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ORIGINAL ARTICLE

Better Adequacy of Food Intake According to Dietary Recommendations of National Cholesterol Education Program in Vegetarian Compared to Omnivorous Men

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Abstract

Background: The lower frequency of cardiovascular (CV) risk factors observed in vegetarians compared to omnivores may be due to more appropriate nutrient intake according to recommendations for the prevention of cardiovascular diseases.

Objective: To compare the dietary adequacy according to the recommendations of the National Cholesterol Education Program (NCEP) in apparently healthy vegetarian (VEG) and omnivorous (OMN) men.

Methods: This was a cross-sectional study, conducted with apparently healthy men (44 omnivorous and 44 vegetarians, ≥ 35 years), who were assessed for daily food consumption, anthropometric data, physical exercise status, and clinical data. Multiple logistic regression was used to test the association between the type of diet and the dietary adequacy. Significant values were considered for $p<0.05$.

Results: Several clinical CV risk markers were significantly lower in VEG when compared to OMN: body mass index (BMI) (23.1 vs. 27.3 kg/m2), systolic blood pressure (119.5 vs. 129.2 mmHg), and diastolic blood pressure (75.7 vs. 83.9 mmHg). VEG presented significant lower values of blood lipids and glucose. No significant difference was observed in caloric intake; however, VEG consumed significantly more carbohydrates, dietary fibers, and polyunsaturated fats. VEG presented an adequate consumption of dietary cholesterol and saturated and polyunsaturated fatty acids, regardless of caloric intake and age.

Conclusion: VEG were more likely to consume saturated fatty acids, dietary cholesterol, and fibers according to the recommendations of NCEP, factors that may contribute to lower levels of CV risk markers than OMN.

Keywords: Cardiovascular diseases; Life Style; Lipids; Risk factors; Vegetarian Diet.

Introduction

Over the past fifty years, there has been a boom in the production of research about vegetarianism,[1] not only related to its impacts on health, but also on other biological processes[2] and the environment, even suggesting that it may well represent a better alternative in order to preserve natural resources for our planet.[3,4] The number of people consuming a vegetarian (VEG) or a plant-based diet is increasing and this is clearly associated with lower prevalence of risk factors for cardiovascular diseases (CVD).[5-8] VEG subjects consume smaller amounts of total fat, saturated fat, and cholesterol, as well as larger amounts of unsaturated fat and fiber than omnivorous (OMN) individuals.[9,10]

There are dietary recommendations regarding the amounts of energy, macronutrients, and micronutrients that should be taken daily to prevent the development of CVD or prevent the worsening of their risk factors. One of the most well-known recommendations for the prevention of CVD is the National Cholesterol Education Program (NCEP).[11]

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The NCEP recommends that the energy intake should be enough to maintain a desirable weight and suggests that the macronutrients should be consumed according to a specific percentage of the daily energy intake, together with the daily amount of dietary cholesterol and dietary fiber. In addition, recommendations include staying physically active and drinking alcoholic beverages in moderation.[11]

The lower frequency of CV risk factors observed in VEG individuals compared to OMN individuals may be due to more appropriate nutrient intake according to the recommendations for CVD prevention, such as the NCEP. However, no studies documented in the literature have made this comparison.

One recent intervention study showed the higher effectiveness of a VEG diet in promoting a reduction in low density lipoprotein cholesterol (LDL-c) levels, while the Mediterranean diet was more effective in promoting a reduction in triglycerides,[12] increasing the need for investigations to better understand the relationship between different dietary patterns and CV risk factors

Therefore, the present study sought to compare dietary adequacy, according to NCEP recommendations, in apparently healthy VEG and OMN men. It was hypothized that VEG individuals would present a more adequate food intake according CV health recommendations.

Methods

Subjects

The present study's sample consists of healthy men participants from the Carotid Atherosclerosis and Arterial Stiffness in Vegetarians and Omnivorous Subjects (CARVOS) study.[13] Initially 745 adult volunteers were recruited in Sao Paulo through social activities and the Internet. The participants filled out questionnaires regarding past medical history, family history, dietary preferences, and personal data. Exclusion criteria were: 1) being female, 2) history of diabetes, 3) history of dyslipidemia, 4) history of cardiovascular or cerebrovascular diseases, 5) history of hypertension or intake of antihypertensive medication, and 6) smoking. All individuals who declared themselves to be "smokers" or "occasional smokers" in the interview or quit smoking for <1 months prior to the interview were considered smokers. Healthy participants ≥35 years were divided into 2 groups – VEG and OMN – according to their dietary patterns. VEG men were defined as having exclusive consumption of a vegetarian diet devoid of meat, fish, and poultry for at least 4 years, who could be lacto-ovo-vegetarians (consuming egg, milk, and dairy products), lacto-vegetarians (consuming milk and dairy products), or vegans (consuming no eggs or milk and dairy products). OMN men were considered those who consume at least five or more servings of any type of meat per week.

During the period of June 2013 to January 2014, after applying inclusion and exclusion criteria, 88 apparently healthy men were enrolled in the study (44 VEG and 44 OMN). All participants provided informed consent to participate in the study. The study protocol was approved by the research committee and the institutional review board of the Heart Institute (InCor), School of Medicine, University of Sao Paulo (logged under protocol number 35704). The sample of 44 participants from each category was a probabilistic calculation taken from the previously described CARVOS study.[13] The reason to choose the male sex was due to a higher prevalence of CVD development in men as compared to women.[14]

Dietary and clinical assessment

All 88 subjects were screened for health status by means of questionnaires concerning past medical history, dietary preferences and personal data, such as smoking status, alcohol consumption, education level, and physical exercise status. Subjects were interviewed and the average of two 24 h dietary recalls (one on weekdays and one on weekends) were used to estimate daily consumption of different nutrients.

The Multiple-Pass Method (MPM) as applied to structure the collection of 24-hour recall in stages or successive steps. In addition, to standardize data collection, the main advantages in the use of MPM include a detailed description of the food, the method of preparation, and the quantification of consumed items, all of which contribute to increased reliability of dietary measure.[15,16]

A database for Brazilian food composition was used to calculate the daily energy and nutrient intake.[17]

Dietary intake of VEG and OMN was evaluated according to adequacy as regards the recommended percentage of carbohydrates, proteins, lipids, and grams of fibers for the prevention of CVDs.[11] Although the NCEP[11] recommended protein intake is approximately

15% of total calories, allowing individuals to distribute these among the categories of consumption, the percentage of adequate daily intake of protein was considered to be from 12 to 18% in order to enable category analysis.

Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured twice in the right arm after 10 min rest in a supine position using a calibrated and averaged digital sphygmomanometer.

Anthropometric evaluation

To measure the weight[18] and height,[19] the previously described method was used. The body mass index (BMI) was calculated by dividing body weight (kg) by the square of height (m).

For waist circumference (WC), the measurement was made at the midpoint between the last rib and the iliac crest, with the abdomen relaxed, at the end of expiration,[20] and the hip circumference (HC) at the gluteal maximum extension.[18]

All measures were performed in triplicate, and the mean value was used for analysis.

Biochemical analysis

After fasting for 10–12 hours overnight, participants had blood samples drawn from the antecubital vein. Serum lipids, including triglycerides (TG), total cholesterol (TC), and high-density lipoprotein cholesterol (HDL-c) were assayed by enzymatic methods, using an automatic multichannel chemical analyzer (Siemens Healthcare, Newark, USA) in the Central Laboratory of the Heart Institute the University of Sao Paulo (USP). LDL-c was calculated by the Friedewald formula.[21]

Glycosylated hemoglobin (HbA1c) was determined by the immunoturbidimetric method, certified by the National Glycohemoglobin Standardization Program (NGSP), using the Flex kit (Siemens Healthcare, Newark, USA). For homocysteine, Apo lipoprotein b (Apo b), and fasting glucose measurements, blood samples were centrifuged at 3000 rpm for 15 minutes within 60 minutes of collection and stored at −70°C until analysis. Fasting serum glucose (FSG) was determined by the glucose oxidase method using a Dimension RXL (Siemens healthcare, Newark, USA) through standard laboratory techniques. Quality control assessment was performed daily for all determinations.

Subclinical carotid vascular disease and arterial stiffness

The arterial stiffening, evaluated as carotid-femoral pulse wave velocity (PWV), functional and structural properties of carotid arteries, measured as carotid intima-media thickness (c-IMT) and carotid relative distensibility were measured as previously described.[13]

Physical Activity

Subjects reported activity levels using the International Physical Activity Questionnaire-Short Form (IPAQ),[22] which measures leisure time, as well as domestic, work-related, and transport-related physical activities. Four domains were measured: sitting, walking, moderate-intensive activities, and vigorous-intensive activity over the last seven days.

For analysis, the follow categorization was considered: physically active (≥ 20 minutes/session of vigorous activities ≥ 3 days/week; and/or ≥ 30 minutes/session of moderate activities or hiking ≥ 5 days/week; and/or ≥ 150 minutes/week of any additional activities – vigorous or moderate or walking), and irregularly active (<150 minutes/week of any of the additional activities – vigorous or moderate or walking).[23]

Statistical Analysis

The normality of data distribution was tested by the Kolmogorov-Smirnov test. Data were presented as means ± standard deviation (SD). The unpaired Student's t-test was used to test differences for numerical variables. The Chi-squared (X^2) was used to compare categorical variables between groups.

The variables presented categorically in this study were the nutrients in the order shown below, within and above that recommended by the NCEP: carbohydrate (< 50%, 50-60% and > 60% of total calories); dietary Fibers (< 20 g, 20-30 g, > 30 g per day); protein (< 12%, 12-18%, and > 18% of total calories); total fat (< 25%, 25-35%, and > 35% of total calories); saturated fatty acids (< 7% and ≥ 7% of total calories); dietary cholesterol (< 200 mg and ≥ 200 mg per day), and plant stanols (< 2 g and ≥ 2 g per day).

The NCEP recommendations were chosen as a reference for this work, as it is a traditional reference that supports several guidelines for cardiovascular prevention in countries on all continents.

To test the association between the type of diet (VEG or OMN) and the dietary adequacy according to NCEP recommendations, multiple logistic regression was used.

The measure of the magnitude of effect was measured by the values of OR (odds ratio) and respective 95% confidence interval (95% CI). The initial procedure followed a univariate analysis, while variables with p<0.20 were included in the multiple regression. The variables of caloric intake and age were maintained for the adjustment of the multiple models, regardless of the level of significance.

Since all individuals consumed ≤ 20% of the total calories from monounsaturated fatty acids and ≤ 10% of the total calories from polyunsaturated fatty acids, it was not possible to carry out the logistical regression for these nutrients.

Significant values were considered for $p < 0.05$, and all analyses were performed using Stata 10.0.

Results

No difference was found between the VEG and OMN ages. VEG presented significantly lower values of BMI, WC, WC/HC ratio, SBP, DBP, TC, TC/HDL-c ratio, LDL-c, non HDL-c, TG, Apo B, FSG, HbA1c, PWV, c-IMT, and carotid distensability (table 1).

Considering the practice of physical activity assessed by IPAQ, the number of VEG classified as physically active (n=36, 81.8%) was significantly greater when compared to 25 OMN (56.8%) (p=0.011).

The table 2 shows the VEG and OMN macronutrient intakes. Although no significant difference was observed between the caloric intakes, VEG consumed significantly more carbohydrates, dietary fibers, polyunsaturated fats,

Table 1 – Anthropometric, clinical, and biochemical characteristics of apparently healthy vegetarians and omnivorous men

	Vegetarians (*n* = 44)	Omnivorous (*n* = 44)	p-value
Age	45.5 ± 7.8	46.8 ± 9.6	0.23
BMI (kg/m^2)	23.1 ± 2.9	27.2 ± 4.8	<0.001
WC	84.9 ± 7.71	95.7 ± 13.8	<0.001
WC/HC ratio	0.87 ± 0.1	0.92 ± 0.1	<0.001
SBP (mmHg)	119.5 ± 10.4	129.2 ± 15.1	<0.001
DBP (mmHg)	75.2 ± 8.6	83.9 ± 10.4	<0.001
TC (mg/dl)	180.1 ± 40.5	202.7 ± 35.3	0.003
HDL-c (mg/dl)	47.6 ± 9.3	45.5 ± 11.6	0.17
TC/HDL-c ratio	4.0 ± 1.3	4.7 ± 1.3	0.005
LDL-c (mg/dl)	110 ± 33.2	128.5 ± 32.4	0.005
Non-HDL-c (mg/dl)	132.5 ± 43.2	157.3 ± 36.6	0.002
TG (mg/dl)	112.2 ± 72.2	143.9 ± 64	0.016
Apo B (mg/L)	0.88 ± 0.28	1.01 ± 0.26	0.009
FSG (mg/dl)	94.8 ± 7.2	102.9 ± 13.1	<0.001
HbA1c (%)	5.3 ± 0.3	5.5 ± 0.5	0.004
PWV (m/s)	7.1 ± 0.8	7.7 ± 0.9	<0.001
c-IMT (μm)	593 ± 94	661 ± 128	0.003
Carotid distensibility (%)	6.39 ± 1.7	5.72 ± 1.8	0.042
Higher physical activity (n, %)	36 (81.8%)	25 (56.8%)	0.011

Data are means ± SD. Significant values for p < 0.05.
Apo B: apolipoprotein B; BMI: body mass index; c-IMT: carotid intima-media thickness; DBP: diastolic blood pressure; FSG: fasting serum glucose; HbA1c: glycosylated hemoglobin; HC: hip circumference; HDL-c: high density lipoprotein cholesterol; LDL-c: low density lipoprotein cholesterol; Non-HDL-c: non high density lipoprotein cholesterol; PWV: pulse wave velocity; SBP: systolic blood pressure; TC: total cholesterol; TG: triglyceride; WC: waist circumference.

Table 2 – Mean intake of macronutrients by apparently healthy vegetarian and omnivore men

	Vegetarian (n=44)	Omnivorous (n=44)	p-value
Energy (Kcal)	2177.2 ± 559.6	2348.9 ± 736.5	0.111
Carbohydrate (g)	341.9 ± 104.4	301.4 ± 99.6	0.033
Carbohydrate (% of energy)	63.2 ± 11.6	51.9 ± 9.7	<0.001
Dietary fiber (g)	28.2 ± 15.9	17.9 ± 13.6	<0.001
Protein (g)	91.3 ± 44.2	112.8 ± 39.9	0.009
Protein (% of energy)	17.1 ± 7.8	19.5 ± 4.5	0.04
Total fat (g)	61.7 ± 29.1	77.4 ± 33.7	0.011
Total fat (% of energy)	24.8 ± 8.3	29.1 ± 7.2	0.006
Saturated fat (g)	10.5 ± 8.8	18.1 ± 10.9	<0.001
Saturated fat (% of energy)	4.4 ± 3.2	6.9 ± 2.9	<0.001
Monounsaturated fat (g)	10.8 ± 7.0	17.6 ± 9.5	<0.001
Mono-unsaturated fat (% of energy)	4.5 ± 2.4	6.8 ± 2.8	<0.001
Polyunsaturated fat (g)	9.5 ± 6.8	6.9 ± 4.1	0.015
Polyunsaturated fat (% of energy)	4.0 ± 2.7	2.7 ± 1.6	0.004
Dietary cholesterol (mg)	69.3 ± 224.8	258.1 ± 169.1	<0.001
Plant stanols (mg)	44.8 ± 40.5	26.6 ± 41.9	0.020

and plant stanols. Moreover, omnivores significantly ingested larger amounts of protein, total fat, saturated fat, monounsaturated fat, and dietary cholesterol.

Most OMN (40.9%) consumed the amount of carbohydrates recommended by the NCEP, while most of the VEG (59.1%) ingested carbohydrates above recommendation (p <0.001). Most of VEG ate the recommended amount of fiber (38.6%) and 36.4% consumed > 30 g of fiber per day, while 65.9% of OMN ingested fibers in a quantity below the recommended amount (p<0.001). Most VEG and OMN ingested protein above the recommended amount, but the percentage of OMN (43.2%) who ingested 12% to 18% of protein is higher when compared to VEG (34.1%) (Table 3).

Most VEG (47.7%) ingested total fat below the recommended level, while most OMN (59.1%) ingested lipids within the recommended percentage, but with no significant difference. Most VEG (77.3%) met the recommendation of the saturated fatty acids rating, while most OMN (52.3%) exceeded this amount. The same thing was found with dietary cholesterol intake, 95.4% of VEG ate < 200 mg per day and 56.8% of OMN ate ≥ 200 mg per day. All VEG and OMN consumed monounsaturated and polyunsaturated fatty acids within the recommendation.

Regarding plant stanols, most VEG and OMN consumed > 2 grams per day, with no difference between groups (Table 3), although the media consumption was statistically higher in the VEG group (Table 2).

To find what type of dietary pattern had a higher chance of meeting the recommendation of each of the macronutrients, it was observed that VEG were more likely to consume < 7% of saturated fatty acids, and < 200 mg of dietary cholesterol (Table 4).

The associations of VEG diet with proper saturated fatty acids (P= 0.030), and dietary cholesterol (P= <0.001) consumption, were maintained after adjustment for caloric intake and age as multiple regression models.

Discussion

This study gathered information on the food intake of apparently healthy vegetarian and omnivorous men, and even linked the consumption of these two groups with dietary recommendations for preventing CVD [11]. Although no significant difference was observed

Table 3 – Distribution of the adequacy of the diet of apparently healthy vegetarian and omnivorous men according to dietary recommendations for the prevention of CVDs

Nutrient	NCEP recommendation		Vegetarian (n=44)	Omnivorous (n=44)	p-value
Carbohydrate	50-60% of total calories	< 50 %	11.4	38.6	<0.001
		50-60 %	29.5	40.9	
		> 60 %	59.1	20.5	
Dietary Fibers	20-30 grams per day	< 20 g	25.0	65.9	<0.001
		20-30 g	38.6	25.0	
		> 30 g	36.4	9.1	
Protein	Aproximately 15% of total calories	< 12 %	27.3	2.3	0.004
		12-18 %	34.1	43.2	
		> 18 %	38.6	54.5	
Total fat	25-35% of total calories	< 25 %	47.7	25.0	0.086
		25-35 %	40.9	59.1	
		> 35 %	11.4	15.9	
Saturated fatty acids	< 7% of total calories	< 7 %	77.3	47.7	0.004
		≥ 7 %	22.7	52.3	
Dietary Cholesterol	< 200 mg per day	< 200 mg	95.4	43.2	<0.001
		≥ 200 mg	4.6	56.8	
Plant stanols	2 grams per day	< 2 g	4.6	15.9	0.079
		≥ 2 g	95.4	84.1	

** Unable to parse because all VEG and OMN be in the same category of consumer.*

between the caloric intakes, these groups differed in the consumption of nutrients, which may be responsible for the development of CV risk factors. A greater number of VEG were classified as physically active when compared to OMN, which may have influenced the maintenance of normal clinical and biochemical parameters, as well as the lowest BMI and WC values.

Vegetarians consumed significantly more carbohydrate and dietary fiber, which can mean that, despite the higher consumption of carbohydrate, most of the nutrient may be of a complex type, with a higher fiber content, rather than a simple carbohydrate. Most of VEG men consumed the recommended amount of fiber and 36.4% ate > 30 g of fiber per day [11], while the majority of OMN men had a fiber intake of below the recommended amount. The higher consumption of fiber by VEG men can also be due to their higher consumption of food groups that provide this nutrient, such as fruits and vegetables, which was already demonstrated in a previous study.[24] As the present study did not analyze the food groups consumed, we can only formulate a hypothesis on this issue.

Although VEG men ingested more carbohydrates than the recommended amount, they presented lower BMI and cardiovascular risk factors, which are among the potential benefits of fiber intake.[25] Elorinne et al. (2016) found a higher consumption of carbohydrates and fiber among vegetarians in a sample of Finnish individuals, between 18 and 50 years of age.[26]

This contradicts the recommendations that a diet with less carbohydrate could have a positive influence on one's lipid profile,[27] which was not shown in this sample.

Most VEG and OMN ingest protein above the recommendation, but the percentage of OMN who ingest 12% to 18% of protein is higher when compared to VEG. Schüpbach et al. (2015)[28] also observed a lower intake of protein consumed in vegetarian than in omnivorous

Table 4 – Univariate regression models of association between type of diet and adequacy to dietary recommendations in apparently healthy vegetarian and omnivorous men

	OR	95% CI	p-value
Carbohydrate (50-60%)			
Omnivores	1		
Vegetarians	0.61	0.25-1.47	0.266
Dietary Fiber (20-30 g)			
Omnivores	1		
Vegetarians	1.89	0.76-4.7	0.172
Protein (12-18%)			
Omnivores	1		
Vegetarians	0.68	0.29-1.61	0.382
Total Fat (25-35%)			
Omnivores	1		
Vegetarians	0.48	0.20-1.12	0.090
Saturated fatty acids (<7%)			
Omnivores	1		
Vegetarians	3.72	1.48-9.35	0.005
Dietary Cholesterol (< 200 mg)			
Omnivores	1		
Vegetarians	27.63	5.93-128.74	<0.001
Plant stanols (≥ 2g)			
Omnivores	1		
Vegetarians	3.97	0.78-20.32	0.098

OR: odds ratio; 95% CI: 95% confidence interval.

Swiss subjects. Furthermore, findings from Gilsing et al. (2013),[29] conducted with 1,150 self-reported vegetarians in the Netherlands Cohort Study, observed increased protein intake among VEG when compared to OMN men, which was due to a higher intake of vegetable protein. Among women, no difference was observed in the intake of total protein, but a significantly higher intake of vegetable protein and a lower intake of animal protein were observed.[29]

Most VEG ingested total fat below the recommended level, while most of the OMN ingested lipids within the recommended percentage, but with no significant difference. What is striking is that most VEG met the recommendation of saturated fatty acids rating and dietary cholesterol intake, while most of the OMN exceeded this level. This finding may well have contributed to the rise in LDL-c and ApoB observed in OMN (Table 1).

Both VEG and OMN consumed monounsaturated fat < 20% of total energy, but when evaluating grams of daily consumption, OMN consumed more monounsaturated fat. There is strong evidence that by replacing saturated fatty acids and carbohydrates with monounsaturated fatty acids, various cardiovascular risk factors will be significantly improved,[30] data that is contradictory to the lipid profile of this sample. The type of carbohydrate, rich in fibers, may well explain this. Many studies explain that an increased intake of fiber is associated with a reduced risk of CVD. One recently published systematic review and meta-analysis provided risk estimates for incident fatal events of CVD regarding total fiber intakes, while fiber sources confirmed the association between low dietary fiber consumption and an increased risk of CVD.[31]

NCEP recommendations do not include trans fatty acid intake, a limit proposed by other references to <1% of the total caloric value, and does not call for a minimum consumption of 5 to 10 grams of soluble fiber per day, as mentioned in the European Guidelines on Cardiovascular Disease Prevention in Clinical Practice,[32] recommending only the intake of 20-30 grams of total fiber per day.

Data similar to the present study were observed by Clarys et al. (2014)[33] in a Belgium sample of VEG and OMN. No differences were observed between total energy intakes, and protein and total fat intakes were significantly lower in VEG, while carbohydrate and fiber intakes were significantly higher in VEG.

In our previous study, the consumption of vegetables, fruits, and other vegetables was correlated with less CV risk factors.[34] Other studies demonstrated a greater variety in the diet of vegetarians, with the consumption of different plant foods, such as fruits and vegetables that have a high amount of antioxidants and compound bioactives, which may result in a beneficial health effect, since its antioxidant potential can help lower oxidation in plasma lipoproteins and lower occurrence of vascular injury.[35]

Tande et al. (2004)[36] observed, in a sample of 9,111 US adults, a positive association between meat and dairy intakes with increased LDL-c, whereas grain and fruit groups were associated with decreased TC and better HDL-c. The dietary pattern found in vegetarian groups is usually associated with an increased consumption of fruits, vegetables, and minimally processed vegetables.[37]

In 2015, Trepanowski and Varady conducted a literature review of available data and observed a greater efficiency of vegetarian diets in controlling glucose metabolism when compared to the application of the dietary recommendations of the American Diabetes Association (ADA) and in regulation of plasma lipoproteins than compared to the implementation of the National Cholesterol Education Program (NCEP) recommendations. The results of this study may suggest that it could be necessary to review the current dietary recommendations to prevent cardiovacular diseases.[38]

Studies seek to compare the food intake of omnivores with traditional dietary recommendations, often showing inadequacies.[39] However, the question that remains in the present study is: Is trying to adapt consumption to nutritional recommendations the best solution or does the adoption of specific dietary patterns, such as vegetarian, despite being outside of specific nutrient quantities, present a better association with cardiovascular health?

The Academy of Nutrition and Dietetics affirm that the low intake of saturated fat and high intake of vegetables, fruits, whole grains, soy products, nuts, and seeds (all rich in fiber and phytochemicals) are characteristics of vegetarian and vegan diets that produce lower total and low-density lipoprotein cholesterol levels and better serum glucose control. These factors contribute to a reduction in chronic diseases.[40]

One limitation of this study was its cross-sectional design, which does not verify causality between the type of diet and the development of cardiovascular risk factors. The was calculated in order to find differences between subclinical atherosclerosis markers, but this did not limit the significant associations observed in the present study. And finally the possible association between dietary intake and cardiovascular risk markers was not directly evaluated in the present study.

Despite this, if there was a representative sample of individuals following each type of vegetarian diet (ovo-lactovegetarian, lacto-vegetarian, and strict vegetarians), we could verify that the adequacy to the dietary recommendations behaves differently for each of these groups. Likewise, this heterogeneity of the vegetarian group may be responsible for the large confidence intervals observed in the analyses for some nutrients, such as dietary cholesterol, since a strict VEG diet is free of dietary cholesterol, and an egg-lactovegetarian can ingest amounts of dietary cholesterol similar to those of OMN individuals, depending on the frequency of consumption of food derived from eggs and dairy products.

This work was innovative in the sense that it compared the adequacy of dietary recommendations for preventing cardiovascular diseases, in the usual diet of apparently healthy VEG and OMN, while characterizing cardiovascular risk factors in both groups.

Conclusion

The present study showed that, despite the higher adequacy of the intake of carbohydrates and proteins by OMN, VEG were more likely to consume saturated fatty acids, dietary cholesterol, and fibers according to NCEP recommendations, regardless of caloric intake and age, factors that may contribute to lower levels of cardiovascular risk factors in VEG than in OMN.

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Author contributions

Conception and design of the research: Antoniazzi L, Acosta-Navarro J. Acquisition of data: Antoniazzi L, Oki AM, Bonfim MC. Analysis and interpretation of the data: Antoniazzi L, Acosta-Navarro J. Statistical analysis: Antoniazzi L. Writing of the manuscript: Antoniazzi L, Gaspar MCA, Oki AM, Bonfim MC. Critical revision of the manuscript for intellectual content: Acosta-Navarro J.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

This study is not associated with any thesis or dissertation work.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the CAPPesq under the protocol number 35704. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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