Journal of Nutrition & Food Sciences
ISSN: 2155-9600

Acosta-Navarro et al., J Nutr Food Sci 2016, 6:4
DOI: 10.4172/2155-9600.1000529

Research Article Open Access

Healthier Body Composition in Vegetarian Men Compared to Omnivorous Men

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Received date: June 05, 2016; **Accepted date:** June 27, 2016; **Published date:** July 01, 2016

Abstract

Background: Previous studies have shown associations between vegetarian (VEG) diet and a healthy lifestyle and the maintenance of adequate body composition evaluated by anthropometric parameters.

Objective: To analyze whether vegetarian men have higher rates of adequate nutritional status compared to omnivorous (OMN) men, evaluated by various methods.

Methods: In this observational study, from 745 individuals from São Paulo, we enrolled 44 OMN and 44 VEG apparently healthy men participants in the CARVOS Study were evaluated by two 24-h dietary recalls, body mass index (BMI), circumference measurements, waist-hip ratio (WHR), skinfolds, and by BIA.

Results: OMN men had the highest percentage of overweight/obesity based on BMI (70.4%, P=0.001), WHR (15.9%, P=0.026), waist circumference (50%, P=0.001), arm circumference (20.5%, P=0.001), tricipital skinfold (77.3%, P=0.008), % body fat by total of skinfolds (77.3%, P=0.001), and % body fat by BIA (47.7%, P=0.001). Multiple logistic regression showed that being OMN compared to being VEG significantly increased the risk of overweight/obesity (OR 12.12, CI 3.7 to 39.4); inadequate waist circumference (OR 8.39, CI 2.4 to 28.9); inadequate WHR (OR 9.85, CI 1.1 to 86.7); obesity by total of skinfolds (OR 6.2, CI 1.9 to 20.3), high % body fat by total of skinfolds (OR 8.93, CI 2.5 to 32.0) and by BIA (OR 5.7, IC 1.7-19.0).

Conclusion: Vegetarian men have higher rates of adequate nutrition and a lower prevalence of overweight according to BMI, excess abdominal fat, and excess body fat estimated by circumferences, skinfold measurement, and by BIA.

Keywords: Body composition; Vegetarian diet; Nutritional status; Omnivorous; BIA

Introduction

Vegetarian diets, when properly planned, like all diets, should promote proper growth and development and can be adopted during all phases of life [1]. Many studies have demonstrated the association between meat consumption and hypertension, risk of heart disease, metabolic disorders, and mortality [2-9] and the protective effect of a vegetarian (VEG) diet, associated with a healthy lifestyle and the maintenance of adequate body weight, offering some protection against these chronic diseases [9-11].

According to data from IBOPE (Institute of Public Opinion and Statistics), 8% of the population of major cities and metropolitan regions in Brazil declare themselves vegetarian. This percentage is higher among people 65-75 years of age (10%) and lowest among young people 20-24 years of age (7%) [12]. Studies have reported lower body mass index (BMI), overweight, and obesity in vegetarians compared to omnivores [13-19].

The World Health Organization (WHO) proposes anthropometry for evaluation of nutritional status as a method easy to apply, inexpensive, noninvasive, and may also be used to predict performance, health, and survival [20]. According to WHO, in addition to weight and height, BMI, skinfolds, and waist and hip circumferences should be measured to assess the deposition of fat mass [20].

Although the skinfold measurement is considered the most convenient way to indirectly estimate the percentage of body fat [21], bioelectrical impedance (BIA) is a method for assessing body composition, with good reproducibility in epidemiological studies and in clinical practice, and is characterized as a non-invasive, easy to use method [22].

Given the increased number of adherents to the practice of vegetarianism, the scientific interest in the influence of this practice on

Citation: Acosta-Navarro JC, Oki AM, de Gouveia LAG, Hong V, Bonfim MC, et al. (2016) Healthier Body Composition in Vegetarian Men Compared to Omnivorous Men. J Nutr Food Sci 6: 529. doi:10.4172/2155-9600.1000529

health, and the lack of studies assessing body composition by BIA, our objective was to analyze whether vegetarian men have higher rates of adequate nutritional status compared to omnivorous (OMN) men, evaluated by various methods.

Materials and Methods

Definition and selection of study populations

In this observational study, from January to September 2013, initially 745 adult volunteers were included in São Paulo through social activities and the Internet. The participants filled out questionnaires regarding past medical history, family history, dietary preferences, and personal data. For these subjects to fulfill the criteria of apparently healthy men, exclusion criteria were applied for people with any of the following conditions: 1) History of diabetes; 2) History of dyslipidemia; 3) History of cardiovascular or cerebrovascular diseases; 4) History of blood hypertension or intake of antihypertensive medication and 5) Smoking. All individuals who declared themselves to be "smokers" or "occasional smokers" at the interview or to have quit smoking for <1 month prior to the interview were considered smokers.

Healthy participants older than 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 void of meat, fish, and poultry for at least 4 years and these men could be lacto-ovo-vegetarians (LOVEG, consuming egg and milk), lacto-vegetarians (LVEG, consuming milk) or vegans (consuming no eggs or milk). Matched OMN men were considered those who consumed any type of meat at least five or more servings per week. During the period from June 2013 to December 2014, after applying inclusion and exclusion criteria, 88 apparently healthy men were enrolled in the study (44 vegetarians and 44 omnivores) who participated of final phase of CARVOS Study (Carotid Atherosclerosis, Stiffness Aortic and Risk Factors in Vegetarians and Omnivorous Subjects) were evaluated (Figure 1). We choose men older than 35 years because the CVD is more prevalent than women in this age. The number was a probabilistic sampling to find differences in the main variables of central research of CARVOS Study that means pulse wave velocity of aorta and intima-media thickness of carotid artery, and despite not having been calculated for the purpose of this study, has shown statistical differences between the studies variables, allowing to carry out these analyzes. All participants provided informed consent to participate in the study. The research committee and the institutional review board of the School of Medicine of São Paulo University approved the study protocol.

Dietary and anthropometric evaluations

Subjects were interviewed and the average of two 24-h dietary recalls (one on week days and one on weekends) was used to estimate daily consumption of different nutrients. A database for Brazilian food composition was used to calculate the daily energy and nutrient intake [23]. In addition a food frequency questionnaire was used to increase the reliability and validity of information. The International Physical Activity Questionnaire-Short Form (IPAQ) was used to evaluate the degree of physical activity that measures leisure time, domestic, work-related and transport-related physical activities. Four domains were measured: sitting, walking, moderate-intensive activities and vigorous-intensive activity in the last 7 days [24]. Participant's body weight, height, waist circumference (WC), hip circumference (HC), and other anthropometric measurements were obtained from the medical examination.

Anthropometric measurements were performed according to the techniques proposed by Lohman et al. [25]. For weight, we used a platform scale with a capacity of 150 kg, with divisions of 100 grams,

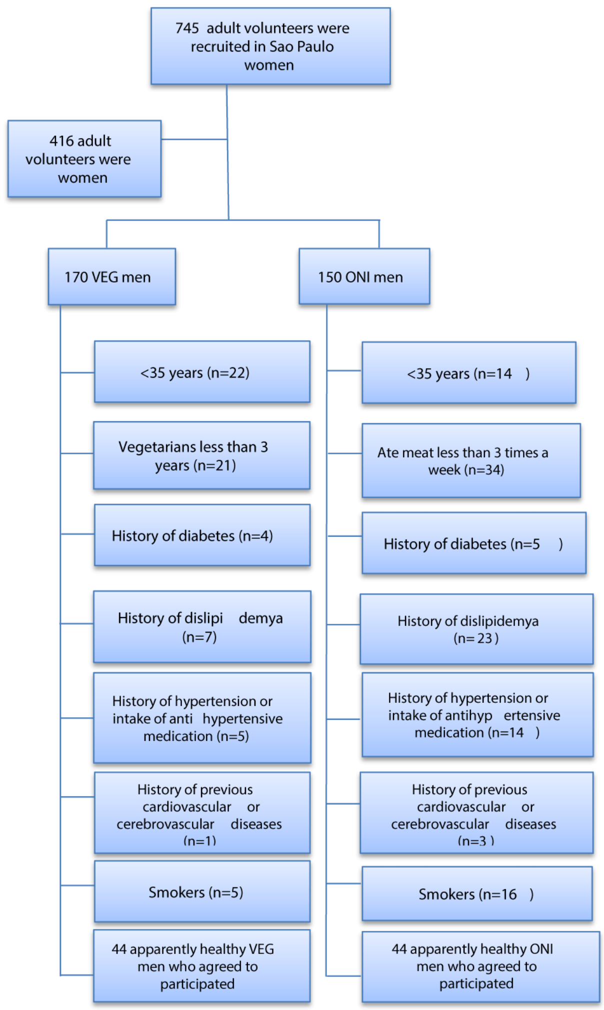

Figure 1: Sample selection process of the CARVOS study.

and the patient was positioned in the center of the scale, standing barefoot wearing the minimum of clothing and as few accessories as possible. To measure height, we used a portable stadiometer, positioned in an appropriate place, with the barefoot volunteer with feet together, standing erect, with the back of the head, shoulders, buttocks, calves, and heels touching the wall, and the head in the Frankfurt horizontal plane (imaginary line from the external auditory canal to the lower eye socket) [26]. Height was measured in triplicate, allowing a change of 0.2 cm between the three measurements, and the mean value was used for analysis. Body mass index (BMI) was calculated by dividing body weight (kg) by the square of height (m).

To measure the circumferences, the individual remained upright with arms relaxed alongside the body, with the region to be measured devoid of clothing. A tape measure was used. For waist circumference, the measurement was made at the midpoint between the last rib and the iliac crest, with the abdomen relaxed, at the end of expiration; arm circumference was measured from the midpoint between the most distal point of the acromion process of the scapula to the distal part of the olecranon; hip circumference was measured at the gluteal maximum extension; and abdominal circumference was measured at the greatest extent of the abdomen. All circumferences were performed in triplicate, allowing a change of 0.5 cm between the three measures, and the mean value was used for analysis.

The waist-to-hip ratio (WHR) was calculated by dividing the waist circumference by the hip circumference. For skinfold measures (biceps, triceps, subscapular, and suprailiac), a Sanny® brand adipometer was used, with scale in millimeters. The measures were taken with the subject standing with the weight distributed on both feet, and the region free of clothing, on the right side of the body. The biceps skinfold thickness was measured vertically on the anterior side, at the midpoint between the acromion and the olecranon; triceps, vertically, on the posterior surface at the midpoint between the acromion and the olecranon; the subscapular, diagonally, at the inferior angle of the scapula; and suprailiac, diagonally above the iliac crest and in the midline between the iliac crest and the armpit.

All skinfold measurements were performed in triplicate, considering an acceptable difference of 1 mm between the three measurements, and the mean value was used for analysis. For the BIA test, we used the Biodynamics tetrapolar impedance 450, included fasting four hours before the test, not drinking alcoholic beverages during the previous 24 hours, suspension of diuretics 24 hours preceding the test, not practicing intense physical activity in the prior 12 hours, and with an empty bladder. The subjects were in a horizontal position, without metal objects with hands and feet free. The legs and arms were separated to prevent contact with the trunk. The electrodes were positioned on the right side, on the hand, wrist, ankle, and foot. Parameters provided by the device itself included % body fat, lean body mass, fat mass and total body water.

Statistical analyses

The distribution of individuals in relative and absolute frequencies is presented according to the study variables. Continuous variables are presented according to their mean value and confidence interval of 95% (CI 95%). The variables analyzed were age, weight, height, BMI (Undernourished: <18.5 kg/m^2; Normal weight: 18.5-24.9 kg/m^2; Overweight: ≥25 kg/m^2), waist circumference (Adequate: <94 cm; Inadequate ≥ 94 cm); abdominal circumference (continuous variable), respiratory inductance plethysmography (RIP) circumference (continuous variable), WHR (<1 or ≥ 1), arm circumference (Undernourished: <90%; Normal weight: 90-110%; Overweight: >110%), tricipital skinfold (Undernourished: <90%; Normal weight: 90-110%; Overweight: >110%), total of folds (continuous variable), % fat mass according to Lohman (<25% or ≥ 25%), % lean mass (<75%, 75-95% and >95%), % fat mass according to BIA (<25% or ≥ 25%), and total body water (<70% of lean mass, adequate: 70-74% of lean mass, >74% of lean mass).

We classified total body water according to the bioimpedanciometer manual. To analyze the adequacy of lean mass and fat mass, we extrapolated the criterion of Lohman. As Lohman recommends, fat mass values <25% or ≥ 25% were considered lean mass values reaching 100% [25]. In a complementary analysis, in order to investigate differences according the time in the VEG regime, the VEG group was classified as "old" VEG (≥ ten years as VEG, n=30) and "new" VEG (VEG regime for four to ten years, n=14).

To verify the differences between types of diet (omnivores, vegetarians) and the other categorical study variables, we used the chi-square test. The differences between mean values were calculated using the t test.

To test the association between the variables, multiple logistic regression was used. The magnitude of effect was measured by the values of OR (odds ratio) and respective confidence interval of 95% (CI 95%). The multiple regression analysis included the initially proceeding univariate analysis and variables with P<0.20 in ascending order of entry. Variables that maintained a P value as the variable of interest and <0.05 were retained in the model.All calculations were carried out by using Stata version 10.0.The Scientific and Ethics Committee of the Heart Institute (InCor), Hospital das Clínicas, School of Medicine, University of São Paulo approved the CARVOS study. All participants signed an Informed Consent Form.

Results

The individual characteristics, anthropometric characteristics and body composition evaluated by BIA are shown in Table 1.

	VEG n=44 mean (CI 95%)	ONI n=44 mean (CI 95%)	P value
Age (y)	45.5 (43.1-47.8)	46.8 (43.9-49.7)	0.236
Height (m)	1.75 (1.73-1.77)	1.74 (1.72-1.76)	0.217
Weight (kg)	70.9 (68.0-73.8)	82.4 (77.8-86.9)	<0.001
BMI (kg/m^2)	23.1 (22.3-24.0)	27.3 (25.8-28.7)	<0.001
Waist circumference (cm)	84.9 (82.6-87.3)	95.7 (91.5-99.9)	<0.001
Abdominal circumference (cm)	86.5 (84.5-88.6)	96.8 (92.7-100.9)	<0.001
RIP circumference (cm)	97.7 (95.9-99.5)	103.3 (101.0-105.7)	<0.001
Arm circumference (cm)	29.1 (28.2-30.1)	32.2 (31.1-33.3)	<0.001
Bicipital skinfold (mm)	9. 1 (7.5-10.7)	12.4 (10.8-14.0)	0.002
Tricipital skinfold (mm)	14.0 (12.3-15.7)	17.4 (15.8-18.9)	0.002
Subscapular skinfold (mm)	16.4 (14.7-18.0)	22.0 (19.8-24.2)	<0.001
Suprailiac skinfold (mm)	15.0 (13.1-16.9)	21.4 (18.6-24.3)	<0.001
Total of folds (mm)	54.5 (48.3-60.7)	73.2 (66.1-80.3)	<0.001
Fat mass by total of folds (%)	24.6 (23.0-26.3)	28.8 (27.3-30.3)	<0.001
Lean mass by BIA (%)	80.5 (79.0-81.9)	76.8 (74.8-78.9)	0.002
Fat mass by BIA (%)	19.3 (17.9-20.7)	23.5 (21.3-25.7)	<0.001
Total body water (%)	72.6 (71.5-73.7)	72.8 (72.2-73.4)	0.371
P<0.05			

Table 1: Mean values and 95% confidence intervals (CI 95%) of individual characteristics, anthropometric indicators, and body composition by dietary group.

Age, height, and total body water were similar between groups. Body mass index, circumference of the waist, abdomen, RIP, and arm; bicipital, tricipital, subscapular and suprailiac skinfolds and total of folds were significantly lower in the VEG compared to the OMN subjects (P<0.05). On the other hand, lean body mass was significantly higher in VEG compared to OMN.

The higher percentage of overweight/obesity based on BMI was observed in OMN by the measurements of arm circumference, tricipital skinfold and fat mass, as well as the inadequate WHR and inadequate waist circumference, as shown at Table 2.

	VEG n=44 %	**ONI n=44 %**	**P value**
BMI			
Undernourished	0	2.3	-
Normal weight	81.8	27.3	<0.001
Overweight	18.2	70.4	-
Waist-to-hip Ratio (WHR) adequate			
Yes	97.7	84.1	0.026
No	2.3	15.9	-
Waist circumference adequate			
Yes	84.1	50	<0.001
No	15.9	50	-
Arm circumference			
Undernourished	54.5	15.9	<0.001
Normal weight	38.6	63.6	-
Overweight	6.8	20.5	-
Tricipital skinfold			
Under weight	34.1	11.4	-
Normal weight	20.5	11.4	0.008
Overweight	45.5	77.3	-
Fat mass by total of skinfolds			
Adequate	56.8	22.7	<0.001
Risk of diseases associated with obesity	43.2	77.3	-
Lean body mass by BIA			
Adequate	84.1	54.5	0.003
Inadequate	15.9	45.5	-
Fat mass by BIA			
Adequate	86.4	52.3	<0.001
Risk of diseases associated by obesity	13.6	47.7	-
Total body water			
Adequate	88.6	69.8	0.03
Inadequate	11.4	30.2	-
(P<0.05)			

Table 2: Distribution of individuals according to anthropometric indicators and body composition by dietary group.

The pattern of nutrient intake of apparently healthy VEG and OMN men is shown in Table 3. The intake of protein, total fat, saturated fat, and cholesterol were significantly lower, and the intake of carbohydrates and fiber were significantly higher in VEG compared to OMN (P<0.05). Physical activity was significantly higher in VEG compared to OMN when divided into two categories: high and moderate vs. low physical activity; 81.8% of VEGs had high physical activity compared to 56.8% of OMN (P=0.011).

Nutritional pattern	**VEG n=44**	**ONI n=44**	**P value**
Energy (kcal)	2177 ± 559	2348 ± 736	0.11
Protein (% of energy)	17.1 ± 7.8	19.5 ± 4.5	0.04
Fat (% of energy)	24.8 ± 8.3	29.1 ± 7.2	0.006
Saturated fat (% of energy)	4.4 ± 3.2	6.9 ± 2.9	<0.001
Cholesterol (g)	69.3 ± 224	258.1 ± 169	<0.001
Carbohydrates (% of energy)	63.2 ± 11.6	51.9 ± 9.7	<0.001
Fibre (g)	28.2 ± 15.9	17.9 ± 13.6	<0.001
Data are means ± SD. Significant values for *P*<0.05			

Table 3: Pattern of nutrient ingestion of vegetarian and omnivorous men.

There was no difference in hemoglobin levels (P=0.065), between VEG's and OMN's; demonstrating that none of the groups had disability signal.

In the univariate regression, being omnivorous significantly increased the risk of overweight, inadequate waist circumference, inadequate WHR, obesity by tricipital skinfold, and elevated fat mass. In the multiple regression models, it is demonstrated that being OMN significantly increased the risk of being overweight; with inadequate waist circumference; obesity by tricipital skinfold and high fat mass, regardless of years of the study, physical activity, and age group. Being an omnivore also significantly increased the risk of inadequate WHR (Table 4).

Age and total body water in the "old" VEG, "new" VEG, and OMN were similar (Table 5). BMI, WC, abdominal circumference, arm circumference, triceps skinfold, biceps skinfold, and total of folds were significantly lower in the "old" and "new" VEG compared to OMN. "Old" VEG had significantly higher lean body mass and significantly lower fat mass compared to OMN. "New" VEG did not have significant differences.

	OR	CI 95%	P value	OR	CI (95%)	P value
BMI (≥ 25 kg/m^2)*						
Vegetarians	1	-	-	1	-	-
Omnivores	12	4.4-33.1	<0.001	12.12	3.7-39.4	<0.001
Waist circumference (≥ 94 cm)*						
Vegetarians	1	-	-	1	-	-
Omnivores	5.29	1.9-14.4	0.001	8.39	2.4-28.9	0.002
Waist to hip ratio (≥ 1)**						
Vegetarians	1	-	-	1	-	-
Omnivores	8.14	0.96-69.2	0.055	9.85	1.1-86.7	0.039
Arm circumference (obesity > 110%)						
Vegetarians	1	-	-	-	-	-
Omnivores	3.51	0.9-14.0	0.075	-	-	-
Tricipital skinfold (obesity)*						
Vegetarians	1	-	-	1	-	-
Omnivores	4.08	1.6-10.3	0.003	6.2	1.9-20.3	0.021
Fat mass by total of skinfolds (≥ 25%)*						
Vegetarians	1	-	-	1	-	-
Omnivores	4.47	1.8-11.3	0.001	8.93	2.5-32.0	0.004
Lean body mass (<75%)*						
Vegetarians	1	-	-	1	-	-
Omnivores	4.4	1.6-12	0.004	4.34	1.3-14.1	0.022
Fat mass by BIA (≥ 25%)*						
Vegetarians	1	-	-	1	-	-
Omnivores	5.78	2.0-16.4	0.001	5.7	1.7-19.0	0.005

OR: Odds ratio; CI 95%: Confidence interval of 95%; *Model adjusted for years of study (<11 or >11 years of study), physical activity (not physically active or physically active) and age group (<50 years ≥ 50 years); **Model adjusted for physical activity (not physically active)

Table 4: Univariate and multivariate regression models of association between type of diet and anthropometric variables, respectively. São Paulo, Brazil, 2013.

Discussion

In this study, we found several major differences in relation to nutritional status/body composition and the type of diet consumed. Variables such as age, height, and total body water were unique and had no differences.

A few previous studies investigated nutritional status and body composition in VEG and OMN men or women. Teixeira et al. [27] analyzed the nutritional status of OMNs (n=134) and VEGs (n=67) of both sexes, 35-65 years, living in a city of Southeastern Brazil, in which the OMNs had a higher risk of overweight and inadequate WHR [27]. On the other hand, Shridhar et al. [28] did not find significant differences in BMI and percentage of body fat by skinfold measurement between VEG and OMN Indian men and women.

	Vegetarian four to ten years n=14		Vegetarian for ≥ ten years n=30		Omnivores n=44	
	Mean	CI (95%)	Mean	CI (95%)	Mean	CI (95%)
Age (y)	44.4	40.7-48.0	45.9	42.8-49.1	46.8	43.9-49.7
Body mass index (kg/m^2)	24.0^a	22.2-25.8	22.8^b	21.7-23.8	27.3	25.8-28.7
Waist circumference (cm)	86.3^a	81.8-90.8	84.3^b	81.4-87.1	95.7	91.5-99.9
Abdominal circumference (cm)	88.5^a	84.3-92.7	85.6^b	83.2-87.9	96.8	92.7-100.9
Arm circumference (cm)	29.7^a	27.9-31.5	28.9^b	27.7-30.0	32.2	31.1-33.3
Tricipital skinfold (mm)	14.5^a	11.3-17.7	13.8^b	11.6-15.9	17.4	15.8-18.9
Bicipital skinfold (mm)	9.3^a	6.3-12.3	9.0^b	7.0-11.1	12.4	10.8-13.9
Total of folds (mm)	56.9^a	47.1-66.7	53.3^b	45.1-61.6	73.2	66.1-80.3
Fat mass by total of skinfolds (%)	25.5^a	22.4-28.6	24.2^b	22.2-26.3	28.8	27.3-30.3
Lean body mass by BIA (%)	79.4	76.7-82.1	81.0^b	79.2-82.8	76.8	74.8-78.9
Fat mass by BIA (%)	20.6	17.9-23.3	18.7^b	17.0-20.3	23.5	21.3-25.7
Total body water (%)	71.9^a	71.3-72.5	72.9	71.3-74.6	72.8	72.2-73.4

a: Significant difference between vegetarians 4-10 years and omnivores; b: Significant difference between the vegetarian ≥ 10 years and omnivores; c: Significant difference between vegetarians 4-10 years and ≥ 10 years

Table 5: Means and confidence intervals (95%) between years of vegetarianism and omnivores. São Paulo, Brazil, 2013.

There are few studies about body composition by BIA in vegetarian male subjects. Nadimi et al. [29] analyzed 20 VEG and 20 OMNs, with 10 men and 10 women in each group. The means of weight, height, BMI, and WHR were not significantly different, nor were fat mass and free fat mass, measured by BIA. Philips et al. [30] examined whether 33 British adults would have changes in anthropometric assessment with a vegetarian diet after six months. In this study, the body weight did not significantly decline; however, a significant reduction in arm circumference, calculated body fat, biceps and triceps skinfold thickness, and WHR were observed.

Dourado et al. [31], evaluated 58 OMNs and 29 ovo-lacto-vegetarian adults and elderly men and women and found no significant differences in relation to BMI, WC, and WHR, a finding that disagrees with our study and others in the literature [27,30]. Fraser et al. [32]

observed that OMNs tended to have higher BMI than vegans, lacto-ovo-vegetarians, and pesco-vegetarians had.

In the multiple regression models, we showed that being OMN significantly increased the risk of being overweight; with inadequate waist circumference; obesity by tricipital skinfold and high fat mass, regardless physical activity, and age group. Being an OMN also significantly increased the risk of inadequate WHR. As there was no significant difference in the caloric intake and physical activity was adjusted, we can hypothesize that the lower prevalence of overweight in VEG can be explained by the higher amount of fiber in the diet. Some studies [33,34] showed the influence of fiber on postprandial thermogenesis, which may explain lower energy demand and therefore the lower prevalence of overweight.

We show that being vegetarian for over ten years seems to influence the decrease in fat mass and increase in lean mass. “Old” VEG had lean body mass significantly higher and fat mass significantly lower compared to OMN. The VEGs ate more calories from non proteic sources for any gram of Nitrogen; it is a more anabolic diet that may have contributed to the observed results. We did not find differences in these variables comparing “old” and “new” VEGS. Longer vegetarianism seems to create a healthier body composition. A similar physiological phenomenon was demonstrated by Ko [35] who observed that the longer the time of vegetarianism, the lower the blood pressure, compared to that in OMN.

There are some limitations to this study: 1-its cross-sectional design does not prove causality; 2-the relative restricted number of individuals on each group could be a limitation, however the sample is highly homogenized in sex, age and being apparently healthy. In addition the bioimpedanciometer used provides the percentage of fat directly, through equations already programmed by the manufacturers on the instrument itself, but not estimated for the Brazilian population. BIA has good reproducibility for the individuals with BMI up to 34 kg/m^2, but it is not reliable for BMI greater than that [36]. In our study, few individuals had BMI greater than 34 kg/m^2, which reduces this limitation.

The strength of our study set we took measurements by using reproducible methods. The importance of the implications of our study is that we studied a sample of apparently healthy men who constitute a large population of our society, so is of great interest in terms of prevention of chronic diseases, as these are associated with some inadequate parameters of nutritional assessment and body composition.

Conclusion

We observed a lower risk of being overweight and better standard of body composition assessed by BIA and by other classic anthropometric parameters in apparently healthy VEG men compared to OMN men suggesting a protective association of VEG diet that could be of great interest in terms of prevention of chronic diseases like as obesity and diabetes mellitus.

Acknowledgement

Heart Institute (InCor) of University of São Paulo.

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