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ORIGINAL ARTICLE

# Nutritional Status, Lifestyle and Lipid Profile in Vegetarians

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## Abstract

**Background:** Vegetarian diets have been linked to reduced risk of chronic noncommunicable diseases, since they positively modulate biochemical parameters, particularly those related with glycemic control and lipemia, and considered as potential strategy for weight control.

**Objective:** To compare the nutritional status, lifestyle and lipid profile of adult vegetarians with omnivores in a sample of individuals in the city of São Paulo.

**Methods:** This was a cross-sectional study. Anthropometric, biochemical and lifestyle variables were compared between vegetarians and omnivores. A significance level of 5% was considered for all analyses.

**Results:** Vegetarians were more likely to practice physical activity (64.3% vs 42.5%, p = 0.056) and consuming dietary supplements (48.1% vs 20.5%, p = 0.012). There was no statistically significant difference for the variables: age, sex, triglycerides, total cholesterol and low-density lipoprotein between the two groups. Vegetarians had significantly lower weight [60.8 kg (56.7 – 69.4) vs 71.1 kg (58.0 – 75.4), p = 0.038], BMI [22.4 kg/m2 (20.9 – 23.8) vs 24.6 kg/m2 (21.7 – 26.1), p = 0.001], and waist circumference [(81.8 ± 8.2 vs 87.8 ± 10.9 cm, p = 0.003)], and higher high-density lipoprotein (54.88 ± 14.44 vs 47.30 ± 12.27 mg /dL p = 0.008) than omnivores.

**Conclusion:** Compared with omnivores, vegetarians had a better nutritional status, with lower BMI and waist circumference, significantly higher levels of plasma lipoprotein high-density, and healthier lifestyle. (Int J Cardiovasc Sci. 2019; [online].ahead print, PP.0-0)

**Keywords:** Diet, Vegetarian; Chronic Disease; Dyslipidemias; Lipoproteins; ife Style; Epidemiology; Body Weight and Measures.

## Introduction

Assessment of nutritional status is made by anthropometry, biochemical tests and evaluation of dietary intake, which altogether, determine whether individuals have "normal" status or are at risk of malnutrition. The evaluation of nutritional status plays an important role as it has an inverse relationship with the incidence of non-communicable diseases (NCDs), including obesity, type 2 diabetes mellitus (DM2), cardiovascular diseases (CVDs), systemic arterial hypertension (SAH) and some cancers.[1] The close relationship between obesity and life style (physical inactivity and poor-quality diet) make this modifiable component the main target of weight control strategies.

Healthy eating is considered eating habits that promote health and that should be guided and encouraged from childhood to adult life.[2] In this context, vegetarian diets may be advantageous as a nutritional strategy not only to promote healthy eating habits but also to help in the treatment and prevention of obesity.[3] According to the Brazilian Vegetarian Society (SVB), a vegetarian is an individual who exclude all kinds of

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meat, poultry and fish from their diet, and may include or not dairy products and eggs.[4]

In the last 30 years, several researches have reported important and measurable benefits of vegetarian diets, especially of well-planned diets followed by individuals living in places where vegetable foods are highly available. Under these conditions, vegetarians can enjoy good health, with body mass index (BMI)[5] and plasma cholesterol levels[6] within healthy ranges,[6] in addition to increased serum levels of antioxidants,[7] low prevalence of obesity, cardiovascular diseases,[8] type 2 diabetes mellitus,[9] systemic arterial hypertension,[10] metabolic syndrome,[11] colon polyps,[12] many types of cancer,[8] and increased life expectancy.[13] There is much evidence that a vegetarian diet can be recommended for the prevention and treatment of cardiovascular diseases[14] and even as a therapeutic alternative for diabetes,[15] hypertension[16] and obesity.[17]

Vegetarian diets offer nutritional benefits, including lower levels of saturated fat, cholesterol and animal protein, as well as higher levels of carbohydrates, dietary fiber, magnesium, potassium, folate, antioxidant vitamins and other bioactive compounds. However, vegans may have a deficient intake of vitamin B-12, calcium, vitamin D and omega-3 fatty acid.[18] The marginal intake of some nutrients does not prevent these diets from being recommended, based on strong scientific evidence showing that the health benefits of these diets exceed potential risks.[19]

Studies comparing body weight of vegetarians and non-vegetarians have shown that those who follow a vegetarian diet tend to have lower weight.[5]

Therefore, it seems that the main characteristic of vegetarian diets, i.e., the exclusion of meat or reduction of its consumption, when combined with a high nutrient density, plays an important role in maintenance of a healthy nutritional status. Thus, the expansion of the study of vegetarian diets may lead to more efficient strategies for weight control, development of healthy habits and consequent reduction of NCDs. The aim of this study was to assess and compare the nutritional status, by means of anthropometric and biochemical parameters, of a sample of adult vegetarians and omnivores from the same population in São Paulo, Brazil.

## Methods

This was a cross-sectional study. Calculation of the sample size (non-probabilistic, convenience sampling) was based on the test of the difference of means of BMI, described in a previous study involving a similar population.[20] BMI was chosen because the variable encompasses a large number of individuals, thereby increasing the power of the sample. Fifty-eight individuals in each group would be necessary for statistically significant results (Student's t-test), with 80% power and level of significance of $\alpha = 0.05$. We studied adults (≥ 18 years and < 60 years) of both sexes. A total of 198 individuals were first selected, and then we excluded women using oral contraceptives (in attempt to establish a hormonal profile), and individuals using antidepressants, anti-hypertensive drugs, beta-blockers or vasodilators. Ninety-six individuals (56 vegetarians and 40 omnivores) were included in the study.

In general, studies comparing the effects of vegetarian diet on health in relation to omnivore diet have not considered different types of vegetarian diets. Rather, the authors have reported differences between exposed and non-exposed to vegetarian diets, or between vegetarians and omnivores.[14] The exceptions in this regard are population-based, longitudinal, cohort studies that involve large sample populations and hence allow a stratified analysis by the type of vegetarian diet. In the present study, we opted to dichotomize the study group as vegetarians and omnivores and to compare the nutritional status and life style between these groups.

For recruitment of vegetarian volunteers (Figure 1), we contacted the SVB, which supported and publicized the study. An e-mail was sent to the addresses registered in the SVB database of more than 2,000 individuals (omnivores and vegetarians), who were invited to participate in the study. The message contained an electronic address to which the volunteers willing to participate in the study could make contact.

Those interested in participating got their first visit scheduled by e-mail; they also published the call for participation on online social medias. After the first interview, vegetarians who met the inclusion criteria were invited via e-mail to the second phase of the study (collection of blood samples).

Omnivores were recruited through advertisement of the study in social medias and in universities, based on the same flowchart of vegetarians (Figure 2).

The first stage of data collection comprised: explanation of the study; explanation of the informed consent form; administration of the questionnaire containing sociodemographic data, lifestyle information and assessment of the nutritional status, with measurement

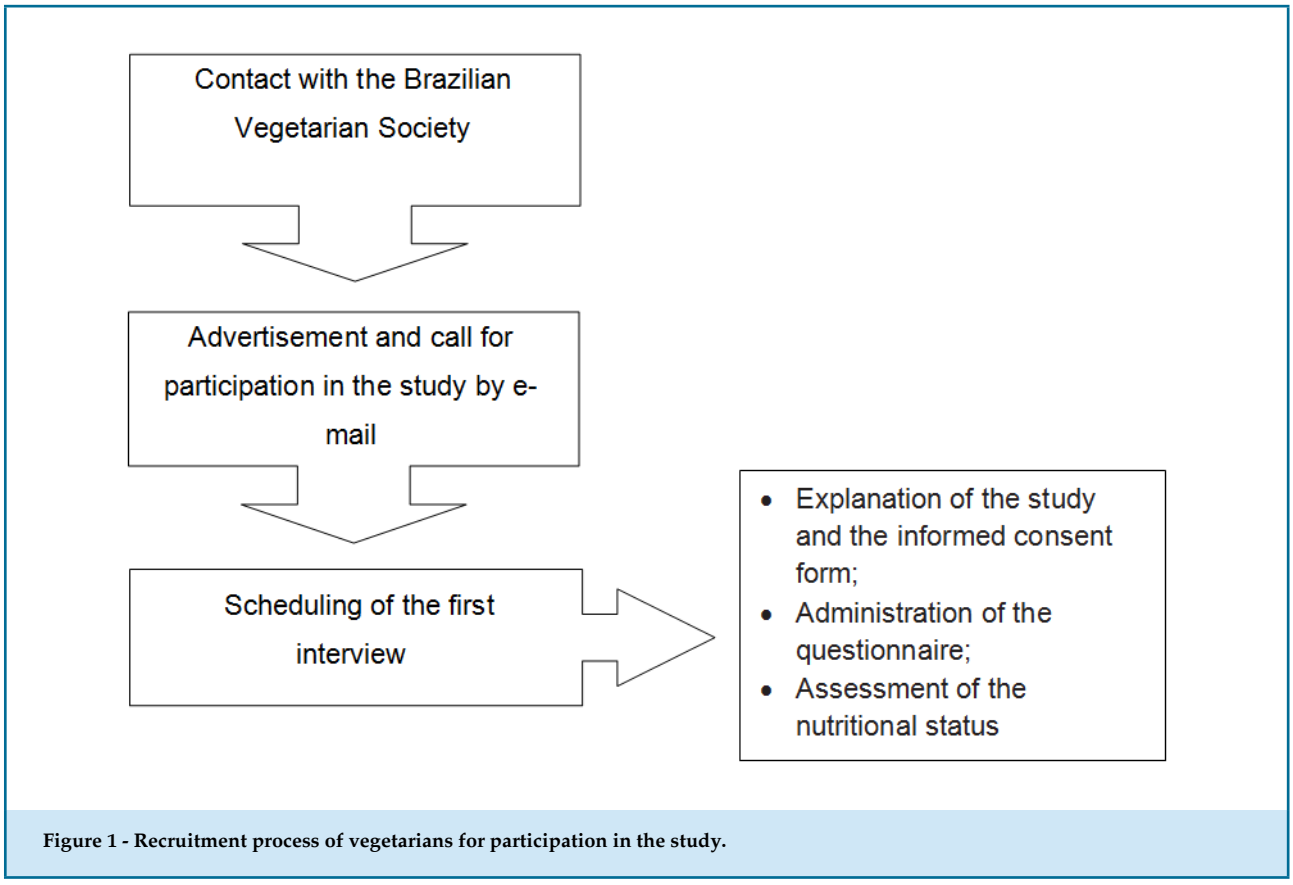


**Figure 1 - Recruitment process of vegetarians for participation in the study.**

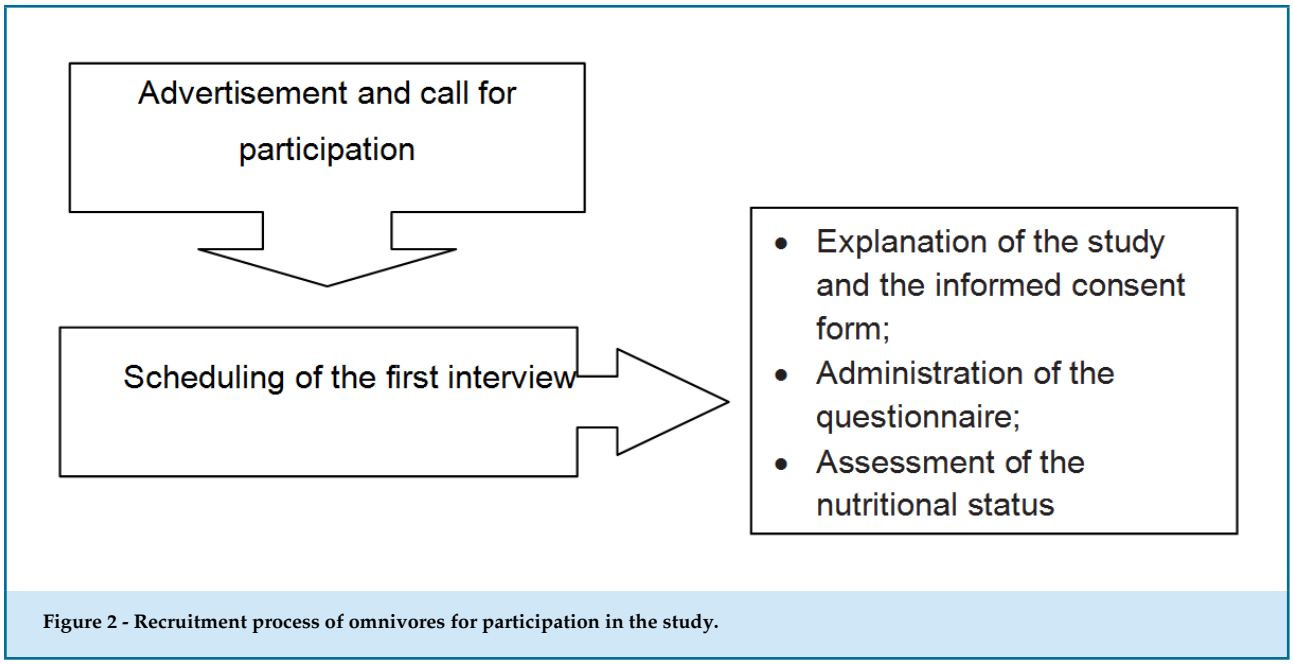


**Figure 2 - Recruitment process of omnivores for participation in the study.**

of weight, height and waist circumference (WC). After application of the exclusion criteria, participants included had blood samples collected for laboratory analysis.

Vegetarianism: participants were classified by the type of vegetarian diet or eating practices by self-report; they were asked if they considered themselves

semivegetarians, ovo-lacto vegetarians, vegans or omnivores. In addition, they were asked which food items they excluded from their diets (fish, red meat, poultry, eggs and dairy) based on the SVB definition of the diet types. Individuals classified as vegetarians (or subgroups), were also asked the reasons for becoming a vegetarian and how long they had been following this type of diet.

Sociodemographic and clinical variables: participants were asked about their age (in years), educational attainment, marital status and health conditions (presence of any disease at the interview).

Life style variables: practice of physical exercise (physically active or inactive), according to the International Physical Activity Questionnaire (IPAQ), smoking habits (yes or no), number of meals/day (three or less meals/day; more than three meals/day); sleeping hours (eight or less hours/day/ more than eight hours/day) and use of vitamins and supplements (yes or no).

**Variables of nutritional status:** nutritional status was assessed by BMI. For weight measurement, volunteers were asked to stand in the middle of the platform of an electronic scale (Welmy®, model R-110, 150 kg capacity and 100 g accuracy). Height was measured using a portable stadiometer (Estad® - Alturexata, 0.35 m – 2.13 m). All measurements were made with participants barefoot and wearing light clothes.[21] For analysis of body composition, WC was measured at the level of the umbilicus, using a non-elastic, retractable tape (Sanny®). Nutritional status was classified according to the WHO classification for BMI[21] individuals were classified as normal or altered nutritional status if they had a BMI of 18.5 – 24.9 kg/m$^2$ or > 24.9 kg/m$^2$, respectively. WC was classified according to the risk of obesity-related complications, by gender. A WC ≤ 80 cm for women and < 94 cm for men was considered normal, and a WC > 80 cm for women and > 94 cm for men considered altered or indicator of risk.[1]

**Biochemical variables:** for biochemical analysis, concentrations of total cholesterol (TC) and cholesterol fractions were measured using the automated enzymatic method. All procedures were conducted in a clinical analysis laboratory. The following cut-off values were used to classify the variables as normal or altered – TC > 200 mg/dL, LDL-c > 100 mg/dL, HDL- cholesterol < 40 mg/dL for men and < 50 mg/dL for womenm and triglycerides (TG) > 150 mg/dL.

### Statistical analysis

Statistical analysis was performed using the SPSS software version 20.0. Sociodemographic data, characteristics of vegetarian diet, lifestyle data and data of nutritional status were expressed as proportion and mean ± standard deviation. Normality of data distribution was tested by the Kolmogorov-Smirnov test, and the chi-squared test used to compare differences in proportions. Comparisons of means were performed using the Student's t-test for normally distributed variables or the Mann-Whitney test for variables without normal distribution. Data were not matched, since only one measure was taken from the sample unit, and the study had a cross-sectional design, with no intervention. Continuous variables with normal distribution (WC, TC, HDL, LDL) were expressed as mean and standard deviation, whereas those without a normal distribution (weight, BMI, glycemia, insulin, HOMA-IR, TG) were expressed as median and interquartile range (1$^{st}$ quartile and 3$^{rd}$ quartile). Categorical variables (type of diet, sex, educational attainment, smoking status, marital status, physical activity, number of meals per day, number of sleeping hours, vitamins/supplements intake) were presented as absolute numbers and percentages. The level of significance was set at 5%.

### Ethical aspects

The present study was approved by the Ethics Committee of the University of Sao Paulo School of Public Health (approval number 2260).

## Results

Ninety-six volunteers were studied, 56 vegetarians and 40 omnivores. Most of participants were women (n = 60, 63%), adults (33.2 years ± 7.1 years), with high educational attainment (n = 66, 69% with higher education and postgraduate study), non-smokers (n = 91, 96%), and lived with a partner (n = 54, 56%). Despite a high percentage of sedentary individuals (n = 43, 45%), median BMI was 22.7, 21.3 – 25.0 kg/m$^2$ (i.e., normal) and participants were considered healthy, since 70% of them did not have any disease at the interview. Table 1 describes the general characteristics of the study population.

Tables 2 and 3 present descriptive data of both groups (vegetarians and omnivores), stratified by sex.

**Table 1 - General characteristics of the study population**

| Variables | | n (%) |
|---|---|---|
| Type of diet | Vegetarian | 56 (58.3) |
| | Omnivore | 40 (41.7) |
| Sex | Male | 36 (37.5) |
| | Female | 60 (62.5) |
| Educational attainment | Completed high school | 9 (9) |
| | Some superior education | 21 (22) |
| | Superior or postgraduate education | 66 (69) |
| Smoker | Yes | 4 (4) |
| | No | 91 (96) |
| Marital status | With a partner | 54 (56) |
| | Without a partner | 42 (44) |
| Physical activity | Active | 53 (55) |
| | Inactive | 43 (45) |
| Age (years) (m ± DP) | | 33.5 + 7.2 |
| BMI (kg/m$^2$) (median (1$^{st}$ Q – 3$^{rd}$ Q); | | 22.7 (21.3 – 25.0)* |

** BMI: body mass index; 1$^{st}$ Q: first quartile; 3$^{rd}$ Q: third quartile.*

To identify possible differences in life style between vegetarians and omnivores, categorical variables, physical activity data, sleeping hours number of meals, smoking habit and use of vitamin were compared between the two groups using the chi-square test (Table 4).

The use of vitamins and dietary supplements was more frequent among vegetarians than omnivores (48.1% vs 20.5%, p = 0.012). Also, although not statistically significant, the practice of exercise was more frequent in vegetarians than in omnivores (64.3% vs 42.5%, p = 0.056).

Comparisons of anthropometric and biochemical variables are summarized in Table 5. No statistically differences were found for age, sex, smoking habits, practice of physical activity, sleeping hours, number of meals per day, TC, LDL-c and TC. However, significant differences were found between the groups for WC (p = 0.003), BMI (p < 0.001), use of vitamins and supplements (p = 0.012), glycemia (p = 0.004), body weight (p = 0.038), insulin (p = 0.035) and HDL-c (p = 0.008).

Although statistically differences were found for anthropometric and biochemical variables between the groups, mean BMI, and glucose and HDL-c levels are within recommended ranges. To increase the power of the analysis, the variables were then categorized into normal and altered (reference values described in Methods). Thus, statistically significant differences between vegetarians and omnivores were found for WC (p = 0.004), BMI (p = 0.002) and HDL-c (p = 0.034) (Table 6).

## Discussion

In the present study, we found that the use of vitamins and supplements is significantly higher among vegetarians than omnivores (48.1% vs 20.5%, p = 0.012) and, although not statistically significant, a higher number of vegetarians are physically active compared with non-vegetarians. The percentages of individuals with BMI, WC and HDL-c within normal ranges were also higher among vegetarians, indicating lower cardiovascular risk in this group. Although mean glucose levels were found within normal ranges in both groups, the lower values in the vegetarian group suggests higher insulin sensitivity. While 8.9% of vegetarians showed an altered WC, this percentage was nearly four times greater in omnivores (35%).

**Table 2 - Sociodemographic and lifestyle data of vegetarians and omnivores, stratified by sex**

| Variables | | | Vegetarians | | Omnivores | |
|---|---|---|---|---|---|---|
| | | | Female | Male | Female | Male |
| | | | Mean ± SD or n (%) | Mean ± SD or n (%) | Mean ± SD or n (%) | Mean ± SD or n (%) |
| | Sex | | 33 (59) | 23 (41) | 27 (68) | 13 (32) |
| | Age | | 35.1 ± 7.3 | 31.9 ± 7.7 | 33.5 ± 7.3 | 32.5 ± 6.3 |
| Sociodemographic | Educational attainment | Completed high school; some higher education | 5 (9) | 5 (9) | 13 (33) | 8 (20) |
| | | Completed higher school; postgraduate degree | 28 (50) | 18 (32) | 14 (35) | 5 (12) |
| | Marital status | Without partner | 20 (36) | 17 (30) | 11 (27) | 6 (15) |
| | | With partner | 13 (23) | 6 (11) | 16 (40) | 7 (18) |
| Life style | Physical activity | Inactive | 20 (36) | 17 (30) | 21 (53) | 11 (27) |
| | | Active | 13 (23) | 6 (11) | 6 (15) | 2 (5) |
| | Smoker | No | 32 (57) | 21 (37) | 25 (64) | 13 (33) |
| | | Yes | 1 (2) | 2 (4) | 1 (3) | 0 (0) |
| | Number of meals | < 3 meals | 6 (11) | 6 (11) | 5 (13) | 2 (5) |
| | | 4 or more meals | 27 (48) | 17 (30) | 22 (55) | 11 (27) |
| | Sleeping hours | < 8 hours | 28 (50) | 20 (36) | 24 (60) | 11 (28) |
| | | > 8 hours | 5 (9) | 3 (5) | 3 (7) | 2 (5) |
| | Vitamins / supplements | No | 15 (28) | 13 (24) | 20 (51) | 11 (28) |
| | | Yes | 17 (31) | 9 (17) | 7 (18) | 1 (3) |

Considerable research on the effects of a vegetarian diet has been done with seventh-day Adventists, whose practices include refraining from eating meat.[22] So far, three cohort studies involving seventh-day Adventists have been conducted in the USA. The Adventist Health Study-1 (AHS-1) collected data from approximately 34,000 non-Hispanic Californian Adventists on fatal and non-fatal events.[23] The study provided important information, showing that obesity was less prevalent among vegetarians, and, similar to our study, the most common diet followed by vegetarians was the ovo-lacto vegetarian diet. The Adventist Health Study-2 (AHS-2), started in 2002, is a cohort prospective study involving more than 96,000 seventh-day Adventists, 52% of them vegetarians. The most common diet also was the ovo-lacto-vegetarian diet (28%), followed by semi-vegetarians (16%) and vegans (8%).[24] The study has reported some important results, including the relationship between vegetarianism and lower risk for diabetes,[25] hypertension[26] and obesity.[27]

There has been much debate on the mechanisms underlying the beneficial effects of vegetarian diets. Petterson et al.[26] highlighted that the lower incidence of hypertension among vegetarians in the AHS-2 study is due to the lower BMI in this group. Another cohort study (the EPIC-Oxford investigation) recruited 65,500 adults (20-89 years old); 51.8% were omnivores, 28.8% ovo-lacto-vegetarians, 15.5% semi-vegetarians and 3.9% vegans. Mean BMI was higher in non-vegetarian men (24.2 kg/m$^2$), in line with our results (see Table

**Table 3 - Nutritional status and biochemical data of vegetarians and omnivores stratified by sex**

| Variables | | Vegetarians | | Omnivores | |
|---|---|---|---|---|---|
| | | Female | Male | Female | Male |
| Nutritional status | Weight (mean [1st Q – 3rd Q]) | 59.0 (54.8 – 61.3) | 71.4 (61.3 – 78.4) | 63.5 (52.7 – 73.5) | 73.6 (69.7 – 83.4) |
| | Height (Mean ± SD) | 1.63 ± 0.07 | 1.75 ± 0.08 | 1.61 ± 0.06 | 1.76 ± 0.08 |
| | BMI (Median [1st Q – 3rd Q]) | 22.1 (20.7 – 22.8) | 22.9 (20.9 – 24.8) | 24.5 (21.5 – 27.3) | 25.2 (23.0 – 25.8) |
| | WC (Mean ± SD) | 78.2 ± 5.63 | 87.1 ± 8.61 | 85.3 ± 10.39 | 92.9 ± 10.34 |
| Biochemical data | TC (Mean ± SD) | 177.7 ± 34.14 | 160.0 ± 36.26 | 175.4 ± 30.45 | 177.2 ± 40.35 |
| | LDL-c (Mean ± SD) | 100.4 ± 24.4 | 99.0 ± 30.6 | 106.7 ± 27.9 | 112.5 ± 30.2 |
| | HDL-c (Mean ± SD) | 61.7 ± 14.35 | 45.1 ± 7.20 | 50.7 ± 12.25 | 40.2 ± 9.05 |
| | TG (Median [1st Q – 3st Q]) | 69.0 (58.0 – 96.0) | 86 (70.0 – 104.0) | 78.0 (61 – 95) | 116.0 (86.0 – 161.0) |
| | CI 1 (Mean ± SD) | 2.94 ± 0.54 | 3.63 ± 1.03 | 3.61 ± 0.91 | 4.50 ± 0.92 |
| | CI 2 (Mean ± SD) | 1.67 ± 0.41 | 2.26 ± 0.86 | 2.20 ± 0.75 | 2.86 ± 0.70 |
| | Glycemia (Median [1st Q – 3rd Q]) | 78.0 (75.0 – 82.0) | 84.0 (80.0 – 89.0) | 85.0 (81.0 – 88.0) | 87.0 (83.0 – 89.0) |
| | Insulin (Median [1st Q – 3rd Q]) | 4.2 (2.4 – 5.3) | 5.8 (4.9 – 7.8) | 6.8 (4.6 – 9.5) | 5.4 (4.1 – 7.5) |
| | HOMA-IR (Median [1st Q – 3rd Q]) | 0.8 (0.6 – 1.0) | 1.2 (1.0 – 1.7) | 1.4 (0.9 – 1.9) | 1.2 (1.0 – 1.7) |

*BMI: body mass index; WC: waist circumference; TC: total cholesterol; LDL: low density lipoprotein; HDL-c: high-density lipoprotein; TG: triglycerides; CI: Castelli's index; HOMA – IR: Homeostasis model assessment of insulin residence; 1st Q: first quartile; 3rd Q: third quartile.*

**Table 4 - Comparison of life style between vegetarians and omnivores**

| Variables | | Vegetarians | Omnivores | p-value |
|---|---|---|---|---|
| | | n (%) | n (%) | |
| Number of meals/day | < 3 meals/day | 12 (22.2) | 7 (17.5) | 0.761 |
| | > 3 meals/day | 42 (77.8) | 33 (82.5) | |
| Sleeping hours | < 8 hours | 48 (85.7) | 35 (87.5) | 1.000 |
| | > 8 hours | 8 (14.3) | 5 (12.5) | |
| Smoker | Yes | 3 (5.4) | 1 (2.6) | 0.883 |
| | No | 53 (94.6) | 38 (97.4) | |
| Physical activity | Yes | 36 (64.3) | 17 (42.5) | 0.056 |
| | No | 20 (35.7) | 23 (57.5) | |
| Supplements | Yes | 26 (48.1) | 8 (20.5) | 0.012* |
| | No | 28 (51.9) | 31 (79.5) | |

**p < 0.05, chi-square test.*

**Table 5 - Comparison of anthropometric and biochemical parameters between vegetarians and omnivores**

| Variables | Vegetarians | Omnivores | p-value |
|---|---|---|---|
| | Mean ± SD or median (1st Q – 3rd Q) | Mean ± SD or median (1st Q – 3rd Q) | |
| Weight (kg) | 60.8 (56.7 - 69.4) | 71.1 (58.0 - 75.4) | 0.038*[b] |
| WC (cm) | 81.8 ± 8.2 | 87.8 ± 10.9 | 0.003*[a] |
| BMI (kg/m²) | 22.4 (20.9 - 23.8) | 24.6 (21.7 - 26.1) | 0.001*[b] |
| Glycemia (mg/dL) | 81.0 (78.0 - 85.0) | 85.0 (82.5 – 89.0) | 0.004*[b] |
| Insulin (Uu/mL) | 5.1 (3.6 - 6.8) | 6.4 (4.4 - 9.2) | 0.035*[b] |
| HOMA-IR | 1 .0 (0.8 - 1.4) | 1.3 (0.9 - 1.8) | 0.021*[b] |
| TC (mg/dL) | 170.4 ± 35.8 | 176.0 ± 33.5 | 0.447[a] |
| HDL-c (mg/dL) | 54.9 ± 14.4 | 47.3 ± 12.3 | 0.008*[a] |
| LDL-c (mg/dL) | 99.8 ± 26.9 | 108.6 ± 28.4 | 0.127[a] |
| TG (mg/dL) | 71.0 (63.5 - 99.0) | 84.5 (67.0 – 122.0) | 0.104[b] |

**p < 0.05. [a]: Student's t-test (mean ± standard deviation); [b]: Mann-Whitney test (median [1st Q – 3rd Q]. 1st Q: first quartile; 3rd Q: third quartile; WC: waist circumference; BMI: body mass index; TC: total cholesterol; HDL-c: high density lipoprotein; LDL: low density lipoprotein; TG: triglycerides.*

3). It has been suggested that vegetarians and vegans usually adopt eating habits that are consonant with healthy eating recommendations and may offer advantages in terms of weight control, prevention of hypertension, and ultimately lower mortality from NCDs.[28] In addition, an association between a BMI > 27.5 kg/m² and a lower incidence of deaths from cardiovascular diseases was reported.[29]

With respect to weight control as a strategy for health protection, in a cohort study, Rosell et al.[30] evaluated weight gain in vegetarian and non-vegetarian individuals over a five-year period. Using logistic regression adjusted by mean age, the authors observed that the lowest weight gain was seen among semi-vegetarian, vegetarian and vegan women and those who, during follow-up, changed to a diet with no animal food. Philipps et al.[31] observed for 6 months individuals who had recently become vegetarian; at the end of the follow-up period, significant changes were found in the percentage of body fat, biceps and triceps skinfolds and WC.

Analysis of data from the Australian Longitudinal Study on Women's Health, which included 9,113 women aged between 22 and 27 years revealed a prevalence of 3% and 10% of vegetarians and semi-vegetarians (consumed fish or poultry), respectively. Compared with non-vegetarians, vegetarians and semi-vegetarians were leaner according to BMI and tended to exercise more.[32]

Data from the American population-based study NHANES 1994-2000 suggested that vegetarian diets naturally lead to weight loss and weight control,[31,33] have higher nutrient density (nutrient/kcal), higher whole-grain content, lower saturated fatty acids and lower salt. On the other hand, the study also showed that vegetarians consumed a less calories per day (mean of 363 kcal/day) than omnivores. One may presume that vegetarians have a healthier life style regardless of dietary factors, including lower prevalence of smoking and sedentary habits, and higher intake of vitamins and dietary supplements. This "health consciousness",[30,32] combined with the substitution of animal-derived foods with vegetable foods would promote a more efficient weight control, indicated by lower BMI and WC,[10,27,30] and consequently lower cardiovascular risk.[26,27]

Visceral fat deposition makes the abdominal visceral obesity a greater risk factor for cardiovascular disease and disturbances in glycemia-insulin homeostasis compared with generalized obesity. It is also associated with hypertension, dyslipidemias, fibrinolysis and progression of atherosclerosis.[33]

**Table 6 - Comparison of nutritional status variables (dichotomized into "normal" and "altered") between vegetarians and omnivores**

| Variables | | Vegetarians | Omnivores | Total | Chi-square test (p) |
|---|---|---|---|---|---|
| | | n (%) | n (%) | n (%) | |
| BMI | Normal | 49 (87.5) | 23 (57.5) | 72 (75) | 0.002* |
| | Altered | 7 (12.5) | 17 (42.5) | 24 (25) | |
| WC | Normal | 51 (91.1) | 26 (65.0) | 77 (80.2) | 0.004* |
| | Altered | 5 (8.9) | 14 (35.0) | 19 (19.8) | |
| Glycemia (mg/dL) | Normal | 51 (91.1) | 37 (92.5) | 88 (91.7) | 1.000 |
| | Altered | 5 (8.9) | 3 (7.5) | 8 (8.3) | |
| TC (mg/dL) | Normal | 45 (80.4) | 33 (82.5) | 78 (81.3) | 1.000 |
| | Altered | 11 (19.6) | 7 (17.5) | 18 (18.8) | |
| HDL-c (mg/dL) | Normal | 41 (73.2) | 20 (50.0) | 61 (63.5) | 0.034* |
| | Altered | 15 (26.8) | 20 (50.0) | 35 (36.5) | |
| LDL (mg/dL) | Normal | 22 (39.3) | 17 (42.5) | 39 (40.6) | 0.916 |
| | Altered | 34 (60.7) | 23 (57.5) | 57 (59.4) | |
| TG (mg/dL) | Normal | 53 (94.6) | 34 (85.0) | 87 (90.6) | 0.214 |
| | Altered | 3 (5.4) | 6 (15.0) | 9 (9.4) | |

**p < 0.05. BMI: body mass index; WC: waist circumference; TC: total cholesterol; HDL-c: high density lipoprotein; LDL: low density lipoprotein; TG: triglycerides.*

A study on estimated prevalence of nutritional status categories among adults, residents of the city of São Paulo, based on self-reported information on weight and height from a population-based inquiry revealed important findings.[34] The prevalence of overweight and obesity in this population was 34.3% and 13.2%, respectively, indicating the need for an intervention, particularly due to the influence of obesity as a risk factor for severe complications.[34] These results are in accordance with VIGITEL,[35] which reported a prevalence of overweight among Brazilian men and women of 54.7% and 47.4%, respectively. This same study reported a 51% of overweight and 18% of obesity in the state of Sao Paulo in both sexes.

Therefore, studies on nutritional strategies with significant positive effects on reducing obesity should guide clinical practices aimed at obesity prevention and weight control. Although there are few Brazilian studies evaluating the metabolic effects of vegetarian diets, there is a consensus that this eating pattern is associated with lower BMI, TG, TC and LDL-c compared with an omnivore diet.[20]

Regarding CVDs, a meta-analysis investigated the mortality rate from CVDs and cancer among vegetarians and omnivores. Mortality rate from CVDs and cancers was lower in vegetarians in seven cohort studies.[8,29] Analysis of mortality data from these cohorts showed that the distribution of deaths from CVDs between vegetarians and omnivores were not significantly different; however, one must consider the mild and moderate protective effects of vegetarian diets on CVDs must be considered.

In Brazil a study that compared nutritional awareness between vegetarians and omnivores showed that vegetarians followed a more balanced diet in terms of adequacy in the number of servings from each food group.[36]

In addition, data from the Brazilian Family Budget Enquiry37 showed that individuals aged from 19 to 59 years showed the highest prevalence of inadequate inatake of vitamin D, E, A and C, calcium and magnesium.

Mean dietary fiber intake was 22 g per day, lower than the recommended value of 25 g/day according to the Brazilian Ministry of Health. The low fiber intake may be explained by a diet based on refined cereals and low intake of fruits, vegetables and whole cereals. In this context, potential benefits of a well-balanced vegetarian diet would be of value, due to its main characteristic of low or no consumption of animal meat combined with increased intake of vegetable foods.[37]

Population-based studies have showed that, compared with an omnivore diet, vegetarian diets have higher nutrient density.[38] The concept of nutrient density is defined by Phillip et al.[2] as the amount of nutrient (g or mg) divided by the total of calories. Vegetarians consume fewer calories and higher amounts of fibers, vitamins A, C and E, thiamin, riboflavin, folate, calcium, magnesium, iron and potassium.[28,38]

The correct intake of all food groups may also normalize plasma lipid and lipoprotein levels, and for this reason, vegetarians are more likely to have normal lipid levels. A recent study by Najjar et al.[39] showed that a plant-based diet has a favorable effect on lipid levels and reduces inflammatory markers and other atherogenic lipoproteins and particles. The authors showed that the levels of HDL-c were significantly higher in vegetarians than in omnivores; it is known that increased HDL-c levels are associated with reduced relative risk for CVDs.[39]

A meta-analysis involving 4,177 individuals was conducted to compare the effects of vegetarian and omnivore diets on HDL-c.[40] Different from what was expected from the authors, vegetarian diets did not alter plasma HDL-c [standardized mean difference (SMD) = 0.02 mmol/l; 95% confidence interval (CI): 20.19 to 0.22 mmol/l]. In Asia and Latin America countries, no significant differences in HDL-c levels were found between vegetarians and omnivores (SMD = 20.09 mmol/l; 95% CI: 20.43 to 0.25 mmol/l), and in Europe and North America countries, plasma HDL-c was also not different between the two diets (SMD = 0.09 mmol/l; 95% CI: 20.19 to 0.36 mmol/l). So far, available studies in Brazil are not sufficient to support these conclusions.

In our study, the higher levels HDL-c in vegetarians compared with omnivores may have been associated with the practice of exercise, which was more frequent in this group, in addition to the absence of smoking habits and higher consumption of monounsaturated fatty acids in this group (not forgetting the genetic predisposition). However, this study was focused on assessing the nutritional status rather than food intake of participants.

Other studies involving vegetarian individuals have reported contradicting results. A study with Buddhist vegetarians showed significantly higher BMI and body fat in these individuals compared with omnivores.[38] The authors attributed this finding to their habits of consuming fried foods, common to the Asian cooking style.

In scientific literature, contradictory findings are as important as conclusive ones, as they may encourage new way of thinking and hypothesis formulation, leading to advances in scientific knowledge. Therefore, it is erroneous to think that the adoption of a vegetarian diet will necessarily promote improvements in biochemical parameters. Factors like ethnicity, culture, among others, may exert an important influence on following a so-called 'healthy' diet.

This study has some limitations that deserve to be mentioned. Since this was a cross-sectional study, both exposure and outcomes were collected at the same time point. For this reason, neither temporal or a causal relationship between the events could be established, nor could we determine whether the results were influenced by facts of the past. Also, regarding the use of nutritional supplements, since we did not evaluate their nutritional composition, the possibility that they constituted a confounding factor cannot be ruled out. Another possible confounding factor that may have influenced HDL-c levels was the practice of physical exercise by vegetarians.

## Conclusion

The findings of this study indicated that, compared with omnivores, vegetarians have better nutritional status, with lower BMI and WC. Vegetarians were also more likely to practice exercise and showed significantly lower levels of HDL-c.

## Author contributions

Conception and design of the research: Pimentel CVMB, Philippi ST, Teodorov E. Acquisition of data: Pimentel CVMB, Simomura VL. Analysis and interpretation of the data: Pimentel CVMB, Philippi ST, Simomura VL, Teodorov E. Statistical analysis: Pimentel CVMB, Simomura VL. Obtaining financing: Pimentel CVMB, Teodorov E. Writing of the manuscript: Pimentel CVMB. Critical revision of the manuscript for intellectual

content: Pimentel CVMB, Philippi ST. Supervision / as the major investigador: Pimentel CVMB, Philippi ST.

### Potential Conflict of Interest

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

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### Study Association

This article is part of the thesis of Doctoral submitted by Carolina Vieira de Mello Barros Pimentel, from *Faculdade de Saúde Pública da Universidade de São Paulo*.

### Ethics approval and consent to participate

This study was approved by the Ethics Committee of the *Universidade de São Paulo – Faculdade de Saúde Pública* under the protocol number 2260. 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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