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Quality Index of the Diet of Patients with High Cardiovascular Risk: Clinical, Biochemical and Anthropometric Markers

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Abstract This study aims to evaluate the diet quality index revised (DQI-R) and the clinical, biochemical and anthropometric markers of patients with high cardiovascular risk. Food consumption, anthropometric, clinical and biochemical data were assessed. Thirty-four patients (60.8±10.2 years) participated in the study, 52.9% being male, with high blood pressure (94.1%), coronary artery disease (94.1%), dyslipidemia (82.4% %) and acute myocardial infarction (79.4%). The average DQI-R punctuation score was 62.7 points (95% CI: 58.9-66.6). The highest DQI-R values (≥p75) were associated with lower diastolic blood pressure and higher respiratory capacity ($p < 0.05$). There was a negative correlation between glycemia and adequacy of saturated fat intake ($r = -0.676$, $p = 0.001$) and between diastolic blood pressure and adequacy of "empty calories" intake ($r = -0.405$, $p = 0.026$). Positive correlation for respiratory capacity and total fruit intake ($r = 0.380$, $p = 0.038$) was observed. The diet quality index, due to lower ingestion of whole grains and fruits may be associated to clinical and biochemical outcomes in patients with high cardiovascular risk. These results indicate the relevance of nutritional interventions that could promote not only a healthy diet but also a better quality of life for these patients.

Keywords: *cardiovascular diseases, diet, nutritional assessment, eating habits*

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1. Introduction

Cardiovascular diseases (CVD) are those that affect the circulatory system, the blood vessels and the heart, with heart failure (HF) being one of the most common types, being associated with impairment in functional capacity, worsening of life quality and increasing of morbidity and mortality [1]. CVDs are registered as Non-Communicable Chronic Diseases (NCD), being the main causes of death in the world [2]. The cardiovascular mortality rate was 53.8% in 2014 and estimates indicate that in 2020 this number will increase, making it a disease of higher mortality and incapacitation [4]. CVDs are the main causes of death in Brazil, accounting for about 30% of all deaths recorded in the country [5].

There are some risk factors for CVDs, among which are the non-modifiable factors, such as heredity, age, race and sex, and modifiable ones such as arterial hypertension (AH), smoking, dyslipidemia (DLP), diabetes mellitus (DM), obesity, sedentary lifestyle, stress and eating habits [6,7,8]. Among the risk factors, it is possible to emphasize the role of inadequate diet, since high consumption of sodium, hydrogenated vegetable fats and saturated fatty acids is associated with a higher incidence of CVD and morbidity and mortality in individuals with established heart disease [6,7]. Thus, it is evident the importance of evaluating the quality of the diet among patients with the disease. Some tools have been developed for this purpose, but there are few reports evaluating the quality of diet for patients at high cardiovascular risk [8,9].

The diet quality index revised (DQI-R) was proposed in Brazil in 2011 [10] after adapting the American Healthy Eating Index 2005 (HEI-2005) [11], based on the recommendations of the 2006 Food Guide for the Brazilian Population. DQI-R has been used in studies aimed at the qualitative and global evaluation of food consumption, replacing research based on nutrient composition of foods [13].

Therefore, the objective of this study was to evaluate the quality of the diet of patients with high cardiovascular risk, as well as to associate the results with clinical, biochemical and anthropometric data.

2. Materials and Methods

2.1. Study Design and Population

This is a cross-sectional study carried out with a non-probabilistic sample of patients with high cardiovascular risk (they have established cardiovascular disease and related comorbidities, of both sexes, age above 18 and in outpatient follow-up). Data were collected between February 2013 and June 2015, at the Cardiovascular and Metabolic Rehabilitation Service of the Jenny de Andrade Faria Institute, Hospital das Clínicas, Federal University of Minas Gerais (HC-UFMG). Exclusion criteria were: incomplete or absent 24-hour reminders and absence of records of biochemical tests in the medical record. The study integrates the project "Effects of aerobic training and strength on quality of life and functional capacity of hypertensive individuals: a multidisciplinary approach" and was approved by the Ethics and Research Committee (COEP) of the Federal University of Minas Gerais (ETIC: number 16472713.0.0000.5449). The participants received and signed the free and informed consent form.

2.2. Study Variables

Data on sociodemographic data, comorbidities (DM, AH, DLP, acute myocardial infarction (AMI) and coronary artery disease) were obtained during the first nutritional consultation.

The anthropometric measures of weight, height, waist circumference (WC), tricipital skinfold (TSF) and arm circumference (AC) were also collected during the first nutritional consultation. Body mass index (BMI) was calculated as weight (kg) / height^2 (m^2) and arm muscle area (AMA) calculated using the following formula: AMA (cm^2) = [(AC- TSF x π)^2 / 4π], subtracting from the result the value of 6.5 cm² and 10.0 cm² for women and men, respectively, with ages equal to or greater than 18 [14]. The weight was measured in a Tanita® brand digital scale (model BF-680), with capacity of 150 kg and accuracy of 100 g. For height evaluation, a Caprice Sanny stadiometer was used, with millimetric precision. For measures of circumference, an inextensible tape measure with a length of 150 cm and an accuracy of 0.01 mm was used. The WC measurement (cm) was made in the smallest diameter between the last rib and the iliac crest. The circumference of the arm was measured at the midpoint between the acromion of the scapula and the ulna olecranon, with arms outstretched. The TSF thickness (mm) was obtained at the midpoint of the non-dominant arm (between the acromial process and the olecranon) with the arm stretched freely along the body. The skin folds were measured using an adipometer (Lange®) with a constant pressure of 10g/mm^2. The cut-off points established by the World Health Organization were used to classify BMI and WC [15,16], and for classification of AMA, the cut-off points proposed by Frisancho [17] were used.

The evaluation of food consumption was carried out through the application of two 24-hour Food Reminders (R24h), with a 14-day interval. The analyzes were carried out with the aid of Dietwin® Professional Nutrition software 2008.

The qualitative evaluation of the diet consumed was performed using the DQI-R proposed by Previdelli et al [10], an instrument that presents 12 components, analyzed in relation to the recommendations for healthy eating and grouped as follows: “total fruits”, “whole fruits”, “total vegetables”, “dark green and orange vegetables and legumes”, “total cereals”, “whole grains”, “milk and dairy products”, “meat, eggs and legumes”, “oils”, “saturated fat and “solid fat, alcohol and added sugar”. The latter is composed of foods considered as a source of “empty calories”, because they present high energy density and low nutrient supply [18].

Each component of the DQI-R is scored at 0, 5, 10 or 20 points, with the intermediate values being calculated as the food or nutrients are consumed. The maximum score to be obtained with DQI-R is 100 points, and the higher the score, the better the individual's diet quality[10]. In the present study, each component had its mean calculated and the percentage was calculated in relation to the maximum score of the same.

The results of the clinical exams - systolic and diastolic blood pressure (AP); of respiratory capacity measured in consumed VO_2 and heart rate (HR); and biochemical tests - glycemia, total cholesterol, HDL and LDL, were collected directly from the medical records of patients with authorization from the Medical File Service (SAME-HC), process no. 20/15.

2.3. Statistical Analysis

Descriptive analysis was performed, including frequency distributions for categorical variables and measures of central tendency and dispersion for continuous variables. A linear regression model was used for each of the anthropometric and clinical variables, as an outcome. In all models there was adjustment by age and gender and the explanatory variable was the DQI-R categorized (0: DQI-R <p75 and 1: DQI-R ≥p75). The partial correlation test, adjusted for age and sex, was performed in order to verify the relationship between the anthropometric and clinical variables of the patients and each component of the DQI-R. The data were analyzed with the aid of the Statistical Package for the Social Sciences (SPSS), version 19.0. For all analyzes, a significance level of 5% ($p < 0.05$) was adopted.

3. Results

The sample consisted of 34 patients (52.9% male) with a mean age of 60.8 ± 10.16 years (Table 1).

AH and coronary artery disease (CAD) were the most frequent (both 94.1%), followed by DLP (82.4%), AMI (79.4%) and DM (38.2%). Regarding the nutritional status, 88.2% of the patients were overweight and 79.4% were classified as having a high or very high risk for the development of cardiovascular and metabolic diseases associated with obesity, according to the results of WC measurement.

The evaluation of the quality of the diet showed that the patients had a mean DQI-R score of 62.7 points (95% CI: 58.9-66.6). When the DQI-R items were evaluated separately, there was a lower score for "whole grains" and "whole fruits" with averages of 0.8 and 1.6 points, respectively, with a percentage of the maximum score of

16% and 32%, respectively. The highest score was found for "oils" and "empty calories" with averages of 9.2 and 11.9 points, respectively, with a percentage of the maximum score of 92% and 59.5%, respectively, low quality of the diet (Table 2).

Table 1. Anthropometric characteristics and comorbidities of the study population.

Variables	n	%
Sex		
Male	18	52.9
Female	16	47.1
Age Range		
Adults	16	47.1
Elderly	18	52.9
Comorbidities:		
Hypertension	32	94.1
CAD	32	94.1
Dyslipidemia	22	82.4
AMI	27	79.4
Diabetes	13	38.2
Body mass index (classification)		
Eutrophic	4	11.8
Overweight	15	44.1
Obesity	15	44.1
Waist circumference (classification)		
Normal	7	20.6
High/very high	27	79.4
Arm muscle area (classification)		
Low deficit level of muscle mass	4	11.8
Normal Muscle Mass	18	52.9
Increased Muscle Mass	12	35.3

CAD: Coronary Artery Disease; AMI: Acute Myocardial Infarction.

Table 2. Average score of the components of the diet quality index revised (DQI-R) (n = 34)

Components	Maximum score	Mean (CI95%)	%
Total Fruits	5	3,6 (3,1-4,1)	72,0
Whole Fruits	5	1,6 (1,2-2,1)	32,0
Total vegetables	5	4,2 (3,8-4,6)	84,0
Dark green and orange vegetables and legumes	5	2,7 (2,1-3,3)	54,0
Total cereal	5	4,7 (4,5-4,9)	94,0
Whole grain cereal	5	0,8 (0,4-1,2)	16,0
Milk and dairy products	10	3,9 (2,9-4,9)	39,0
Meat, eggs and legumes	10	8,0 (7,2-8,9)	80,0
Oil	10	9,2 (8,9-9,6)	92,0
Saturated fat	10	9,0 (8,2-9,7)	90,0
Sodium	10	2,7 (1,5-3,8)	27,0
Calories from solid fats, alcohol and added sugar	20	11,9 (9,7-14,1)	59,5
DQI-R total	100	62,7 (58,9-66,6)	-

CI95%: 95% confidence interval.

It was found that there was an association between DQI-R, diastolic pressure and respiratory capacity. The high DQI-R (≥p75) reduced on average 9.4 mm of mercury (mmHg) of diastolic pressure ($p = 0.044$) and increased on average 7.9 liters of oxygen consumed per minute ($p = 0.016$), improving respiratory capacity. No associations were identified between the DQI-R and the other clinical and anthropometric variables ($p>0.05$) (Table 3).

Table 3. Linear regression coefficient for associations between variables.

Variables	DQI-R** <p75	DQI-R** ≥p75	β (EP)	Valor p**
BMI (kg/m^2)	30,2 (3,6)	29,9 (6,9)	-0,17 (2,0)	0,936
WC (cm)	96,4 (9,6)	100,0 (16,2)	-0,6 (4,8)	0,900
TSF (mm)	22,7 (7,1)	21,5 (10,6)	3,2 (3,0)	0,308
AC (cm)	33,8 (3,7)	35,6 (4,6)	1,6 (1,8)	0,360
AMA	49,0 (18,4)	58,3 (17,8)	4,6 (8,1)	0,572
BP systolic (mm Hg)	118,8 (9,7)	125,0 (10,4)	8,3 (5,1)	0,117
BP diastolic (mm Hg)	68,6 (8,8)	61,6 (4,0)	-9,4 (4,4)	0,044
VO_2 maximum (liters/minute)	16,2 (5,1)	23,2 (7,5)	7,9 (3,1)	0,016
RR	116,5 (18,6)	135,6 (25,8)	5,3 (9,9)	0,599
Blood Glucose (mg/dL)	128,5 (64,8)	102,8 (24,3)	-30,9 (34,1)	0,375
Cholesterol (mg/dL)	173,7 (33,6)	152,1 (31,0)	7,0 (18,5)	0,709
HDL (mg/dL)	52,5 (34,3)	21,5 (8,7)	-17,4 (12,3)	0,173
LDL (mg/dL)	93,6 (24,0)	81,3 (42,7)	5,2 (0,7)	0,761

BMI: Body Mass Index; WC Waist Circumference; TSF: Tricipital Skinfold; AC: Arm Circumference; AMA: Arm Muscle Area; BP: Blood Pressure, VO_2: Oxygen Volume; RR: Respiratory Rate; HDL: High Density Lipoprotein; LDL: Low Density Lipoprotein.
* Average (standard error).
** Percentile 75 of DQI-R: 71.5 points.
*** Linear regression having as explanatory variable the Diet Quality Index Revised (≥p75) and as a dependent variable the anthropometric / clinical marking. Each model was adjusted by sex and age.

When analyzing the relationship between the components of DQI-R with the clinical and anthropometric variables of the patients, adjusted for sex and age, it was observed that there was an inverse correlation between glycemia and adequacy of saturated fat consumption ($r = -0.676$, $p = 0.001$), and between diastolic pressure and adequacy of calorie intake from the item "empty calories" ($r = -0.405$, $p = 0.026$). There was also a direct correlation between respiratory capacity and total fruit intake ($r = 0.380$ $p = 0.038$) (Table 3).

4. Discussion

The nutritional profile of the participants in this study was characterized by high frequency of overweight, increased body adiposity and accumulation of fat in the abdominal region, as well as high frequency of AH, CAD, DLP and DM. These findings corroborate data from the literature demonstrating that these comorbidities are highly prevalent in patients at high cardiovascular risk [19].

Adequate diet has been recognized as an important component in the treatment and prevention of CVD, being associated with increased survival and reduction of morbidity and mortality [8]. Improvement in diet quality, characterized by a reduction in the consumption of sodium, cholesterol and saturated fatty acids, as well as increased intake of fruits, vegetables and grains, is associated with a lower risk of recurrent cardiovascular events among individuals with cardiovascular disease or diabetes mellitus, reflecting that inadequate dietary quality may be considered a marker of risk [20]. Among Chinese adults, fruit consumption was inversely associated with lower blood pressure and blood glucose levels, consequently reducing the risk of cardiovascular events in the subjects evaluated [21].

The risk of CVD, characterized by beneficial changes in the lipid profile, was reduced in postmenopausal women after 12 weeks of consumption of Mediterranean diet (rich in vegetables and fruits, whole grains, olive oil and fish, low in simple sugars and saturated fats and rich in monounsaturated fat, omega 3 fatty acids and dietary fiber) [22]. Other authors also observed that consumption of the Mediterranean diet, compared to consumption of a low-fat diet, was beneficial in reducing the incidence of cardiovascular events in coronary patients after seven years [23].

In the present study, the mean quality score of the evaluated diet was 62.7 points (95% CI: 58.9-66.6), which is considered as a diet that requires modification, according to the present classification in a study carried out by *Horta & Santos* [13], in which the authors considered as an adequate diet the one with DQI-R values above 80 points. Most of the studies that evaluated the quality of the diet found DQI-R values between 50 and 70 points, showing the need to change eating habits, mainly in the components “sodium”, “whole grains”, “whole fruits”, “empty calories” and “milk and dairy products”. A population-based cross-sectional study with a sample of 1,509 elderly people in Campinas, found a score of 62.4 [24], while the study by Horta & Santos [13], conducted in Belo Horizonte with 144 users of the City Gym (Academia da Cidade) who were overweight, showed a score of 57.2. Mendes et al [25] found a score of 62.1 and 67.1 points in a study with adults and elderly, respectively.

The low intake of cereals and fruits was evidenced in the participants of the present study, as well as associations of the DQI-R score with some clinical outcomes. A similar result was observed by Dehghan et al [20], who evaluated 31,546 people over 55 years of age diagnosed with CVD or with DM. The authors found a lower risk of cardiovascular events (death, myocardial infarction, stroke or congestive heart failure) in subjects who presented higher consumption of vegetables, fruits, soy protein and alcohol, and increased risk associated with higher consumption of meat, poultry and eggs. Horta & Santos [13] found lower adequacy for intakes of sodium, whole grains, empty calories and milk and dairy products and better quality of diet among users of the Belo Horizonte City Gym (Academia da Cidade) with hypertension and in use of medicines. These findings indicate the need for effective strategies of nutritional intervention in this population, in order to increase mainly the consumption of fruits, vegetables and whole grains [13,20].

Hilgenberg et al [8] observed a high intake of saturated fats and cholesterol and inadequate fiber intake in 166 cadets of the Brazilian Air Force Academy with a high prevalence of cardiovascular risk factors. Similar results were found in the Brazilian population, where the prevalence of inadequate intake of simple sugars, saturated fats and fiber was 50%, 80% and 60%, respectively, for men and 53%, 84%, 61 % respectively, for women, in the age group 60 years or more [26].

The findings of the present study denote the inverse relationship between the adequacy of "empty calories" intake and diastolic blood pressure, which are in line with evidence in the literature, showing the influence of high consumption of fats, refined carbohydrates and salt and sedentary lifestyle in the onset of hypertension [27].

It was observed in the present study, a relationship between adequacy of fruit intake and increase of respiratory capacity, reflecting in the improvement of the physical fitness of the participants. The study by Eriksson et al [28] showed that the physical activity intervention and dietary counseling increases respiratory capacity and reduces cardiovascular risk in men and women with hypertension, dyslipidemia, type 2 diabetes or obesity.

It was also identified in the present study that the greater adequacy in the consumption of saturated fatty acids was associated with lower glycemic values. Saturated fatty acids stimulate increased secretion of insulin to maintain postprandial glucose homeostasis, which may lead to insensitivity to insulin action and consequently hyperglycemia [29], and are detrimental to cardiovascular health. Evidence has shown that the adoption of strategies for the consumption of monounsaturated fatty acids in substitution for saturated fatty acids may provide cardiovascular benefits for high-risk individuals by improving insulin action and glycemic control [30].

This paper has potential limitations. First, the reduced number of the sample may not adequately represent the study population. In addition, no adjustment techniques were used to guarantee less intrapersonal variability in the R24h collected. As a potential of the study, DQI-R is used to evaluate food consumption, since this instrument provides the overall quality of the diet already considering the influence of all the food groups, and few authors have used this method, specifically for patients with cardiovascular diseases.

5. Conclusion

The present study evidenced inadequacies in the diet quality of patients at cardiovascular risk, especially for the cereals and fruits. The higher quality score of the diet as well as of some of its components is associated with better clinical and biochemical outcomes, which indicates the relevance of the use of DQI-R score for nutritional evaluation of the patients, emphasizing the importance of effective interventions to promote better quality of the diet, helping in the treatment and promoting better quality of life.

Statement of Competing Interests

The authors have no competing interests.

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