ARTIGO

EMPIRICAL DIETARY INFLAMMATORY PATTERN IN DIABETIC PATIENTS IN PRIMARY CARE

PADRÃO INFLAMATÓRIO ALIMENTAR EMPÍRICO EM PACIENTES DIABÉTICOS NA ATENÇÃO PRIMÁRIA

DOI: 10.56083/RCV3N9-053
Recebimento do original: 11/08/2023
Aceitação para publicação: 14/09/2023

Carlos Cardoso Neto
Specialist in Sports Nutrition and Aesthetics
Institution: Universidade Estadual do Ceará (UECE)
Address: Avenida Doutor Silas Munguba, 1700, Itaperi, Fortaleza – CE, CEP: 60714-903
E-mail: nutricarloscardoso@outlook.com

Antonio Augusto Ferreira Carioca
PhD in Nutrition in Public Health
Institution: Universidade de Fortaleza (UNIFOR)
Address: Avenida Washington Soares, 1321, Edson Queiroz, Fortaleza – CE, CEP: 60811-905
E-mail: aafc7@hotmail.com

Mayanne Iamara Santos de Oliveira Porto
Specialist in Elderly Health and Gerontology
Institution: FortaleSer
Address: Rua Duque de Caxias, 893, Centenário, Campina Grande – PB, CEP: 58428-025
E-mail: mayanneiamara@gmail.com

Mariana Dantas Cordeiro
Master in Nutrition and Health
Institution: Universidade Estadual do Ceará (UECE)
Address: Avenida Doutor Silas Munguba, 1700, Itaperi, Fortaleza – CE, CEP: 60714-903
E-mail: marianadantas04@gmail.com

Soraia Pinheiro Machado
PhD in Collective Health
Institution: Universidade Estadual do Ceará (UECE)
Address: Avenida Doutor Silas Munguba, 1700, Itaperi, Fortaleza – CE, CEP: 60714-903
E-mail: soraia.arruda@uece.br
ABSTRACT: Aims: Chronic low-grade inflammation, often present in type 2 diabetes mellitus (DM2), can be modulated by diet. The study aimed to evaluate the empirical dietary inflammatory pattern (EDIP-SP) of diabetic patients seen in primary care in Fortaleza – Ceará - Brazil. Methods: In this cross-sectional study, the sample was of convenience and included 229 people. The ELSA-Brazil Food Frequency Questionnaire was applied, and body mass index (BMI) and waist circumference (WC) were measured. The EDIP-SP, an index validated in Brazil, was calculated. The project was designed according to Resolution 466/2012, submitted and approved by the Ethics Committee in Research with Human Beings. Results: Among the participants, 70.7% were overweight, and 69% had high WC. The mean EDIP-SP was -2.83 (±1.59), and 100% of the diets were anti-inflammatory. There was no correlation between EDIP-SP and BMI, and WC. The high proportion of high BMI and WC values and anti-inflammatory diets may have influenced the findings. Conclusion: In the group evaluated, diet is not a risk factor for low-grade chronic inflammation.

KEYWORDS: Empirical Dietary Inflammatory Pattern, Type 2 Diabetes Mellitus, Inflammation, Primary Care.

RESUMO: Objetivos: A inflamação crônica de baixo grau, muitas vezes presente no diabetes mellitus tipo 2 (DM2), pode ser modulada pela dieta. O estudo teve como objetivo avaliar o padrão inflamatório dietético empírico (EDIP-SP) de pacientes diabéticos atendidos na atenção primária em Fortaleza - Ceará - Brasil. Métodos: Neste estudo transversal, a amostra foi de conveniência e incluiu 229 pessoas. Foi aplicado o Questionário de Frequência Alimentar ELSA-Brasil e medido índice de massa corporal (IMC) e circunferência da cintura (CC). Foi calculado o EDIP-SP, índice validado no Brasil. O projeto foi elaborado de acordo com a Resolução 466/2012, apresentado e aprovado pelo Comitê de Ética em Pesquisa com Seres Humanos. Resultados: Entre os participantes, 70,7% estavam com sobrepeso e 69% com WC alto. A média EDIP-SP foi de -2,83 (±1,59) e 100% das dietas foram anti-inflamatórias. Não houve correlação entre EDIP-SP e BMI, e WC. A alta proporção de valores de IMC e CC elevados e dietas anti-inflamatórias podem ter influenciado os achados. Conclusão: No grupo avaliado, a dieta não é um fator de risco para inflamação crônica de baixo grau.
1. Introduction

Chronic non-communicable diseases (NCDs) are highly prevalent worldwide and the leading cause of death around the globe. In 2016, 41 of the 57 million deaths were caused by a NCD, with cardiovascular diseases being the deadliest [1]. In Brazil, in a recent survey, more than 52% of individuals over 18 stated that they had at least one NCD [2].

The situation has led scholars to investigate factors associated with triggering or preventing these diseases. In recent years, another risk factor for NCDs has begun to be studied: chronic low-grade inflammation. This has been pointed out as a risk factor for type 2 diabetes mellitus (DM2), cardiovascular diseases, cancer, obesity, and metabolic syndrome [3].

Chronic low-grade inflammation is a constant, unresolved inflammation characterised by up to a fourfold increase in serum levels of specific inflammatory mediators, such as interleukin-6 (IL-6) and C-reactive protein [4]. One of the factors that may be associated with the increase of these inflammatory mediators is the increase in body adiposity, which causes an increase in the production and release of pro-inflammatory cytokines, chemokines, and adipokines by the adipose tissue due to its increased volume and cell hypertrophy. These components promote the accumulation of macrophages in the adipose tissue that mediates pro-inflammatory factors, which, added to high oxidative stress and lipotoxicity, promote the Development of metabolic and immunological diseases [5]. The adipose tissue is responsible for the production and release of several cytokines,
which can act pro or anti-inflammatory, as in the case of adiponectin, IL-6, and tumor necrosis factor alpha [6]. The hypertrophy and apoptosis of adipocytes cause increased production of pro-inflammatory adipokines, consequently activating the immune system [7].

The role of inflammation in the early stage of atherosclerotic events is already well documented. However, it is increasingly seen that chronic low-grade inflammation can lead to other pathologies such as metabolic syndrome, non-alcoholic fatty liver disease, and insulin resistance, which is directly related to hypertrophy of adipose tissue leading to the Development of type 2 diabetes mellitus [8].

Diet is important in the onset of chronic inflammation, with studies categorizing different dietary components as anti-inflammatory or pro-inflammatory [9,10]. Diet can alter some markers related to chronic inflammation, such as interleukin-6, C-reactive protein, tumor necrosis factor (TNF-α), and adiponectin [11].

An unhealthy eating pattern is known to be directly associated with some pathologies such as obesity, high serum levels of triglycerides and cholesterol, and lower serum HDL [12]. Some studies show an association between dietary patterns and the risk of developing chronic metabolic diseases [13-16].

Therefore, in 2016 the "Empirical Dietary Inflammatory Index" (EDII) was developed, an index that considers dietary patterns. This type of assessment is considered more comprehensive because it can assess the interactions between nutrients and food, so dietary patterns may be more effective in predicting diet-related diseases [17]. In 2019, this index was validated in Brazil as Empirical Dietary Inflammatory Pattern (EDIP-SP), considering the consumption of six components in the diet of the Brazilian population divided into three groups: rice and beans; fruits, vegetables, and legumes; and processed meats [11].
Thus, this study aims to evaluate the empirical dietary inflammatory pattern in the diet of diabetic patients in primary care in the city of Fortaleza - Ceará.

2. Methods

This is a cross-sectional study, from a larger project entitled PREVENDO (Project – Health, aging, diet and inflammation: development, validation and standardization of instruments for health promotion and prevention of non-communicable chronic diseases), developed in Primary Health Care Units (PHCUs) of Fortaleza, capital of Ceará, located in northeastern Brazil. The PHCUs of the Municipal Health Secretariat of Fortaleza are distributed in 6 Regional Executive Secretariats (RES). We chose one unit of each RES, informed by the body as the one with the most significant number of people with DM2. The convenience sample consisted of 229 DM2 patients, 32 in RES I, 46 in RES II, 36 in RES III, 48 in RES IV, 40 in RES V, and 27 in RES VI.

Inclusion criteria were users of the Unified Health System (UHS) with DM2, over 18 years of age, of both sexes, literate, and without cognitive deficits that could interfere with understanding the information requested. Among the exclusion criteria were those who had already undergone coronary surgery or had had a myocardial infarction and pregnant women.

Data collection occurred from September 2018 to July 2019. In addition to the application of the ELSA – Brazil Food Frequency Questionnaire, data regarding the gender, age, years of study, housing, family income, smoking, and alcohol consumption were also collected.

The information from the Food Frequency Questionnaire ELSA – Brazil, referred to as home measures, was transformed into grams, and these values were entered into the software Diet Win Professional 3090 to determine macro and micronutrients in each diet participant. The Empirical
Dietary Inflammatory Pattern (EDIP-SP) was then calculated, considering the food groups identified in the Brazilian validation study [11]. Thus, the following were considered: rice and beans, fruits, vegetables, legumes, and processed meat. The rice and beans and fruits/legumes/vegetable groups are considered anti-inflammatory, and the processed meats group is considered inflammatory. In this validation study, the processed meats are sausage, pork sausage, nuggets, bacon, ham, bologna, salami, and roast beef.

Each of these groups has a weight, a serving size, and a proportion in the EDIP-SP calculation. The rice and beans group weighs -0.27, considering the proportion of five parts of rice to one part of beans, and the serving size is 180g. The fruits, vegetables, and greens group weighs -0.12 considering the proportion of one part of fruits to one part of vegetables and the serving size is 90g. The group is considered to be inflammatory, processed meats, weights 0.27, and the serving size is 40g. The more negative the final EDIP-SP value, the more anti-inflammatory the diet is.

For statistical analysis of the data, a descriptive analysis of the variables was performed. The numerical variables were presented by means (standard deviation), and the categorical variables by simple frequencies and percentages. The normality of quantitative variables was tested using the Shapiro Wilk test. To rank the EDIP-SP, the sample was divided into quartiles. A correlation test was applied between Empirical Dietary Inflammatory Pattern (EDIP-SP) and its components and anthropometric variables.

The project was designed according to Resolution 466/2012, submitted and approved by the Ethics Committee in Research with Human Beings. Participants were informed about the purpose and procedures of the research and signed an informed consent form. Furthermore, all text followed the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) checklist.
3. Results

Most research participants were female, 200 women (87.3%) and 29 men (12.7%). The mean age of the participants was 59 years (±11), and 51.5% were elderly. There were 212 participants (93.0%) with a family income of up to three minimum wages. Besides the diagnosis of DM2, 66.8% of the group stated that they had hypertension. This information can be seen in table 1.

Table 2 shows the data regarding the anthropometric variables. The data are not broken down by gender due to the low number of men in the study. A high prevalence of overweight (overweight and obesity) was observed, reaching 70.7% of the group. WC was also high in 69% of the individuals.

The average Body Mass Index (BMI) of the male population was 28.3kg/m² (±4.2), and the average for the female population was 30.5kg/m² (±5.7). The mean waist circumference of the male participants was 96.4cm (±10.5), and that of the female participants was 96.8cm (±12.2).

To rank the EDIP-SP, the sample was divided into quartiles, the first three with 57 participants and the last with 58 participants. The mean EDIP-SP was -2.83. Information related to EDIP-SP can be seen in table 3.

The consumption of the pro-inflammatory component, as processed meats, of the EDIP-SP was low, implying anti-inflammatory diets, considering all quartiles.

Table 4 shows the correlation test results between EDIP-SP and anthropometric indicators. There was no correlation.
4. Discussion

Studies state that a potentially inflammatory diet is associated with the Development of an unhealthy phenotype, such as overweight and obesity and insulin resistance, creating a favorable environment for the appearance and Development of DM2 [14,20-22]. Despite this, the present study found no significant correlation between the inflammatory dietary pattern of the DM2-affected population and their nutritional status. This may be due to the cross-sectional design of the study. It may also be since all diets were anti-inflammatory, although to a greater or lesser extent, and the a high proportion of overweight and high WC in the study participants.

Indeed, some longitudinal studies performed with inflammatory indices in the diet prove that individuals belonging to the more pro-inflammatory quintiles have greater chances of developing and evolving DM2 when compared to individuals in the more anti-inflammatory quintiles and, as is known, overweight and obesity, with the consequent insulin dysregulation, are risk factors for the Development of DM2 [23,24].

A study with a similar design to this one, but using the Dietary Inflammatory Index proposed by Shivappa et al. [10], sought to investigate the inflammatory potential of diet in 723 patients with DM2. The authors found no correlation between the anthropometric measurements and the categories of the index, a result that may reinforce the absence of correlation due to the studies' cross-sectional design the studies [25].

Again, using the dietary inflammatory index, a systematic review and meta-analysis were performed to associate the risk of cardiometabolic diseases and their risk factors with the inflammatory potential of the diet. This study found significant associations between the index score and hyperglycemia, but no associations were found with other risk factors for metabolic syndromes, such as abdominal obesity [26].
In a study with more than 70,000 postmenopausal women, two indexes were used to predict the risk for developing DM2: the Empirical Dietary Index for Hyperinsulinemia (EDIH) and the Empirical Dietary Inflammatory Index (EDII). In both indices, the more pro-inflammatory diets showed higher risks for developing DM2; when associated with BMI, they showed only a tiny correlation [27].

O EDIP-SP, an index validated in Brazil [11], uses only three food groups, including far fewer components than an index widely used worldwide, the dietary inflammatory index developed by Shivappa et al [10]. These authors use 45 components, considering foods, nutrients, and non-nutrients. The original index used to validate the EDIP-SP, the Empirical Dietary Inflammatory Index (EDII), also has more components, with 18 food groups, nine pro-inflammatory and nine anti-inflammatory [17]. It is worth noting that the validation of the EDIP-SP is recent, having been little used so far, which does not allow us to detect whether the small number of food groups that comprise it may influence findings.

The EDIP-SP was developed from the analysis of 21 food groups' contribution to plasma C-reactive protein concentrations. After applying linear regression models adjusted for factors such as sex, BMI, age, physical activity, and anti-inflammatory drugs, among others, the three food groups that showed significant correlation with C-reactive protein were found: rice and beans, fruits and vegetables, and processed meats [11]. Besides the correlation with C-reactive protein concentrations, foods or food groups positively associated with insulin resistance, such as processed meats. Conversely, some foods are negatively associated with insulin resistance, such as green leafy vegetables [28].

Processed meats are strongly associated with T2DM because, besides their natural pro-inflammatory potential, it has been seen that the high intake of this food group significantly increases the risk of developing the disease [29]. The study population's low consumption of processed meats
significantly contributed to the participants' anti-inflammatory diets. In a meta-analysis conducted in 2017, it was seen that some food groups have an inverse relationship with DM2, among them being the group of vegetables, fruits, and legumes [30]. These are considered in the EDIP-SP and contributed to the values found here, showing that, under this aspect, patients are protected against worsening disease.

An aspect that can be a paradox is the one related to the intake of rice and beans. These two foods are the group with the highest anti-inflammatory weight in the EDIP-SP calculation, but concerning DM2, it is recommended to be careful not to overconsume these two foods, considering their energy value and carbohydrate content. These foods can significantly increase the meal's glycemic load and, consequently, the individual's glycemic response of the individual [31]. The same paradox may apply to fruit intake; a component evaluated together with vegetables. Fruit in excess may also unbalance the glycemic control of the person with DM2.

Thus, in the case of the individual with type 2 diabetes mellitus, it is essential to consider an anti-inflammatory diet that does not contribute to an imbalance in calorie and carbohydrate intake. In this perspective, guidance should be aimed at achieving an anti-inflammatory diet at the expense of a balance in the intake of fruits, rice, and beans.

The study highlights gaps in knowledge regarding the interactions between EDIP-SP, nutritional guidelines for DM2, and metabolic control of those affected by this disease.

5. Conclusion

The diet of patients in this study is anti-inflammatory, according to the EDIP-SP. There was no correlation between diet and anthropometric markers BMI and WC.
The study highlights the need to evaluate the diet of this type of patient by combining the EDIP-SP calculation with the nutritional guidelines for type 2 diabetes mellitus.
References


Table 1 – Distribution of participants with type 2 diabetes mellitus studied (n=229), according to demographic, socioeconomic variables, and comorbidities. Fortaleza, 2023.

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (Years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 60</td>
<td>111</td>
<td>48.5</td>
</tr>
<tr>
<td>≥ 60</td>
<td>118</td>
<td>51.5</td>
</tr>
<tr>
<td><strong>Years Studied</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 8</td>
<td>136</td>
<td>59.4</td>
</tr>
<tr>
<td>9 – 11</td>
<td>43</td>
<td>18.8</td>
</tr>
<tr>
<td>≥ 12</td>
<td>50</td>
<td>21.8</td>
</tr>
<tr>
<td><strong>Family Income (MW)</strong></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&lt; 1</td>
<td>66</td>
<td>28.9</td>
</tr>
<tr>
<td>1 – 2</td>
<td>146</td>
<td>64.0</td>
</tr>
<tr>
<td>≥ 3</td>
<td>16</td>
<td>7.1</td>
</tr>
<tr>
<td><strong>Marital Status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>106</td>
<td>46.3</td>
</tr>
<tr>
<td>Not Married</td>
<td>123</td>
<td>53.7</td>
</tr>
<tr>
<td><strong>Comorbidities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAH</td>
<td>153</td>
<td>66.8</td>
</tr>
</tbody>
</table>

*MW = Minimum Wage. The MW in effect at the time was R$998.00. There was one participant who did not inform family income. **SAH = Systemic Arterial Hypertension. Source: Authors.

Table 2 – Anthropometric characterization of participants with type 2 diabetes mellitus studied (n = 229). Fortaleza, 2023.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Regional Executive Secretariats (RES)</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMI</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td></td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>9 (4.0)</td>
</tr>
<tr>
<td>Eutrophic</td>
<td></td>
<td>6</td>
<td>16</td>
<td>8</td>
<td>14</td>
<td>11</td>
<td>3</td>
<td>58 (25.3)</td>
</tr>
<tr>
<td>Overweight</td>
<td></td>
<td>6</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>10</td>
<td>6</td>
<td>58 (25.3)</td>
</tr>
<tr>
<td>Obesity</td>
<td></td>
<td>20</td>
<td>16</td>
<td>14</td>
<td>21</td>
<td>16</td>
<td>17</td>
<td>104 (45.4)</td>
</tr>
<tr>
<td><strong>WC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td></td>
<td>7</td>
<td>13</td>
<td>16</td>
<td>18</td>
<td>14</td>
<td>3</td>
<td>71 (31.0)</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td>25</td>
<td>33</td>
<td>20</td>
<td>30</td>
<td>26</td>
<td>24</td>
<td>158 (69.0)</td>
</tr>
</tbody>
</table>

*BMI = Body Mass Index (Kg/m²); classification according to WHO¹⁸, if adults; and according to PAHO¹⁹, if elderly. **WC = Waist Circumference (cm); classification according to WHO¹⁸. Source: Authors.
Table 3 – Values of the Empirical Dietary Inflammatory Pattern (EDIP-SP)* and its components, in quartiles**, of the participants with type 2 diabetes mellitus studied (n = 229). Fortaleza, 2023.

<table>
<thead>
<tr>
<th>Components</th>
<th>Q1  (n = 57)</th>
<th>Q2  (n = 57)</th>
<th>Q3  (n = 57)</th>
<th>Q4  (n = 58)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice and Beans</td>
<td>-0.66</td>
<td>-1.05</td>
<td>-1.07</td>
<td>-2.08</td>
</tr>
<tr>
<td>Fruits and Vegetables</td>
<td>-0.71</td>
<td>-1.18</td>
<td>-1.83</td>
<td>-2.93</td>
</tr>
<tr>
<td>Processed Meat</td>
<td>0.05</td>
<td>0.06</td>
<td>0.04</td>
<td>0.06</td>
</tr>
<tr>
<td>EDIP-SP</td>
<td>-1.32</td>
<td>-2.16</td>
<td>-2.86</td>
<td>-4.94</td>
</tr>
</tbody>
</table>

*EDIP-SP (11); **Quartile (Q) 1 = more pro-inflammatory; Q4 = more anti-inflammatory.

Source: Authors.

Table 4 – Correlation Test between Empirical Dietary Inflammatory Pattern (EDIP-SP)* and its components and anthropometric variables of participants with type 2 diabetes studied (n=229). Fortaleza, 2023.

<table>
<thead>
<tr>
<th>Variables**</th>
<th>Components of EDIP-SP</th>
<th>EDIP-SP (Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rice and Beans</td>
<td>Fruits and Vegetables</td>
</tr>
<tr>
<td>BMI</td>
<td>-0.027</td>
<td>0.683</td>
</tr>
<tr>
<td>WC</td>
<td>-0.001</td>
<td>0.991</td>
</tr>
</tbody>
</table>

*EDIP-SP (11); **BMI = Body Mass Index (Kg/m²); WC = Waist Circumference (cm).

Source: Authors.