

DIETARY PATTERNS OF ADULTS WITH ASTHMA TREATED AT A REFERRAL CENTER FOR ASTHMA

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ABSTRACT

Introduction: Consumption of foods with anti-inflammatory and antioxidant components could contribute to a better control of the asthma. The aim of this study was to assess the association between dietary patterns, nutritional status, and asthma control in patients treated at an asthma referral center in Porto Alegre, Brazil.

Methods: This is a cross-sectional study with 198 adult asthma patients. Participants completed a 24-hour food recall and a questionnaire on disease history, degree of control, and severity, as well as pulmonary and anthropometric assessments. We used exploratory factor analysis and principal component analysis as an extraction method to derive the dietary patterns.

Results: The mean body mass index was 29.6 (SD, 5.7) kg/m², and 41.9% were classified as obese. Regarding disease severity, 72.7% were classified as having severe persistent asthma, and concerning the degree of control, 59.6% of the patients had uncontrolled asthma. Three dietary patterns were identified: "Sugars", "Healthy", and "Fats and Alcohol". It was observed that the Fats and Alcohol pattern was significantly associated with men. However, no associations were observed between the other variables and dietary patterns.

Conclusion: This was the first study to identify the dietary patterns in asthmatics in Brazil. Patterns found in the present study were "Sugars", "Healthy" and "Fats and Alcohol". However, there was no significant association between the 3 patterns and nutritional status or disease control.

Keywords: *Asthma; Feeding behavior; Nutritional status*

INTRODUCTION

Asthma is a chronic inflammatory disease of the airways, characterized by respiratory symptoms, bronchial hyperresponsiveness, and reversible airflow limitation¹. The World Health Organization (WHO) estimates that asthma affects 300 million people worldwide, including children and adults². In Brazil, it affects 6.4 million people over the age of 18, accounting in 2014 for 105,500 hospital admissions, resulting in a public health cost of \$ 57.2 million³.

The pathogenesis of asthma is complex and not fully understood. However, overweight has been considered an important risk factor for adults with asthma^{4,5}. On the one hand, studies show that individuals with persistent asthma tend to perform fewer physical activities due to functional limitation, which reduces caloric expenditure and leads to overweight and obesity in the long term⁶; on the other hand, there is asthma severity and a worsening of symptoms when there is an increase in body mass index (BMI)^{7,8}.

Similarly, the relationship between diet and the development and control of asthma has not yet been elucidated. It is known that the consumption of foods with anti-inflammatory and antioxidant components⁹ could contribute to

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a better control of the disease^{10,11}. However, studies on dietary patterns, derived from factor analysis or cluster analysis, are relatively new, mainly in adults¹². Nutritional epidemiology has recommended that the dietary pattern of individuals and the population should be evaluated, and that nutrient intakes should not be assessed separately, especially when studying noncommunicable chronic diseases¹³.

Among the studies that used this approach, 3 found positive associations between dietary intake and asthma development with dietary patterns “Meat and Cheese” (red meat, processed meat, and cheese)¹⁴, “Traditional” (rice, vegetables, and wheat flour)¹⁵, and “Rich in Fat, Salt, and Sugar” (bakery, chocolate, desserts, pastries, chips, fruit juice, soft drinks, and alcoholic beverages)¹⁶, and 2 found negative associations with “Cheese and whole-grain Bread” (high intake of these foods)¹⁴ and “Fish, Fruits and Vegetables” (high intake)¹⁶.

Thus, this study aimed to identify dietary patterns of asthma patients treated at the asthma clinic of the Hospital de Clínicas de Porto Alegre and its relation to nutritional status and disease control.

METHODS

This was a cross-sectional study with 198 adult asthmatic patients treated at the asthma clinic of the Pulmonology Service of the Hospital de Clínicas de Porto Alegre.

Patients were referred to the outpatient clinic and diagnosed with asthma according to the guidelines of the Brazilian Society of Pulmonology and Asthma Physiology for Asthma Management¹. Smoking patients with a smoking index > 10 pack-years, patients diagnosed with another chronic pulmonary disease, such as chronic obstructive pulmonary disease, bronchiectasis, and diffuse pulmonary disease, those diagnosed with human immunodeficiency virus infection or disabling neurological disease, and those who did not complete the assessments proposed by the study were excluded. Sociodemographic information and clinical data on the disease were collected using a structured questionnaire.

The clinical asthma outcomes were assessed by severity, degree of control, and pulmonary function. The degree of asthma control was assessed according to the Global Initiative for Asthma (GINA)¹⁷, classifying patients into controlled, partially controlled, and uncontrolled asthma. The severity of the disease was classified according to the drug regimen used and the response to treatment was classified according to GINA¹⁷, in mild persistent asthma, moderate persistent asthma, and severe persistent asthma¹⁷. The spirometric evaluation was performed using the Jaeger, version 4.31a (Jaeger, Wuerzburg, Germany), and 3 successive forced expiratory curves were

performed and recorded at higher values. Forced expiratory volume in the first second (FEV₁) and forced vital capacity (FVC), in liters and percentage of predicted, were recorded in FEV₁/FVC in absolute value and percentage of predicted values¹⁸. For analysis, this variable was categorized as: FEV₁ > 80%; FEV₁ 60-80%; < 60%¹⁹.

In the anthropometric evaluation, weight and height measurements were performed to calculate the BMI. The cutoff points for BMI were: normal weight (18.5 to 24.9 kg/m²), overweight (25 to 29.9 kg/m²), and obese (≥ 30 kg/m²). To measure weight (kg), the patient had to stand in the center of the scale, wearing light clothing. The electronic scale used was a high precision Urano® model that supports up to 150 kg, with a 50 g variation. Height was measured in meters using a Tonelli & Gomes® stadiometer, fixed to a smooth wall without skirting, with a movable rod, graduated in centimeters and millimeters.

To assess food consumption, a 24-hour recall (R24h) was used, administered by trained professionals. The patients reported their food consumption on the day before the interviews and the amount of each item of food consumed in household measures. The reported home measurements were transformed into grams/food^{20,21}.

To determine the dietary patterns, the food items were first grouped into food groups according to the frequency of consumption and nutritional similarity. Food items with an intake of less than 5% were excluded from the analysis.

We conducted a principal components factor analysis (PCA) to derive major dietary patterns. The reliability of the factor analysis procedure was assessed via the Kaiser–Meyer–Olkin statistics (coefficient reference: KMO ≥ 0.8) and the Bartlett test of sphericity (reference: $p \leq 0.05$). The factors were rotated by an orthogonal (Varimax) transformation. The number of factors retained was based on the following criteria: components with an eigenvalue of > 1, scree plot test, and the interpretability of the factors.

The eigenvalues signify the amount of variance explained by each of the factors. Food items were considered to load on a factor if they had an absolute correlation ≥ 0.30 with the factor and thus were retained in the calculations of the dietary pattern scores.

The dietary patterns were analyzed as continuous variables. The associations between the other variables and the dietary patterns were tested using Student's *t* test and ANOVA. Significance was set at 5% in all analyses. Statistical analyses were performed in SPSS, version 18. According to the rule proposed by Hair²² to identify dietary patterns using principal component analysis, the required sample size would be 140 individuals (28 food items × 5).

The Research Ethics Committee of the Hospital de Clínicas de Porto Alegre approved the research under number 12.0103, and all participants signed the Informed Consent Form.

RESULTS

After applying the exclusion and inclusion criteria to the 344 asthmatic patients in the target population from March to November 2013, a total of 71 individuals were not eligible and 75 were recruited to participate in the study. Thus, 198 individuals were included in the final sample of this study.

The final sample consisted of individuals with a mean age of 56.2 (SD, 14.8 years). There was a predominance of women (81.8%) and individuals who declared themselves to be white (75.3%). The mean BMI was 29.6 (SD, 5.7) kg/m², 21.7% of the subjects were classified as eutrophic, 36.4% were overweight, and 41.9% were obese. Regarding the severity of the disease, 11.6% were classified as having mild persistent asthma, 15.7% moderate persistent asthma, and 72.7% severe persistent asthma. Regarding the degree of control, 59.6% of patients had uncontrolled asthma, 14.1% partially controlled, and 26.3% controlled. The characteristics of the sample are shown in Table 1.

Table 1: General characteristics of patients with asthma.

Variables	N = 198
Sex, n (%)	
Female	162 (81.8)
Male	36 (18.2)
Age (years), mean ± SD	56.2 ± 14.8
Ethnicity, n (%)	
White	150 (75.3)
Other	48 (24.2)
Age at diagnosis (years), median (IQR)	20.5 (44)
Smoking status, n (%)	
Never	138 (69.7)
Former	60 (30.3)
Comorbidities, n (%)	125 (63.1)
Allergic Rhinitis, n (%)	141 (71.2)
GINA severity classification, n (%)	
Mild	23 (11.6)
Moderate	31 (15.7)
Severe	144 (72.7)
GINA asthma control, n (%)	
Controlled	52 (26.3)
Partly controlled	28 (14.1)
Uncontrolled	118 (59.6)
BMI (kg/m ²), mean ± SD	29.6 ± 5.7
Nutritional status, n (%)	
Normal weight	43 (21.7)
Overweight	72 (36.4)
Obese	83 (41.9)
Pulmonary Function (pre-bronchodilator), mean ± SD	
FVC (L)	2.5 ± 0.9
FVC % predicted	81.2 ± 21.3
FEV1 (L)	1.7 ± 0.7
FEV1 % predicted	68.2 ± 22.2
FEV1/FVC % predicted	82.1 ± 13.0

N: number of cases (% total cases); SD: standard deviation; IQR: interquartile range; GINA: Global Initiative for Asthma; BMI: body mass index; FVC: forced vital capacity; FEV₁: forced expiratory volume in 1s.

The food items and the frequency of consumption after grouping are shown in Table 2. A total of 28 food groups were formed from the 142 items recorded on the R24h. Three dietary patterns were identified that accounted for 22.84% of the total variance explained, as shown in Table 3. Pattern 1, called Sugars was associated with a higher intake of biscuits and cakes, pasta, bread, coffee and tea, soda and powdered juice, sugar, and fast food. Pattern 2 was classified

as Healthy, positively charged for white meats, juices, citrus fruits, other fruits, dark green vegetables, cruciferous vegetables, yellow vegetables, other vegetables, white rice, beans, bananas, apples, and whole grains. And lastly, pattern 3, Fats and Alcohol, was associated with the increased intake of whole grains, tubers, milk and dairy products, red meats, sausages, margarine and mayonnaise, butter and sour cream, and sweets and alcohol.

Table 2: Final food items and absolute and relative consumption frequency in individuals.

Food Items	N	%
Milk and dairy products	152	76.8
White rice	141	71.2
Red meat	122	61.6
Breads	120	60.6
Coffee and tea	118	59.6
Sugar	98	49.5
Other vegetables	94	47.5
Soda and powder juice	92	42.5
Dark green vegetables	84	42.4
Beans	79	39.9
White meat	69	34.2
Biscuit and cakes	66	33.3
Margarine mayonnaise	64	32.3
Banana	59	29.8
Sweets	58	29.3
Whole grains	55	27.8
Sausages	54	27.3
Juices	50	25.3
Citrus fruits	45	22.7
Tubers	39	19.7
Other fruits	35	17.7
Apple	32	16.2
Pastas	28	14.1
Crucifers	26	13.1
Butter and milk cream	25	12.6
<i>Fast foods</i>	19	9.6
Alcohol	10	5.0

Table 3: Food patterns identified, food items and factorial loads that compose them and percentage of variance explained.

Food Items	Dietary patterns		
	Sugars	Healthy	Fats and Alcohol
Sugar	0.630		
Soda and powder juice	0.586		
Coffee and tea	0.507		
Breads	0.386		
Fast food	0.150		
Biscuit and cakes	0.106		
Pastas	0.044		
Vegetable dark green		0.638	
Beans		0.616	
Banana		0.536	
Juices		0.520	
White rice		0.520	
Other vegetables		0.416	
Apple		0.415	

Continue...

Table 3: Continue

Food Items	Dietary patterns		
	Sugars	Healthy	Fats and Alcohol
Whole grains		0.289	0.308
Crucifers		0.115	
White meat		0.051	
Citrus fruits		0.042	
Yellow vegetables		0.042	
Other fruits		0.001	
Red meat			0.642
Sausages			0.529
Alcohol			0.506
Milk and dairy products			0.426
Margarine and mayonnaise			0.266
Butter and milk cream			0.185
Tubers			0.165
Sweets			0.101
% cumulative variance	8.35	16.52	22.84

Table 4 shows the means and respective standard deviations of the association between consumption of dietary patterns and demographic variables, nutritional status, and asthma control.

It was observed that the Fat and Alcohol pattern was significantly associated with men. No associations were observed between the other variables and dietary patterns.

Table 4: Means and standard deviations of the associations between dietary patterns and demographic variables, nutritional status, and asthma control.

	Dietary patterns					
	Sugars		Healthy		Fats and Alcohol	
	Mean (\pm SD)	p-value	Mean (\pm SD)	p-value	Mean (\pm SD)	p-value
Sex		0.937*		0.496*		< 0.001*
Male	0.012 (0.925)		0.103 (1.446)		0.641 (1.315)	
Female	- 0.002 (1.018)		- 0.022 (0.875)		- 0.142 (0.857)	
Age (years)		0.077**		0.350**		0.853**
< 46	0.240 (0.889)		- 0.036 (1.307)		0.026 (0.916)	
47 – 57	0.050 (1.013)		- 0.143 (0.728)		0.038 (1.369)	
58 – 65	0.018 (1.242)		0.213 (1.141)		- 0.113 (0.876)	
> 66	- 0.274 (0.774)		- 0.017 (0.756)		0.040 (0.727)	
Nutritional status		0.835*		0.824**		0.299**
Normal	0.073 (0.931)		0.082 (1.475)		- 0.089 (0.846)	
Overweight	0.002 (1.043)		- 0.033 (0.775)		0.146 (1.135)	
Obese	- 0.039 (1.005)		- 0.013 (0.873)		- 0.080 (0.943)	
GINA asthma control		0.331**		0.117**		0.163**
Controlled	- 0.165 (0.841)		0.026 (0.918)		0.166 (1.375)	
Partly controlled	0.149 (1.223)		0.340 (1.558)		0.161 (0.789)	
Uncontrolled	0.037 (1.005)		- 0.092 (0.847)		- 0.111 (0.827)	
GINA severity		0.243**		0.406**		0.854**
Mild	- 0.300 (0.989)		- 0.114 (0.699)		- 0.052 (1.456)	
Moderate	- 0.746 (0.898)		0.212 (1.205)		0.087 (0.828)	
Severe	0.064 (1.018)		- 0.027 (0.992)		- 0.010 (0.951)	
Pulmonary function (FEV ₁)		0.608**		0.430**		0.257**
< 60%	0.088 (1.132)		- 0.029 (0.855)		- 0.132 (1.114)	
60 – 80%	- 0.032 (0.831)		0.125 (1.070)		0.146 (0.995)	
> 80%	- 0.078 (0.998)		- 0.102 (1.091)		0.006 (0.827)	

SD: standard deviation; FEV₁: forced expiratory volume in 1 s.

* Student's *t* test; **ANOVA.

DISCUSSION

This study, conducted in asthmatic patients treated at a reference center in the municipality of Porto Alegre, identified 3 eating patterns: Sugars, Healthy, and Fat and Alcohol. The Fats and Alcohol pattern was associated with men. However, no association was observed between the 3 dietary patterns and the nutritional status, pulmonary function, and degree of disease control in these patients.

The patterns found in this study are similar to the patterns found in other studies with asthmatic populations, especially in the study by Shi et al.¹⁵, who identified 4 patterns: Male, characterized by meat and alcohol; Traditional, with high rice and vegetable intake; Sugar, rich in cakes, milk, yogurt, and sugary drinks; and Rich in Vegetables, with high consumption of whole grains, fruits, tubers, vegetables, milk, eggs, and fish. Lv et al.¹² performed a meta-analysis to analyze eating patterns and categorized 3 patterns: Healthy, characterized by high consumption of fruit, vegetables, whole grains, and/or fish; Unhealthy, characterized by a high quantity of refined grains, red meat, processed meat, fast food, foods rich in sugar and/or fat; and Neutral, consisting of the combination of the 2 previous patterns. Thus, the Healthy pattern found in our study resembles the homonymous pattern stipulated by the authors of this meta-analysis, and the combination of the Sugars and Fats and Alcohol patterns in our study resembles the Unhealthy pattern also stipulated by them.

In addition to this meta-analysis, other authors^{10,12,14,23,24} also found in their studies a healthy pattern characterized by a high intake of fruits, vegetables, whole grains, and fish. The sugar pattern found in the present study was similar to that found in the studies by Shi et al.¹⁵ and Barros et al.¹⁶, where the most positively charged foods were soft drinks, processed juices, bakery foods, cakes, sweets, desserts, and chocolate. The Fats and Alcohol pattern was similar to that found in the studies by Shi et al.¹⁵, Hooper et al.²⁴, Bakolis et al.²³, Rosenkranz et al.¹⁴, and McKeever et al.¹¹ consisting mainly of red meat, bacon, sausage, and fat added to food and alcohol.

Dietary patterns in asthmatic individuals also appear to be associated with sex. Rosenkranz et al.¹⁴ analyzed the dietary patterns of men and women separately, and a positive association was observed between the pattern Meat and Cheese in men and a negative association of the pattern Cheese and Whole bread in women. Similar results to the present study were observed by McKeever et al.¹¹, who verified that the Cosmopolitan pattern (high consumption of vegetables, fish, chicken, wine, and rice) was associated with women and the Traditional pattern (characterized by red meat, processed meat, potatoes, cooked vegetables, added fat to foods,

coffee, and beer) was associated with men. According to Vigitel 2014²⁵, overweight is higher among men. In addition, regular consumption of soft drinks, whole milk fat, and meat with excess fat is higher among men. On the other hand, women consume more fruit and vegetables.

Similar to the present study, Bakolis et al.²³, Lv et al.¹², and Hooper et al.²⁴ found no significant associations between asthma outcomes and the eating patterns assessed. However, control of the disease seems to be important in relation to the pattern of food consumption among these individuals, since other studies have shown positive associations between eating patterns and asthma, such as Meat and Cheese (red meat, processed meat, and cheese)¹⁴, Traditional (rice, vegetables, and wheat flour)¹⁵, and Rich in Fat, Sugar, and Salt (bakery, chocolate, desserts, pastries, chips, fruit juice, soft drinks, and alcoholic beverages)¹⁶. Varraso et al.¹⁰ observed that the Nuts and Wine pattern was negatively associated with the risk of asthma attacks, whereas in the Western pattern this risk is significantly increased. In addition, McKeever et al.¹¹ observed an association between the Traditional pattern and lower pulmonary function. On the other hand, other authors have described some dietary patterns as protective for asthma: the food patterns Cheese and Whole Grains¹⁴ and Fish, Fruits, and Vegetables¹⁶.

In general, dietary patterns positively associated with asthma can be classified as calorie-rich and nutrient-poor, which is also associated with a high score of disease symptoms and increased prevalence of asthma in children²⁶. The increased consumption of omega-6 polyunsaturated fatty acids and the reduction of omega-3 polyunsaturated fatty acids have contributed to the increase in cases of the disease. This demonstrates an important role of fatty acid intake in modulating inflammation and may explain the protective effect of omega-3 on the disease²⁷. According to Bidad et al.²⁸, the type of fat ingested seems to be more important than the amount of fat.

In addition to fat, other aspects of the relationship between diet and development and control of the disease can already be described, such as a low intake of dietary antioxidants, which can be a risk factor for asthma, together with the important role of sodium, potassium, and magnesium in the development of the disease, since asthma is associated with an important oxidative imbalance, and the antioxidant levels affect the risk of the disease by influencing the immune response to allergen provocation or inflammatory response²⁹. Studies have already shown that a diet containing fruit and fish is related to a lower incidence of asthma^{30,31}, and diets restricted in fruits and vegetables are related to an increase in the symptoms characteristic of the disease³²⁻³⁵. In addition, wine and oilseeds also

appear to have an important protective effect, which can be explained by the large amount of vitamin E and selenium found in oleaginous plants, preventing oxidative stress^{29,36}, and flavonoids, especially when coming from apple³⁷ and red wine³⁸.

The present study has some limitations. The cross-sectional design does not allow for the assessment of temporality between cause and effect. Also, the sample size, although adequate for identifying eating patterns, may not have been able to detect associations between eating patterns and other explanatory variables. Finally, the present study used R24h to assess food intake. This instrument may not be able to measure the habitual food consumption of individuals.

Identifying eating patterns that play a protective role in asthma symptomatology and development is of utmost importance since individuals do not consume

nutrients alone and the food combination contains numerous substances and interactions between nutrients, which a nutrient-only analysis may not detect³⁵. In addition, nutritional recommendations are based on foods and their combinations.

Although there were no significant associations between the 3 patterns found and the nutritional status or disease control in this study, we recommended the adoption of a healthy dietary pattern, consuming natural and the least processed foods possible, to obtain the amounts and qualities of micronutrients important for overall health, prevention and control of asthma, and to avoid excessive weight gain, which is an important risk factor for asthma and other chronic noncommunicable diseases. Furthermore, additional studies focusing on the relationship between dietary intake and clinical outcomes of asthma are also recommended.

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