Dietary patterns and hypertension: a population-based study with women from Southern Brazil

Padrões alimentares e hipertensão arterial: um estudo de base populacional com mulheres do Sul do Brasil

Patrón alimentario e hipertensión: un estudio basado en la población de mujeres del sur de Brasil

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Abstract

This study investigated the association between dietary pattern and hypertension using the rank reduced regression (RRR). It was a cross-sectional population-based study with a representative sample of 1,026 women living in the city of São Leopoldo, Rio Grande do Sul State, Brazil. In order to identify dietary patterns, dietary variables from a dietary frequency questionnaire were used as predictors and sodium, potassium and saturated fat consumption were selected as response variables. The RRR identified three dietary patterns: Factor 1, Factor 2 and Factor 3. The association between hypertension and factors 1, 2 and 3, after adjustment for socio-demographic, behavioral and obesity variables, was not significant. After stratification by age, the association between hypertension and factor 2 was present in 40-60 year-old women (tertile 2 compared to 3 RP = 0.62, 95%CI: 0.43-0.91; p = 0,05). The new statistical method (RRR), proved to be a useful tool for identifying dietary patterns. In this study, healthier dietary pattern was directly associated with hypertension in women between 40 and 60 years of age.

Feeding Behavior; Hypertension; Women; Cross-sectional Studies

Resumo

O estudo investigou a associação entre os padrões alimentares, obtidos usando-se a regressão de posto reduzido (RRR), e hipertensão arterial. Foi um estudo transversal de base populacional com 1.026 mulheres residentes na cidade de São Leopoldo, Rio Grande do Sul, Brasil. Para a identificação dos padrões alimentares foram utilizadas como preditores as variáveis alimentares de um questionário de frequência alimentar e como variáveis respostas o consumo de sódio, potássio e gordura. Foram identificados três padrões alimentares: o Fator 1, o Fator 2, e o Fator 3. Em uma análise ajustada para fatores sociodemográficos, comportamentais e obesidade não houve associação entre a hipertensão e os padrões alimentares. Em uma análise estratificada para idade, houve associação entre hipertensão e o Fator 2 nas mulheres com 40 anos ou mais (tercil 2 comparado ao 3 RP = 0.62; IC95%: 0.43-0.91; p = 0,050). O método estatístico (RRR), mostrou-se uma ferramenta útil para a identificação de padrões alimentares. Neste estudo, o padrão alimentar saudável esteve diretamente associado à hipertensão nas mulheres entre 40 e 60 anos.

Comportamento Alimentar; Hipertensão; Mulheres; Estudos Transversais

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Introduction

Hypertension deserves attention as it is one of the main risk factors for cerebrovascular and cardiovascular diseases and renal failure [1]. The World Health Organization (WHO) estimates that 600 million people in the world have systemic arterial hypertension [2]. According to data from the Brazilian Hypertension Society, the prevalence of systemic arterial hypertension in the Brazilian adult population ranges from 23% to 43.9%. Population-based studies show prevalence rates of between 22% and 44% in the southeast and 22% and 37% in southern Brazil [3,4].

The studies conducted in Brazil show high hypertension prevalence and low adhesion to pharmacological treatment. Behavioral interventions such as encouraging the practice of physical activity and consumption of healthy food are complementary to the pharmacological treatment [5]. In a study conducted in France in 2002, results showed that individuals who had followed the DASH diet (*Dietary Approaches to Stop Hypertension*) – a diet rich in fruits, vegetables and light dairy products – had reduced their levels of systolic and diastolic pressure [6].

The analysis of dietary patterns arose as a complementary approach for studying the relationship between diet and chronic diseases. Therefore, instead of assessing nutrients or food in isolation, the analysis of dietary patterns considers the combinations present in the overall diet and incorporates the complex interactions that occur among the nutrients. The dietary patterns represent a broader frame of nutrients and food consumption, thus being more appropriate for the study of dietary factors and diseases [7,8,9,10,11,12,13,14,15,16]. In order to address these questions, several authors are proposing alternatives to study the global consumption of food, considering that food is usually consumed in a combination of nutrients.

Factors and the cluster analyses are the techniques most commonly used for the study of dietary patterns [8,9,10,17,18]. However, Hoffmann et al. [19] have recently proposed a new statistical approach, the reduced rank regression (RRR). This is a more efficient method for predicting diseases, since it relates the *a priori* knowledge to the *a posteriori* one, i.e., it matches the power of the statistical tool correlating diet components (predictor variables) to previous information on the disease (response variables).

The present study aims to investigate the association of the identified dietary patterns and hypertension in adult women living in of the city of São Leopoldo, Rio Grande do Sul State, Brazil. For the identification of dietary patterns, a methodological approach recently introduced in Nutritional Epidemiology will be used – the RRR.

Methodology

A population-based cross-sectional study was conducted in 2003 including a representative sample of 1,026 women aged 20 to 60 years living in the urban area of the city of São Leopoldo.

The sample size was estimated according to the outcomes, and the biggest size of sample was chosen, which in this case, was the prevalence of diabetes mellitus. For the analyses of associations, the sample size was calculated in order to identify a prevalence ratio of 2.0 with a 95% confidence interval (95%CI) and an 80% statistical power, keeping a non-exposed ratio of 1:3 for the economic class variable. Considering possible losses/refusals during fieldwork and the control of confounding factors in the data analysis, the sample was increased by 25%, with a total of 1,358 women interviewed.

The sampling process was probabilistic clusters and carried out in multiple stages through the census sectors, blocks and residences. In order to find the 1,358 women, an average number of people per residence was estimated resulting in 3.35 people per residence in the city of São Leopoldo and 28.2% of the overall population was comprised of women in the 20 to 60 age range (IBGE. *Censo Demográfico 2000*. http://www.ibge.gov.br). Based on these data, the number of residences required for the research was calculated, resulting in 1,437. These residences were selected by a systematic sampling of 40 census sectors selected by probabilistic sampling.

For the sample selection, initially all census sectors comprising the city of São Leopoldo were listed. The rural area was excluded and also those census sectors considered as special, including military bases, lodgings, camping areas, ships, boats, Indian villages, penitentiaries, penal colonies, prisons, jails, asylums, orphanages, convents and hospitals. All women aged 20 to 60 years living in the selected residences were included in the study. Of the 1,358 women, 1,084 were contacted, resulting in a total of 1,026, excluding losses and refusals.

The socioeconomic, demographic and behavioral data were collected through standardized, previously tested and pre-coded questionnaires applied by interviewers submitted to a practical-theoretical training program. The socioeconomic variables were: economic status, defined according to the criteria from the Brazilian Association of Polling Companies (ABEP) [20] and categorized by class: A, B, C and D+E; and per capita family income, based on the reported income for each family member in the last month. Income was analyzed according to minimum wages; one Brazilian minimum wage is equivalent to US$120 in 2012. The demographic variables were: age collected in completed years and categorized as 20 to < 40 years and 40 to 60 years for stratified analysis; marital status, informed by the interviewee and classified as married/living together, single, separated/divorced, widower; and skin color, which was observed and categorized as white or non-white.

Finally, behavioral variables were: smoking, categorized as smoker, ex-smoker and never smoked; physical activity classified as moderately active or not, considering moderately active the ones who informed practicing some physical activity of medium or high intensity three times a week or more, for at least 10 minutes. For the classification of individuals according to the intensity of physical activity, it was explained during the interview that the high intensity activities were those that make people sweat a lot with a considerable increase in breathing pace and heartbeats; the medium intensity activities are those in which people sweat a little and the breathing pace as well as the heartbeats increase a little; the low intensity activities are the ones that do not change neither the breathing nor the heartbeats pace. A standardized and pre-coded questionnaire was used, it included the specific instrument on physical activity habits, which was adapted from *Agita Brasil* [21]. In order to evaluate the nutritional status, the body mass index (BMI), which is calculated as weight/(height)^2, was used. Therefore the data concerning weight and height were collected according to WHO recommendations [2]. Weight was collected using a Sunrise brand mechanical weighing scale, (Promesul Metallurgic Industry, São Leopoldo, Brazil), with a 100g-precision. The two measurements were collected, then the mean value was used to calculate the BMI. For the height measurement, a stadiometer from the brand Seca Body Meter (Seca, Hamburg, Germany) with a 1mm-precision was used. Two measurements were collected and the mean value was later used to find the BMI. The BMI variable was categorized as a dichotomous variable: not obese (BMI < 30kg/m^2) and obese (BMI ≥ 30kg/m^2).

The blood pressure measurement, an outcome of interest, was took from the right arm, using a stethoscope and aneroid sphygmomanometer. The woman being interviewed should be seated, without having smoked or consumed any coffee, *mate* tea (a local herbal beverage that contains high levels of caffeine) or any other food during the interview. The blood pressure of each woman was taken twice during the questionnaire application: in the middle and at the end. Both measurements were enough for the later calculation of arithmetical means for each of the systolic and diastolic pressures. The interviewers were trained for performing blood pressure measurements according to the *V Hypertension Brazilian Guidelines* [22]. The usage of antihypertensive medications was also investigated.

The definition of hypertension was established according to blood pressure levels from the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure [23] and/or with the usage of antihypertensive medication. Hence, women with diastolic pressure above or equal to 140mmHg and simultaneously diastolic pressure above or equal to 90mmHg and/or with blood pressure measurements below these levels but with the usage of antihypertensive medication were classified as hypertensive.

In order to investigate the dietary patterns, a qualitative *Dietary Frequency Questionnaire* was applied with 70 food items (DFQ-70) placed randomly, that is, not in groups. The DFQ consists of a list of food items with frequency options for the consumption of each one of these items. These frequencies may be in terms of number of times a day, a week or a month, in a previously established time period [24]. In this study, this instrument previously applied in the adult population living in the city of Pelotas, also located in Southern Brazil, was used. However, after carrying out the previous pilot study in the Vale do Rio dos Sinos region, it was necessary to add some food items into the questionnaire. For this matter, the DFQ frequencies and the daily consumption frequency have been transformed. More details are found in other publications [8,9].

The dietary patterns were analyzed using the RRR a statistical technique used to derive dietary patterns which predict diseases [19]. Using the RRR it is possible to determine the linear functions of predictive variables (frequency of food consumption), which explain the biggest possible quantity of variation of the response variables. This is not an *a priori* method, nor a purely exploratory one, it is possible to say that it makes use of both tools: the study data and the previous information on the disease (response variables). The response variables may be nutrients or biomarkers. In this way, the present study will use as response variables some of the nutrients more frequently associated with hypertension. The first response variable chosen was "sodium consumption", due to the considerable literature on the topic indicating that sodium restriction significantly reduces blood pressure levels to normotensive and hypertensive. The other response variable chosen was ‘potassium consumption’ considering the inverse relation of its consumption with hypertension. And the last response variable was “saturated fat consumption”; although this association is controversial [25].

Data on food consumption obtained using the DFQ-70 was used for the identification of dietary patterns. This instrument was used to obtain the predictor variables and the response variables. To obtain the predictor variables we perform groupings of some foods according to nutritional information. Thus instead of 70 food items, 48 food and food groups were used. As for the construction of the response variables, it was necessary to evaluate the consumption of nutrients.

One of the presuppositions of the RRR technique is that both predictor variables and response variables must be quantitative. For this matter, the DFQ frequencies and the daily consumption frequency have been transformed. In order to obtain the nutrients consumption, average consumption portions were estimated for each item according to the information from the Food Guide and the *Pinheiro*’s table [26,27] as a second option. For the nutritional composition analysis, firstly, the Table of United States Department of Agriculture (USDA) was used and then the Brazilian National Table of Food Composition (TACO). This way, the daily frequency consumption of each food item was multiplied by the amount of nutrients present in each food portion. The sum of the values of each nutrient for each individual resulted in the total consumption amount of each of the nutrients (sodium, potassium and saturated fat) per individual. At the end, the RRR analysis enabled the identification of two dietary patterns that were categorized in tertiles. The loading factor used to retain food was 0,20. In order to apply the statistical RRR technique, the response variables should have a normal distribution. Thus, such variables were submitted to normality tests and presented normal distribution, meeting the presuppositions of the RRR analysis.

At the end of the study 1,026 women met the criteria to comprise the sample. There were 58 losses and refusals (5.6%). Among the total number of women, nine were excluded from the analysis, four of them due to excessively high food consumption and five because they didn’t have their pressure measured. A total of 1,017 women were included in the analysis.

The statistical analysis of data included: describing the sample; crude analysis, chi-square test for the categorical variables according to the tertile of each dietary pattern, and the Analysis of Variance (ANOVA) for continuous variables. For the development of the multivariate model, three models were used: the first one with no adjustment; the second with adjustment for age, skin color and economic status; and the third one, adjustment for age, skin color, economic class, physical activity, obesity and smoking. For controlling the confounding factors, it was decided that only the variables with a $p < 0.2$ value in the crude association with exposure and outcome would be taken for the adjusted analysis. Multivariate analysis, using the Poisson regression with robust variance was used to investigate association of the outcome with the dietary patterns, controlling for potential confounders (socio-demographic and behavioral variables). At the end, the variables with a significance level less than 5% were considered factors associated to hypertension. A stratified analysis by age (20 to < 40 years, and 40 to 60 years) was performed in order to investigate the interaction. This analysis was adjusted for age, skin color, economic class, physical activity, obesity and smoking. The RRR was performed through the PROC PLS18 routine of the SAS 9.2 software (SAS Inst., Cary, USA), and the remaining analyses were performed using the SPSS Statistics 17.0 (SPSS Corp., Chicago, USA).

The study protocol was approved by the Ethics Research Committee of the Medical School from the Federal University of Pelotas. A written informed consent was obtained from all participants. Confidentiality was respected throughout the study.

Results

The 1,017 women included in the analysis were 38 years old on average (SD = 11), most of them lived with a partner (64.2%) and had white skin color (83.8%). Regarding socioeconomic factors, 22.6% of the sample belonged to the “D+E” economic classes and 36.8% of the women had a per capita income that was lower than the minimum wage. About a third of the sample had an education level of less than five years of schooling, 22.5% were smokers, 68.5% did not practice any physical activity and 18% were obese. The prevalence of hypertension was 26.2% (95%CI: 23.5-28.9). After stratification, it was noted that the 20 to < 40 years stratum showed prevalence rate of 12.4% (95%CI: 10.2-16.9) for hypertension whereas in the 40 to 60 years stratum it was of 38.6% (95%CI: 36.5-41.9). Stratification was performed with this cutoff point because in previous studies, with the same database, women of both strata differed in terms of eating habits.

The average sodium intake among hypertensive patients was 1318.37mg/day (SD = 510.435) and among non-hypertensive patients was 1377.07 mg/day (SD = 512.939). Already the average potassium intake among hypertensive patients was 2172.00mg/day (SD = 726.731) and among non-hypertensive patients was 2137.98mg/day (SD = 648.399). Regarding saturated fat, the non-hypertensive group had a daily intake of 28.21g (SD = 10.25), while this figure was 27.26g (SD = 10.9) for the hypertensive group.

Through the RRR statistical method, three factors were extracted, Factor 1, Factor 2 and Factor 3, which explained 67.8%, 20.2% and 11.9% of the variation in response variables respectively. It was noticed that smoking and low class change significantly among Factor 1 tertiles. In Factor 2, smoking, inactivity and low economic status change significantly among the tertiles (Table 1). A high score of Factor 1 is associated with a greater consumption of cheese, cream and processed meat. The high score of Factor 2, on the other hand, is associated with a greater consumption of skimmed milk, papaya, apple, banana, orange, pumpkin, green leafy vegetable, other vegetable and natural fruit juice and with a lower consumption of processed meat. And the high score of Factor 3 is associated with a greater consumption of whole milk, cream, red meat and industrial mayonnaise and with a lower consumption of processed meat (Table 2). Besides the factor loadings, RRR allows for measurement of the percentage variation accounted for each food and food group intake by each factor (Table 2).

In Factor 1, sodium, potassium and saturated fat have high weights (0.61, 0.53 and 0.59 respectively), i.e., all of them strongly contribute to this factor. In Factor 2, it is observed that potassium positively contributes to this factor, while sodium and saturated fat contribute negatively. In Factor 3, saturated fat and potassium positively contribute, while sodium contributes negatively (Table 3).

The ratios for hypertension prevalence according to the factors tertiles are presented in Table 4. After crude analysis (non-adjusted model), it was noticed that a low consumption in Factor 2 conferred protection against hypertension

Table 1

Subject's characteristics according to tertiles (T) 1, 2 and 3 for factors derived by rank reduced regression in 1,017 women. São Leopoldo, Rio Grande do Sul State, Brazil, 2003.

	T1	T2	T3	p-value
Factor 1				
Age (Y)	38.15 (11.0)	38.23 (11.3)	38.29 (11.0)	0.988 *
White (%)	82.5	81.2	87.4	0.090 **
Smoking (%)	28.7	20.9	18.2	0.001 **
Inactive (%)	68.6	70.3	66.5	0.543 **
Low economic status (%)	36.2	22.1	20.6	< 0.001 **
Obese (%)	17.6	19.3	16.8	0.774 **
Factor 2				
Age (Y)	37.36 (11.2)	38.23 (11.3)	39.07 (10.9)	0.135 *
White (%)	85.8	83.2	82.1	0.188 **
Smoking (%)	28.7	22.4	16.8	< 0.001 **
Inactive (%)	73.7	66.8	65.0	0.015 **
Low economic status (%)	27.2	28.3	23.3	0.030 **
Obese (%)	18.6	16.3	18.8	0.950 **
Factor 3				
Age (Y)	37.29 (11.5)	38.41 (11.1)	38.96 (10.8)	0.136 *
White (%)	85.2	82.9	82.9	0.654 **
Smoking (%)	22.8	23.2	21.8	0.896 **
Inactive (%)	66.6	67.9	70.9	0.466 **
Low economic status (%)	30.5	25.1	23.3	0.259 **
Obese (%)	16.6	18.4	18.7	0.752 **

* Test ANOVA;
** Chi-square test.

Table2

Factor loadings and % de variance explained of food and food group intake according to factor derived by rank reduced regression in 1,017 women. São Leopoldo, Rio Grande do Sul State, Brazil, 2003.

Foods	Loading			% variance explained		
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
Skimmed milk	-	0.21	-	0.64	11.25	12.25
Whole milk	-	-	0.21	3.98	4.38	8.94
Cheese	0.27	-	-	21,71	25,02	25.69
Banana	-	0.23	-	9,05	22,12	22.83
Papaya	-	0.29	-	8,24	28,99	29.45
Apple	-	0.23	-	4,67	18,15	18.21
Orange	-	0.24	-	8,76	24,11	24.31
Processed meat	0.37	-0.21	-0.46	42,68	53,15	76.55
Pumpkin	-	0.20	-	8.36	18.59	18.60
Vegetables, green leafy	-	0.26	-	8,98	26,24	26.34
Vegetables, other	-	0.20	-	3,91	13,80	13.86
Natural juice	-	0.23	-	4.22	16.84	16.85
Cream	0.21	-	0.46	24.91	17.66	49.71
Read meat	-	-	0,46	8.63	17.61	42.35
Industrial mayonnaise	-	-	-0,22	9.09	14.74	19.86

Table 3

Weight of response variables according to factors derived by rank reduced regression in 1,017 women. São Leopoldo, Rio Grande do Sul State, Brazil, 2003.

	Sodium	Potassium	Saturated
Factor 1	0.61	0.53	0.59
Factor 2	-0.30	0.85	-0.45
Factor 3	-0,23	0,10	0,67

(tertile 2 compared to 3 RP = 0.61; 95%CI: 0.41-0.92; p = 0.038). For Factor 1 (tertile 2 compared to 3 RP = 1.28; 95%CI: 0.84-1.94; p = 0.177) and Factor 3 (tertile 2 compared to 3 RP = 0.94; 95%CI: 0.64-1.40; p = 0.954), no significant association was observed. In a second model with adjustment for age, skin color and economic status, the association between hypertension and Factor 2 remained the same (tertile 2 compared to 3 RP = 0.62; 95%CI: 0.42-0.90; p = 0.05). In a third model (final model), smoking, physical activity and nutritional status were included in the multivariate analysis. In this last model, the association did not continue, that is, there was no significant association between hypertension and the three factors. In Table 5 results stratified by age are presented since this variable was an effect modifier. Then, it was possible to verify that the association between Factor 2 and hypertension was statistically significant (tertile 2 compared to 3 RP = 0.62 95%CI: 0.43-0.91; p = 0.05), in the 40 to 60 years age group.

Discussion

The present study used the RRR to identify dietary patterns. This statistical technique enabled identifying three dietary patterns in the studied population. The patterns were set according to the response variables. In this case, since the nutrients sodium, potassium and saturated fat were used, patterns were formed in order to better explain the combination of these three nutrients. The first dietary pattern (Factor 1) contributed the most to the analysis, explaining 67.82% of the variance of responses and it was marked by the high consumption of the three nutrients, characterizing individuals who consume both healthy and unhealthy food. The food or food group items that mostly contributed to this factor were cheese, processed meat and cream. Food items found in this pattern are typical of an easy-to-prepare diet, also including industrialized foods, following contemporary eating patterns.

The second pattern (Factor 2) explained 20% of the variance of responses and has reasonably contributed to the analysis as it was character-

Table 4

Ratios for hypertension prevalence according to the factors 1, 2 and 3 tertiles (T) for factors derived by rank reduced regression in 1,017 women. São Leopoldo, Rio Grande do Sul State, Brazil, 2003.

	T3	T2	T1	p-value *
Factor1				
Model 1	1.00	1.27 (0.84-1.94)	1.48 (0.98-2.23)	0.177
Model 2	1.00	1.19 (0.80-1.76)	1.33 (0.91-1.96)	0.341
Model 3	1.00	1.23 (0.83-1.81)	1.30 (0.89-1.90)	0.376
Factor 2				
Model 1	1.00	0.61 (0.41-0.92)	0.71 (0.49-1.04)	0.038
Model 2	1.00	0.62 (0.42-0.90)	0.83 (0.59-1.19)	0.046
Model 3	1.00	0.65 (0.45-0.94)	0.88 (0.61-1.28)	0.073
Factor 3				
Model 1	1.00	0.96 (0.65-1.41)	0.94 (0.64-1.40)	0.954
Model 2	1.00	1.03 (0.72-1.47)	1.06 (0.74-1.52)	0.953
Model 3	1.00	0.94 (0.66-1.35)	0.95 (0.66-1.37)	0.940

Model 1: not adjusted; Model 2: adjusted for age, skin color and economic status; Model 3: adjusted for all variables included in model 2 and smoking, physical activity and nutritional status.
* Test of model effects.

Table 5

Stratified analysis by age according to the factors tertiles (T) 1, 2 and 3 for factors derived by rank reduced regression in 1,017 women. São Leopoldo, Rio Grande do Sul State, Brazil, 2003.

	T3	T2	T1	p-value *
20 to < 40 years (n = 533)				
Factor 1				
Model 1	1.00	1.11 (0.30-4.09)	0.95 (0.24-3.85)	0.960
Model 2	1.00	1.13 (0.28-4.48)	0.74 (0.19-3.29)	0.617
Model 3	1.00	1.26 (0.29-5.39)	0.96 (0.25-3.68)	0.809
Factor 2				
Model 1	1.00	0.69 (0.19-2.53)	0.49 (0.12-1.95)	0.593
Model 2	1.00	0.83 (0.22-3.16)	0.64 (0.16-2.49)	0.765
Model 3	1.00	0.90 (0.23-3.46)	0.70 (0.18-2.45)	0.781
Factor 3				
Model 1	1.00	1.23 (0.34-4.51)	0.92 (0.23-3.62)	0.898
Model 2	1.00	1.30 (0.35-4.88)	0.98 (0.24-3.92)	0.755
Model 3	1.00	1.31 (0.35-4.84)	0.96 (0.23-3.98)	0.813
40-60 years (n = 484)				
Factor 1				
Model 1	1.00	1.45 (0.95-2.19)	1.69 (1.12-2.53)	0.035
Model 2	1.00	1.24 (0.83-1.86)	1.47 (0.99-2.18)	0.160
Model 3	1.00	1.27 (0.85-1.90)	1.39(0.94-2.07)	0.231
Factor 2				
Model 1	1.00	0.60 (0.40-0.89)	0.78 (0.54-1.12)	0.034
Model 2	1.00	0.59 (0.40-0.88)	0.84 (0.59-1.21)	0.032
Model 3	1.00	0.62 (0.43-0.91)	0.88 (0.61-1.28)	0.049

(continues)

Table 5 (continued)

	T3	T2	T1	p-value *
Factor 3				
Model 1	1.00	0.94 (0.64-1.39)	1.04 (0.71-1.53)	0.887
Model 2	1.00	0.99 (0.69-1.43)	1.05 (0.73-1.52)	0.940
Model 3	1.00	0.93 (0.65-1.35)	0.96 (0.66-1.39)	0.934

Model 1: not adjusted; Model 2: adjusted for skin color and economic class; Model 3: adjusted for all variables included model 2 and smoking, physical activity and nutritional status.
* Test of model effects.

ized by the high consumption of healthy food such as banana, papaya, apple, orange, pumpkin, green leafy vegetable, other vegetables and natural fruit juice in contrast with a low consumption of foods which are not very healthy such as processed meat. Similar patterns to this were identified in other studies, being labeled a "healthy pattern". In Southern Brazil, Alves et al. [8] identified five food patterns from the Analysis of Main Components, of which two were considered healthy, one richer in fruits and the other marked by vegetable consumption. Similarly, a study conducted with adult women in the city of São Paulo, Brazil [28], identified a pattern characterized by two groups of foods: the fruit group and the vegetable group. Already the third pattern (Factor 3) had a higher contribution of saturated fat and potassium, is associated with a greater consumption of whole milk, cream, red meat and industrial mayonnaise and with a lower consumption of processed meat.

One of the study's objectives was to verify the association between dietary patterns and hypertension. By the crude analysis the dietary pattern (Factor 2) characterized by a low consumption of sodium and saturated fat and a high consumption of potassium presented a direct association with hypertension. However, after adjustments for age, marital status, socioeconomic level, skin color, nutritional status and physical activity, the effect was diluted. Thus, our results agree with the ones from Wirfält et al. [29] in his study on dietary patterns and components of the metabolic syndrome where no association was found between dietary patterns and hypertension. On the other hand, other studies found an inverse association between healthy food and hypertension [12,17,30]. And, still, others found a direct association between unhealthy patterns and hypertension [15,18,31].

Recently, a study aiming to test the association between dietary patterns derived by factorial analysis and hypertension among a Korean population was released. Three dietary patterns where identified: "whole food", "western" and "drinking". Participants with a high drinking pattern score (moderate to high alcohol intake, salted fermented seafood intake) presented a significantly higher prevalence of pre-hypertension or hypertension than those with a lower drinking pattern score; odds for the top quintile vs. the bottom quintile were OR = 1.56 (95%CI: 1.23-1.99; p-trend = 0.001) for pre-hypertension and OR = 3.05 (95%CI: 2.12-4.40; p-trend < 0.001) for hypertension. The whole food pattern was not associated with either pre-hypertension or hypertension, while the Western pattern was associated with the prevalence of hypertension only among men [15].

After stratifying by age in 20 to < 40 years and 40 to 60 years, it was possible to observe that hypertension was associated only with factor 2 in older women aged above 40. Similarly in the literature, there are findings that show that older women have healthier eating habits [15,32]. Lenz et al. [9], in a cross-sectional study using the same database of the present study, but with the use of the Analysis of Main Components to identify dietary patterns, were able to show a trend of a healthier behavior in older women. Jaime & Monteiro [33], in their study on the consumption of fruits and vegetables with adults in Brazil, have observed a direct association between fruit consumption and age. Another study conducted in Spain showed that younger women consumed more processed food, fast food and food items rich in fat when compared to older women [34].

This association identified in the group of women over 40 is contrary to what is expected and it also contrasts with the results found in the literature [18,21,30,31]. But one possible explanation for this finding may be the reverse causality, a consequence of the study design. It happens when exposure and outcome are measured simultaneously, therefore it is not possible to know which one came first or second and it mainly affects studies where exposure is modified by eating habits and physical activity among factors. In the association studied here, the reverse causality may occur when people, after being diagnosed with hypertension, change their eating habits due to disease and start eating healthier food such as fruit and vegetables and avoid fatty foods and ones rich in sodium. The instrument used may also have intensified this effect because it evaluates the usual consumption of the last month, therefore, it is a tool subject to changes [8,9,35]. Another aspect to be considered is the bias of information, which in this case could be resulting from the under- or over-report of consumption of the food items from the DFQ. The under- or over-report of consumption of food is present in the literature. Overweight people tend to inform that they eat less than what they really do and the opposite happens as well, people with low weight or even mothers of malnourished children usually inform that they consume more than what it is truly consumed [36,37].

Importantly, it is possible to identify dietary patterns from different statistical approaches but it is difficult to compare them. In this study the reduced rank regression is applied to identify patterns which best explain the variability of the response variables while there are other techniques such as principal components analysis, and suggests that the cluster identifies the usual intake of the population. In addition, a study to reproduce using the identical statistical technique for reducing the data when applied to different populations, will most likely produce different results. But despite this, the study of dietary patterns arises as an alternative to better represent the variety of food items found in a diet [38]. Based on this assumption, the WHO has recently suggested that such evaluations should be based on dietary profiles instead of on nutrients [2]. The construction of dietary patterns based on statistic techniques is a target for criticism in the nutritional epidemiology, mainly because of the subjectivity present at several moments along the analysis. But although there is uncertainty and subjectivity in the decisions during the statistical process, these methods have been crucial when working with a great number of data proceeding from the instruments used for data collection of food consumption, especially in population-based epidemiological studies involving large populations.

The present study has some limitations. The first one regards the way the information about food consumption was collected. Since it was a qualitative DFQ, it was not possible to measure precisely the consumption of nutrients used as response variables, that's why it was necessary to estimate the consumption by average portions, a fact that may bias the results. Another limitation concerns sodium consumption, as it was only possible to measure the intrinsic sodium in food and present in industrialized foods, while sodium coming from additional salt found in food preparation was not measured. However, we believe that even with this limitation, it was possible to observe the differences in consumption, since sodium intake is strongly correlated with the consumption of industrialized food.

Therefore, the use of dietary patterns is quite important in nutritional epidemiology, and the RRR is the most commonly used statistical technique when seeking to study the relation between dietary patterns and disease development. In this particular study it proved to be quite appropriate for deriving dietary patterns associated with the outcome. It was expected that hypertension would be associated with an unhealthy dietary pattern, but the opposite was observed, that is, hypertensive women consumed a healthier eating pattern, which may be due to reverse causality. However, to better explain this relation further, more studies are necessary.

Resumen

El estudio investigó la asociación entre los hábitos alimentarios, obtenidos por la regresión con rango reducido (RRR) y la hipertensión. Fue un corte transversal de 1.026 mujeres, basado en la población que vive en São Leopoldo, Río Grande do Sul, Brasil. Para identificar los hábitos alimentarios se utilizó como predictor de variables de la dieta un cuestionario de frecuencia alimentaria y las variables de respuesta fueron: consumo de potasio, sodio y grasa. Se identificaron tres patrones alimenticios: Factor 1; Factor 2 y Factor 3. En un análisis ajustado sociodemográfico, de conducta y obesidad no hay asociación entre la hipertensión y los hábitos alimentarios. En un análisis estratificado por edad, se observó una asociación entre la hipertensión y el Factor 2 en las mujeres de 40 años o más (tercil 2, en comparación con el 3 RP = 0,62, IC95%: 0,43-0,91; p = 0,05). El método estadístico (RRR) fue una herramienta útil para la identificación de los patrones dietéticos. En este estudio, el patrón de dieta saludable está directamente asociado con la hipertensión en las mujeres entre 40 y 60 años.

Conducta Alimentaria; Hipertensión; Mujeres; Estudios Transversales

Contributors

B. D. P. Silva participated in the design and preparation of the project, analysis and interpretation of data and article writing. M. B. Neutzling provided orientation, participated in the design and preparation of the project, data interpretation and critical revision. S. Camey participated in the analysis and interpretation of data and critical revision. All authors participated in the final approval of the version to be published. M. T. A. Olinto coordinated the study, participated in the design and preparation of the project, provided analysis and interpretation of data and critical revision.

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