://doi.org/10.1155/2018/4585412
5. Asadi Z, Shafiee M, Sadabadi F, Saberi-Karimian M, Darroudi S, Tayefi M, *et al.* Association between dietary patterns and the risk of metabolic syndrome among Iranian population: a cross-sectional study. Diabetes Metab Syndr. 2019;13(1):858-65. https://doi.org/10.1016/j.dsx.2018.11.059
6. Suliga E, Kozieł D, Cieśla E, Rębak D, Głuszek S. Dietary patterns in relation to metabolic syndrome among adults in Poland: a cross-sectional study. Nutrients. 2017;9(12):1366. https://doi.org/10.3390/nu9121366
7. World Health Organization. Obesity: preventing and managing the global epidemic. Joint WHO/FAO Expert Consultation. WHO Technical Report Series no. 894. Geneva: Organization; 2000.
8. Faludi AA, Izar MCO, Saraiva JFK, Chacra APM, Bianco HT, Afiune NA, *et al.* Atualização da diretriz brasileira de dislipidemias e prevenção da aterosclerose - 2017. Arq Bras Cardiol. 2017;109(2Suppl 1):1-76. https://doi.org/10.5935/abc.20170121
9. Sociedade Brasileira de Diabetes. Diretrizes sociedade brasileira de diabetes 2019-2020. São Paulo: Clannad; 2019 [cited 2021 Apr 21]. Available from: https://www.diabetes.org.br/profissionais/images/DIRETRIZES-COMPLETA-2019-2020.pdf

10. Malachias MVB, Souza WKSB, Plavnik FL, Rodrigues CIS, Brandão AA, Neves MFT, *et al*. 7ª diretriz brasileira de hipertensão arterial. Arq Bras Cardiol. 2016;107(3Suppl 3):1-6. https://doi.org/10.5935/abc.20160151

11. World Health Organization. WHO guidelines on physical activity and sedentary behaviour: at a glance. Geneva: Organization; 2020 [cited 2022 Apr 05]. Available from: https://apps.who.int/iris/handle/10665/337001

12. Mannato LW. Questionário de frequência alimentar Elsa-Brasil: proposta de redução e validação da versão reduzida [dissertation]. Vitória: Universidade Federal do Espírito Santo; 2013.

13. Ministério da Saúde (Brasil). Alimentos regionais brasileiros. 2nd ed. Brasília: Ministério; 2015 [cited 2022 Apr 5]. Available from: https://bvsms.saude.gov.br/bvs/publicacoes/alimentos_regionais_brasileiros_2ed.pdf

14. Cattafesta M, Zandonade E, Bissoli NS, Salaroli LB. Dietary patterns of bank employees and their association with socioeconomic, behavioral and labor factors. Cien Saude Colet. 2019;24(10):3909-22. https://doi.org/10.1590/1413-812320182410.31342017

15. Neumann AICP, Martins IS, Marcopito LF, Araujo EAC. Padrões alimentares associados a fatores de risco para doenças cardiovasculares entre residentes de um município brasileiro. Rev Panam Salud Pública. 2007 [cited 2021 Apr 21]; 22(5):329-39. Available from: https://www.scielosp.org/pdf/rpsp/2007.v22n5/329-339

16. Rezagholizadeh F, Djafarian K, Khosravi S, Shab-Bidar S. A posteriori healthy dietary patterns may decrease the risk of central obesity: findings from a systematic review and meta-analysis. Nutr Res. 2017;41:1-13. https://doi.org/10.1016/j.nutres.2017.01.006

17. Fabiani R, Naldini G, Chiavarini M. Dietary patterns and metabolic syndrome in adult subjects: a systematic review and meta-analysis. Nutrients. 2019;11(9):2056. https://doi.org/10.3390/nu11092056

18. Figueiredo PS, Inada AC, Marcelino G, Cardozo CML, Freitas KC, Guimarães RCA, *et al.* Fatty acids consumption: the role metabolic aspects involved in obesity and its associated disorders. Nutrients. 2017;9(10):1158. https://doi.org/10.3390/nu9101158

19. Al Thani M, Al Thani AA, Al-Chetachi W, Al Malki B, Khalifa SA, Haj Bakri A, *et al.* A 'high risk' lifestyle pattern is associated with metabolic syndrome among Qatari women of reproductive age: a cross-sectional national study. Int J Mol Sci. 2016;17(6):698. https://doi.org/10.3390/ijms17060698

Received: May 14, 2021
Final version: April 13, 2022
Approved: June 21, 2022