

## Dietary patterns and glycemic indexes in type 2 diabetes patients

### *Padrões alimentares e níveis glicêmicos de pacientes com diabetes tipo 2*

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#### ABSTRACT

##### Objective

To identify the main dietary patterns in type 2 diabetes patients and study their association with glycemic indexes.

##### Methods

This is a cross-sectional study carried out in a diabetes treatment reference institution located in the city of Fortaleza (CE). Two R24h were applied, as well as 12h fast blood glucose tests and anthropometric assessments in 188 diabetic patients. The principal components factor analysis method was applied together with a Varimax orthogonal rotation method to identify dietary patterns. The Poisson Regression and the Spearman coefficient were used to test the association with glycemic indexes.

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## Results

A hundred eighty eight diabetic patients were evaluated, of which 51.1% patients had decompensated glucose values. Five main dietary patterns were identified: traditional Brazilian, energy-dense, infusion and wholegrain cereal, sandwich and dairy, and healthy diets, which explained 37.2% of the total variance in intake. A negative correlation with glucose was found for the traditional Brazilian diet ( $p=0.018$ ;  $r=-0.173$ ).

## Conclusion

Out of the five identified dietary patterns consumed by the type 2 diabetes patients studied, a higher adherence to the *traditional Brazilian* dietary patterns resulted in lower blood glucose levels.

**Keywords:** Blood Glucose. Diabetes *Mellitus*. Feeding behavior.

## RESUMO

### Objetivo

*Este estudo tem como objetivo identificar os principais padrões de consumo alimentar de pacientes diabéticos tipo 2, bem como investigar sua associação com níveis glicêmicos.*

### Métodos

*Trata-se de um estudo transversal realizado em uma instituição de referência no tratamento do diabetes na cidade de Fortaleza (CE). Foi realizada aplicação de dois R24h, bem como aferição de glicemia de jejum de 12h e medidas antropométricas em 188 pacientes diabéticos. Foi utilizado o método de Análise fatorial por Componentes Principais e rotação ortogonal Varimax para identificação dos padrões alimentares. Regressão de Poisson e coeficiente de correlação de Spearman foram utilizados para testar a associação com os níveis glicêmicos.*

### Resultados

*Foram avaliados 188 pacientes diabéticos, dos quais 51,1% apresentaram valores de glicemia descompensada. Foram identificados cinco principais padrões alimentares – tradicional brasileiro; denso em energia; infusões e cereais integrais; sanduíches e lácteos; e saudável – os quais explicaram 37,2% da variância total de ingestão. O padrão tradicional brasileiro apresentou correlação negativa com os níveis glicêmicos ( $p=0,018$ ;  $r=-0,173$ ).*

### Conclusão

*Dos cinco padrões identificados como consumidos pelos diabéticos tipo 2 estudados, a maior adesão ao padrão tradicional brasileiro indicou menores níveis glicêmicos.*

**Palavras-chave:** Glicemia. Diabetes *Mellitus*. Comportamento alimentar.

## INTRODUCTION

The incidence of diabetes has progressively increased in the world, and to a greater extent in developing countries [1,2], as the prevalence of diabetes affected more than 300 million people in 2013 [3].

Type 2 diabetes is characterized as being a disturbance in the efficient metabolism of glucose and it is related to a considerable increase in the risk of cardiovascular diseases, which can lead to serious complications [3].

Most people with this type of diabetes are overweight or obese and do not rely on exogenous insulin to survive, but may require its use only as a treatment for metabolic control [4].

Genetic conditions do play an important role for the development of the disease, but the current epidemic indicates changes in lifestyle. Overweight and obesity are considered important risk factors for Type 2 diabetes, which result from imbalanced food intake and caloric expenditure often due to an unhealthy lifestyle,

insufficient physical exercise, and unhealthy food consumption [1,5]. These facts show that environmental elements are the main causes of the increase of type 2 diabetes [4,6].

It is evident that the diet is one of the main risk factors that modifies other risk factors [7]. With the onset of diabetes, food choice and eating habits play a crucial role in controlling disease progression [8].

In traditional epidemiology, the main nutritional approach is to investigate the nutrients or food and their relationship with chronic diseases, including diabetes. However, the human diet is complex, since foods are not consumed in isolation and the nutrients operate in a synergistically or inhibitory way, making it difficult to detect these possible associations. This fact justifies the global consideration of the use of dietary patterns as an alternative to overcome these limitations, analyzing the effects of multiple dietary factors on the individual's health [7,9].

Thus, it is important to know the eating patterns of diabetic individuals and their association with clinical aspects of the disease. In Brazil, we have not found any studies that analyze the dietary patterns among diabetics, nor their relationship with glycemic control.

In this context, the aim of the present study was to identify the main eating consumption patterns of type 2 diabetic patients and investigate their association with glycemic levels.

## METHODS

This cross-sectional study was carried out at an important diabetes treatment institution that receives patients from the *Sistema Único de Saúde* (SUS, Unified Health System), in *Fortaleza* (CE).

The study population consisted of 188 diabetic female and male patients; patients with type 2 diabetes *Mellitus* diagnosed more than 2 years ago (thus, identifying the glycemic control

of the individuals); the patients were continuously monitored at the institution; adults or elderly (age  $\geq 20$  years); Body Mass Index (BMI) of 25.0-34.9kg/m<sup>2</sup>; use of oral hypoglycemic agentes such as metformin hydrochloride, glibenclamide and/or glicazide, which are distributed by SUS; and they were not on insulin; The patients were not affected by other known diseases, except those commonly associated with type 2 diabetes *Mellitus* (hypertension, dyslipidemia, diabetic dermopathy, among others). Since many diabetics are overweight, the BMI was standardized because advanced obesity has more negative metabolic consequences than overweight [9] and obesity grade I.

The research was approved by the Research Ethics Committee of *Universidade Estadual do Ceará* (UECE) under report CAAE nº 30308114.1.0000.5534. The interviews were carried out through a semi-structured form, containing data related to sex, age, race (self-reported), years of education, occupation, monthly income, use of medications, and known health problems.

The 24-hour food recall (R24h) and 12-h fasting glycemia were evaluated using the Alere Cholestech LDX® device (Alere, *São Paulo, São Paulo, Brasil*) and anthropometric measurements of weight, height, and waist circumference. Two R24h were used, one being collected during the interview and the other one was filled out on a weekend day and collected by telephone [10].

According to the American Diabetes Association (ADA) [11], glycemic levels are considered controlled when values are lower than 130mg/dL for fasting glycemia and uncontrolled when they are equal to or greater than 130mg/dL.

The data collected by home measurements through the R24h were then converted to grams or milliliters using a specific table [12]. The foods were listed and grouped, taking into consideration the nutritional composition, to reduce the number of dietary variables, since this food survey allows an unlimited number of

items to be listed. The adjusted mean weight by the intra-individual variance of the two R24h was then calculated by the Multiple Source Method (MSM), which represented the dietary variable used in the analysis to identify the dietary patterns.

The Principal Component exploratory factorial Analysis (PCA) was used, followed by Varimax orthogonal rotation, to identify the dietary patterns of the group studied.

This analysis collected the food variables based on the degree to which they are related to each other and the scores for each factor allows the categorization into groups, such as quartiles. This technique is widely used to reduce data and build a theory [13].

Bartlett's sphericity test and the Kaiser-Meyer-Olkin coefficient (KMO) were carried out at a cut-off value of  $p \leq 0.05$  and  $KMO \geq 0.50$ , respectively [14-16], indicating satisfactory level of confidence for the factorial analysis.

The criteria that determined the number of factors retained were the components with eigenvalues higher than 1.0, Cattell scree plot, in which the number of points on the more declined determine the appropriate number of factors to be retained, and the conceptual significance of the patterns was identified [13]. After establishing the factors, they were rotated by the Varimax method.

The principal components were formed as the foods presented important factorial loads, established at  $\geq 0.3$  (indicating direct correlation with the pattern) or  $\leq -0.3$  (inverse correlation with the pattern) [17]. In nutritional epidemiology, these techniques aim at building linear combinations of food intake to explain the high rate of variation in food consumption in general [13].

The nutritional composition of the foods in each component were determinant for their appointment and denominations previously used in other studies were prioritized when the composition pattern was similar.

Each individual received a score for each principal component. These were categorized into quartiles and the upper quartile indicated greater adherence to the dietary pattern.

Statistical analysis was performed using the Stata program, version 12.0. (Stata Corporation, College Station, Texas, United States) Initially, descriptive analysis of the data was performed, the categorical variables were presented in simple and percentage frequencies, and numerical variables presented as means (standard deviation) or median (interquartile range), which were determined by the Shapiro-Wilk test that tested the normality of these variables.

To evaluate the association between the dietary patterns and glycemic levels, a Poisson regression with robust variance estimation was used, which indicated the Prevalence Ratios (PR) of independent variables (dietary patterns) in relation to the outcomes, and classified the dependent variable (glycemic level) as dichotomous: controlled and uncontrolled. Bivariate and multivariate analyses were carried out. The multivariate analysis was verified by two adjusted analyses, one for sociodemographic data (education, income, age and sex) (model I) and the other one for nutritional status (model II).

Spearman's correlation coefficient was used to verify the correlation between the factorial scores (quartiles) in each pattern and blood glucose levels. Estimates were measured by points and intervals with 95% confidence and at a 5% significance level.

## RESULTS

The study sample consisted of 188 diabetics, of which 56.9% were elderly and 51.1% were men. The mean age of the individuals was 61 years ( $\pm 9.09$ ), with a median income of 2.8 minimum wages (1.9-4.0) and 49.2% of them had not completed high school.

The median BMI of the group was 29.0 kg/m<sup>2</sup> (27.7-31.0) and frequencies of 65.4% overweight and 34.6% of obesity grade I

were found. The median Waist Circumference (WC) for men was 103.5cm (98-106.3) and for women 99 cm (96-104) of the diabetics studied, 76.5% presented waist circumference above the normality parameters (Table 1).

In addition to diabetes, other pathologies diagnosed were: hypertension, Cardiovascular Disease (CVD), dyslipidemia, hypothyroidism, arthrosis, neuropathy, depression, fibromyalgia, gastritis, glaucoma, labyrinthitis, diverticulitis,

and renal failure. The most common drugs administered were hypoglycemic agents (glibenclamide, gliclazide, metformin, glifage, glimepiride, diamicon, galvus), antihypertensives (atenolol, enalapril, ramipril, captopril, losartan, amlodipine, natrilix), statins (atorvastatin, simvastatin), diuretics (hydrochlorothiazide, furosemide), among others such as aspirin and omeprazole.

After confirming the adequacy of the data by the KMO coefficient (0.5) and Bartlett's

**Table 1.** Anthropometric and socioeconomic characteristics of the type 2 diabetic patients interviewed. *Fortaleza* (CE), Brazil, 2017.

Variables	n	%	Mean/Median
<i>Sex</i>			
Men	96	51.1	
Women	92	48.9	
Age (years)			61 ( $\pm$ 9.09)
<i>Age group</i>			
Adults	81	43.1	
Elderly	107	56.9	
<i>Ethnicity (self-reported)</i>			
White	32	17	
Brown	113	60.1	
Black	38	20.2	
Not reported	5	2.7	
BMI (kg/m <sup>2</sup> )			29.0 (27.7-31.0)
<i>BMI classification</i>			
Overweight	123	65.4	
Obesity grade I	65	34.6	
<i>WC (cm)</i>			
Men			103.5 (98.0 – 106.2)
Women			99 (96 – 104)
Income (MW)			2.8 (1.9 – 4.0)
<i>Education</i>			
Completed high school or university degree	96	50.8	
Did not complete high school	92	49.2	
<i>Occupations</i>			
Retired	76	40.4	
Housekeeper	24	12.8	
Self employed	8	4.2	
Merchant	8	4.2	
Daily wages	8	4.2	
Public service	6	3.2	
Graduate profession	6	3.2	
Others	52	27.8	

Note: BMI: Body Mass Index; MW: Merriam-Webster; WC: Waist Circumference.

sphericity test ( $p < 0.001$ ), the 24 food groups that were included in the analysis (Chart 1) resulted in five identified eating patterns, which were denominated as follows: traditional Brazilian, energy-dense, infusion and whole grain cereal, sandwich and dairy, and healthy dietary patterns, which together explained 37.2% of the total variance in intake.

Foods in the traditional Brazilian pattern were those that are most commonly consumed by the Brazilian population, such as rice, beans and poultry (with negative load for regional foods in the northeast). The energy-dense pattern was

composed of processed beverages, biscuits and cakes, sweets and pasta with a negative load for soups and broths. The infusion and whole grain pattern included sweetener, coffee and infusions and whole grain cereals with a negative load for bovine and pork, eggs and smoothies. The sandwich and dairy pattern consisted of beef and pork, dairy and porridges, white bread and fats. The healthy pattern was composed of foods such as oil and oilseeds, fruits and natural juices, roots and tubers and vegetables with a negative load for ultra-processed foods (Table 2).

A total of 96 individuals (51.1%) presented uncontrolled glycemia, with a median value of

**Chart 1.** Food distribution in each group. *Fortaleza* (CE), Brazil, 2017.

Food groups	Food
Sweetening	Sweeteners
Rice	White rice, rice with milk, parboiled rice.
Poultry	Chicken, roasted turkey, chicken, <i>vatapá</i> .
Oils and oilseeds	Olive oil, peanuts, nuts.
Industrialized beverages	Soft drinks, industrialized juices.
Biscuits and cakes	Sweet biscuits, salty biscuits, fried cake, cake without filling, broccoli, arrowroot biscuit, cake
Coffee and infusions	Coffee, tea.
Beef and pork	Beef, pork, viscera.
Whole grains	Barley, brown rice, oats, cereal bar, chia, granola, flaxseed, whole wheat bread.
Regional Foods	Beans and rice, couscous, flour, corn on the cob, <i>mungunzá</i> , <i>paçoca</i> , <i>pamonha</i> , <i>pirão</i> , <i>tapioca</i> , <i>canjica</i> , popcorn.
Sweets	Chocolate powder, sugar, filled biscuits, cake with filling, chocolate, churros, jam, gelatin, ice cream.
Beans	<i>Feijoada</i> , beans.
Fruits and natural juices	Avocado, pineapple, açaí, plum, banana, cashew, kaki, guava, kiwi, orange, lemon, apple, papaya, mango, watermelon, melon, strawberry, noni, pear, sapoti, tangerine, grape, water coconut, and natural juices.
Fats	Sauce, mayonnaise, butter, margarine, pate.
Dairy products and porridge	Skim curd, skimmed yogurt, soymilk, skim milk, white cheese, light curd cheese, whole curd, yogurt, whole milk, cream, cheese, traditional curd, sour cream, porridge.
Pasta	Macaroni, pasta, fried pasta, pizza, salted snacks, sandwich, natural sandwich.
Egg	Egg, omelet, eggnogg.
White bread	Toast, bread.
Fish and seafood	Shrimp, fish, seafood.
Roots and tubers	Potato, sweet potato, beetroot, carrot, manioc, potato chips.
Soups and broths	Risotto, soups, and broths.
Ultra-processed	Canned olive, processed meat, sausages, canned corn, canned peas, coconut milk, 3-minute pasta, canned fish, microwave popcorn, ketchup, industrialized snacks.
Vegetables	Garlic, vinaigrette, zucchini, broccoli, onion, green odor, chuchu, gherkin, cucumber, chili, okra, pumpkin, tomato, chard, lettuce, cauliflower, cabbage butter, spinach, cabbage, arugula.
Fruit smoothy	Smoothies.

**Table 2.** Distribution of the factorial load of main eating patterns identified in type 2 diabetics. *Fortaleza* (CE), Brazil, 2017.

Food groups	Eating patterns				
	Traditional Brazilian	Energy-dense	Infusions and whole grains	Sanduich and dairy	Healthy
Rice	0.700				
Poultry	0.686				
Beans	0.603				
Regional foods	-0.443				
Industrial beverages		0.743			
Sweets		0.638			
Pasta		0.519			
Biscuits and cakes		0.364			
Soups and broths		-0.346			
Whole grains			0.622		
Coffee and infusions			0.390		
Sweetener			0.350		
Beef and pork			-0.460		
Egg			-0.452		
Fruit smoothy			-0.335		
Fats				0.802	
White bread				0.640	
Beef and pork				0.415	
Dairy and porridge				0.301	
Vegetables					0.650
Roots and tubers					0.499
Oil and oilseeds					0.401
Fruits and natural juices					0.350
Ultra-processed					-0.460
Variance Explained (%)	7.89	7.49	7.41	7.36	7.08
Eigenvalue	2.09	1.96	1.78	1.61	1.49

Note: Foods with factorial load  $\geq 0.3$  and  $\leq -0.3$ ; Total variance: 37.2%.

131mg/dL (109.5-152.5). The glycemic values were negatively correlated only with the traditional Brazilian pattern ( $p=0.018$ ;  $r=-0.173$ ) (Table 3).

No associations between adherence to dietary patterns and the glycemic level category were observed in the bivariate and multivariate association analyses, and adjustment models I and II (Table 4).

## DISCUSSION

In the present study, five main eating patterns of the diabetics (traditional Brazilian,

**Table 3.** Correlation between glycemic levels and dietary patterns of type 2 diabetic patients. *Fortaleza* (CE), Brazil, 2017.

Patterns	r	p
Traditional Brazilian	-0.173	0.018
Energy-dense	-0.028	0.704
Infusions and whole grains	0.018	0.810
Sandwich and Dairy	0.125	0.087
Healthy	0.105	0.151

Note: r: Spearman's correlation coefficient.

energy-dense, infusion and whole grain, sandwich and dairy, and healthy diets) were

**Table 4.** Unadjusted and adjusted Prevalence Ratio (PR) and Confidence Interval (95% CI) for the association between glycemia and eating patterns in type 2 diabetic patients. Fortaleza (CE), Brazil, 2017.

Eating pattern	Glycemia			
	n (%)	Unadjusted PR (95%CI)	Adjusted PR (95% CI)*	Adjusted PR (95% CI)**
<i>Traditional Brazilian</i>		$p=0.204$	$p=0.128$	$p=0.262$
Q1	28 (59.6)	Reference	Reference	Reference
Q2	27 (57.4)	0.99 (0.87 – 1.12)	1.00 (0.88 – 1.15)	1.00 (0.87 – 1.14)
Q3	22 (46.8)	0.92 (0.81 – 1.05)	0.91 (0.80 – 1.04)	0.92 (0.81 – 1.05)
Q4	19 (40.4)	0.88 (0.77 – 1.01)	0.88 (0.77 – 1.00)	0.89 (0.78 – 1.02)
<i>Energy-dense</i>		$p=0.290$	$p=0.401$	$p=0.535$
Q1	27 (57.4)	Reference	Reference	Reference
Q2	19 (40.4)	0.89 (0.78 – 1.02)	0.90 (0.79 – 1.03)	0.92 (0.80 – 1.05)
Q3	27 (57.4)	1.00 (0.88 – 1.14)	0.98 (0.87 – 1.11)	0.99 (0.88 – 1.12)
Q4	23 (48.9)	0.95 (0.83 – 1.08)	0.92 (0.80 – 1.06)	0.93 (0.81 – 1.07)
<i>Infusions and whole grains</i>		$p=0.599$	$p=0.729$	$p=0.620$
Q1	22 (46.8)	Reference	Reference	Reference
Q2	23 (48.9)	1.01 (0.88 – 1.16)	1.00 (0.87 – 1.15)	1.00 (0.87 – 1.15)
Q3	23 (48.9)	1.01 (0.88 – 1.16)	0.98 (0.86 – 1.13)	0.98 (0.85 – 1.13)
Q4	28 (59.6)	1.09 (0.95 – 1.24)	1.06 (0.92 – 1.21)	1.07 (0.93 – 1.22)
<i>Sandwich and dairy</i>		$p=0.466$	$p=0.595$	$p=0.430$
Q1	20 (42.6)	Reference	Reference	Reference
Q2	26 (55.3)	1.09 (0.95 – 1.25)	1.08 (0.94 – 1.24)	1.10 (0.97 – 1.26)
Q3	23 (48.9)	1.04 (0.91 – 1.20)	1.00 (0.87 – 1.15)	1.00 (0.88 – 1.15)
Q4	27 (57.4)	1.10 (0.97 – 1.26)	1.05 (0.92 – 1.20)	1.05 (0.92 – 1.20)
<i>Healthy</i>		$p=0.529$	$p=0.687$	$p=0.585$
Q1	24 (51.1)	Reference	Reference	Reference
Q2	20 (42.6)	0.94 (0.82 – 1.08)	0.97 (0.84 – 1.11)	0.98 (0.85 – 1.12)
Q3	25 (53.2)	1.01 (0.89 – 1.16)	1.03 (0.90 – 1.19)	1.05 (0.91 – 1.20)
Q4	27 (57.4)	1.04 (0.91 – 1.19)	1.05 (0.91 – 1.21)	1.07 (0.93 – 1.23)

Note: \*Prevalence ratio adjusted for sociodemographic factors (education, income, age group and sex); \*\*Prevalence ratio adjusted for demographic factors (education, income, age and sex) and nutritional status (BMI). Poisson analysis with robust variance estimation; P: trend value.

identified and an inverse correlation between glycemia and the traditional Brazilian pattern was observed, indicating that the higher the adherence to this dietary pattern, the lower the blood glucose values.

The so-called traditional Brazilian pattern was characterized by higher consumption of rice, poultry, and beans. In the literature researched no studies on the dietary patterns of type 2 diabetic patients. However, in a study of black and Hispanic American diabetics, the 'Caribbean' pattern was identified, which is characterized by

the consumption of rice and Rioja beans, the one closest to the Brazilian diet [18]. Similar dietary patterns were found in Brazilian adults who consume rice and beans [14] along with other foods such as meat and margarine [19], but no association with glycemic levels was investigated.

The consumption of pasta and sweets, as found in the energy-dense dietary pattern (industrialized beverages, sweets, pastas, biscuits, and cakes), was also observed in the study of Davis [18], who described it as the "pizza and

sweet" pattern that also included other foods such as bread, *pizza*, and fried chicken. In another study with Australian individuals with and without diabetes, a pattern called "sweet" dietary pattern (consumption of cake, biscuits, chocolate, ice cream, and sweets) was found [20].

In Brazil, a study with elderly people with hypertension discussed a similar denomination and diet composition that included sweets, soft drinks, and pasta, but also meat and viscera, which differ from the findings of the present study [15].

No studies with a pattern similar to the infusion and whole grain dietary pattern that included whole grains, coffee and infusions, or sweeteners in the same eating pattern were found. The presence of whole grains in eating patterns known as 'healthy' are usually mentioned [19,21], as well as coffee belonging to the so-called 'traditional' eating pattern [14,15]. These foods, particularly whole grains and sweeteners, are commonly recommended for diabetic patients, since their consumption contributes to the treatment of the disease due to the metabolic advantages of slow release of glycogen during the digestive process [22].

One study with Japanese diabetics determined a eating pattern called 'meat, fats and oils, seasonings and eggs' [23] and one with Korean diabetics identified as 'bread, meat and alcohol' pattern [21] were the ones that most resembled the sandwich and dairy dietary pattern including the consumption of fats, meats and bread in the same factor.

The so-called healthy pattern was composed of vegetables, roots and tubers, olive oil and oilseeds, fruits, and natural juices. In the literature, patterns with this same denomination are quite frequent. The food consumption of diabetic patients in Iran [24], the United States [18], and Australia [20] was similar to the healthy pattern in the present study, as they consumed fruits and vegetables within the same factor,

as well as oilseeds and fish, which was also classified as a 'healthy' dietary pattern.

In other studies with the Brazilian population, we also found 'healthy' eating patterns similar to the ones in the present study, but they included more foods in the same pattern [14,15,19].

Foods that are generally called 'healthy' patterns positively affect glucose metabolism, reduce insulin resistance, even in patients with type 2 diabetes, since they have been confirmed in other studies, and they are inversely associated with the incidence of type 2 diabetes [25,26].

The explanation can be given through the beneficial effects of some nutrients widely found in healthy diets called plant-rich fruits such as fiber, antioxidants, unsaturated fatty acids and micronutrients, such as magnesium, in addition to the low saturated fat content has shown a direct improvement in postprandial glycemia as well as in long-term glucose metabolism [27].

A study in an Eastern Chinese cohort with a sample of type 2 diabetic individuals or those who presented altered fasting glycemia found an association only between the so-called pattern 'rich in vegetables' with diabetes and glycemic control. Thus, those who adhered to this dietary pattern presented improved fasting glucose control and lower risk of diabetes [28].

The epidemiological study with Japanese individuals, which also found an association between the adherence to a 'healthy' pattern and lower incidence of diabetes, emphasized that the diet significantly improves glucose metabolism when combined with a healthy lifestyle, such as the practice of physical activities, and the regular consumption of the dietary pattern [26]. This may partially explain why this association was not observed in the present study as the greatest adherence and food regularity was found in the traditional Brazilian pattern, probably due to customs and economic conditions. This pattern was the one that best explained the consumption variation

in the group, while the healthy pattern was the one that least explained variation.

Thus, among the patterns identified in the present study, only the traditional Brazilian pattern was related to glycemic levels, and the higher the factorial score (greater adherence) to this pattern, the lower the glycemia values. Although this pattern does not include foods identified as protectors, such as fruits and vegetables, it does contain low-fat foods, such as white meat, and bean fibers and essential amino acids found in beans and rice.

Thus, it may be assumed that individuals who follow more traditional habits consume less industrialized foods, rich in sugars and fats, which are usually associated with greater health hazards, and consequently diabetes. The highly industrialized diet is a trend in the Brazilian population [29], but we found that diabetic patients have a greater adherence to the more traditional dietary pattern.

Although it is recommended to adhere to a diet rich in vegetables and other protective foods for diabetes, the greater adherence to the traditional Brazilian pattern may have been influenced by the socioeconomic status of the individuals, since the food does not contain an excess of carbohydrates and fats and it is less expensive when compared to the so-called healthy pattern.

It is evident, therefore, that nutritional practice does not always follow the knowledge and nutritional guidelines of diabetic patients. There is often a gap between knowledge and practice [30].

The present study has some limitations. The cross-sectional design, which does not establish cause and effect; the use of the 24-hour food recall method to investigate consumption, which may be biased memory, in addition to leading patients to underestimate or overestimate consumption; and the identification method of eating patterns used in this study due to the subjectivity inherent to the process. Thus,

it may not be concluded that the data can be generalized to a wide range of the population, even in patients with type 2 diabetes.

However, all measures to mitigate the impact of such limitations were taken, such as the detailed training of the interviewers and the detailed description, based on the literature, of the stages of analysis of the factorial components. The present study investigated the main dietary patterns in a group of type 2 diabetics in Brazil and its association with glycemic levels, which may contribute to explain the gaps in the research on the diet-diabetes relationship, a disease with a significant prevalence all around the world.

## CONCLUSION

Five main eating patterns were identified among the type 2 diabetics studied (traditional Brazilian, energy-dense, infusion and whole grain, sandwich and dairy, and healthy diets). The traditional Brazilian pattern was inversely correlated with the glycemic levels, indicating that it can also be used as a protection standard for diabetics.

## CONTRIBUTIONS

EPM STUDART Main author; conception; data collection, data interpretation and review. SPM ARRUDA data analysis and interpretation; review and approval of the final version. HAC SAMPAIO Review and approval of the final version of the article. TU PASSOS Data collection. AAF CARIOCA Data analysis and interpretation.

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