

Original

## Relation between dietary and circulating lipids in lacto-ovo vegetarians

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Abstract

**Introduction:** As factors that have a positive influence on health and specifically on serum lipids and blood pressure, the nature and composition of vegetarian diets is one of the most speculated issues in nutrition.

**Aims:** The aim of the present study was to compare diet, lipid profile and blood pressure levels in Brazilian lacto-ovo vegetarians and non-vegetarians.

**Methods:** A cross-sectional study was carried out involving 87 male and female adult volunteers (29 lacto-ovo vegetarians and 58 non-vegetarians). Two non-vegetarians were selected for each vegetarian (paired for age and gender) in order to enhance the power of the statistical tests. Mean age was 40 (13) years; 58.6% were males.

**Results:** No differences were found regarding nutritional status based on the BMI. This similarity may be explained by the similar energy intake and degrees of physical activity in both groups. Regarding blood pressure, the only difference between groups was systolic arterial pressure, which was higher among the non-vegetarians. Among the intake parameters analysed, only energy intake and the intake of polyunsaturated fat were similar between groups. Mean total cholesterol and LDL were higher among non-vegetarians. Mean serum TG was higher among the vegetarians. The greater consumption of carbohydrates among the vegetarians was reflected in the higher serum triglyceride levels.

**Conclusions:** Although all products of animal origin have a greater amount of protein, fat and saturated fatty acids, the absence of meat from the diet may have accounted for the better lipid profile among the lacto-ovo vegetarians may also stem from the high intake of fibre and antioxidants.

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Key words: Diet. Vegetarian. Cholesterol.

### RELACIÓN ENTRE LÍPIDOS DIETÉTICOS Y CIRCULANTES EN OVOLACTOVEGETARIANOS

Resumen

**Introducción:** La naturaleza y composición de la dieta de los vegetarianos, como factores que interfieren positivamente en la salud y específicamente sobre los lípidos séricos y la tensión arterial, constituyen uno de los temas más especulados en Nutrición.

**Objetivos:** El presente estudio tuvo como objetivo comparar la dieta, perfil lipídico y niveles de tensión arterial de huevo-lacto-vegetarianos y no-vegetarianos brasileños.

**Métodos:** Estudio transversal que se realizó con 87 voluntarios adultos del sexo masculino y femenino (29 ovolactovegetarianos y 58 no-vegetarianos). Dos no-vegetarianos fueron seleccionados para cada vegetariano (pareados por edad y sexo) a fin de reforzar el poder de los tests estadísticos. La edad promedio fue 40 (13) años, el 58,6% eran del sexo masculino.

**Resultados:** No se encontraron diferencias en cuanto al estado nutricional basado en el IMC. Esa semejanza puede ser explicada por el consumo de energía y niveles de actividad física semejantes en ambos los grupos. En cuanto a la tensión arterial, la única diferencia entre los grupos se dio en la tensión arterial sistólica, que fue mayor entre los no-vegetarianos. Entre los parámetros de consumo analizados, solo el consumo de energía y el de grasa poliinsaturada fue semejante entre los grupos. El promedio del colesterol total y LDL fue mayor entre los no-vegetarianos. El promedio de TG sérico fue mayor entre los vegetarianos. El mayor consumo de carbohidratos entre los vegetarianos se reflejó en los niveles más elevados de triglicéridos en el suero.

**Conclusiones:** Aunque todos los productos de origen animal posean una mayor cantidad de proteínas, grasas y ácidos grasos saturados, la ausencia de carne de la dieta puede haber sido responsable por el mejor perfil lipídico entre los huevo-lacto-vegetarianos que también puede haber sido resultado de la ingestión elevada de fibras y antioxidantes.

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Palabras clave: Dieta. Vegetariano. Colesterol.

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## Introduction

Cardiovascular disease is a serious public health problem throughout the world. Coronary artery disease, in particular, is the main cause of morbidity and mortality in industrialised societies.<sup>1</sup> The association between high lipid levels in the blood and the incidence of cardiovascular disease is well documented in the literature, especially atherosclerosis, which can lead to conditions such as myocardial infarction and stroke.<sup>2</sup> Clifton and Nestel suggest that the type of diet has little influence over levels of serum cholesterol, which the authors state are determined nearly exclusively by metabolic activity (expression of genetic load), age and gender.<sup>3</sup> However, lower levels of blood lipids have been found in individuals who consume a vegetarian diet in comparison to those who eat meat.<sup>4,5</sup> Key et al. analysed five prospective studies involving 76,172 male and female vegetarians and non-vegetarians with similar lifestyles; a comparison of causes of death revealed that death by ischemic heart disease was 24% lower among vegetarians and even lower among lacto-ovo vegetarians.<sup>6</sup> The lower risk of cardiovascular disease among vegetarians may be partially explained by the lower levels of cholesterol in these individuals.<sup>7</sup> Arterial hypertension is one of the most important risk factors for the development of coronary artery disease and diet plays an important role in its aetiopathogenesis. A vegetarian diet seems to have a hypotensive effect; when normotensive and hypertensive non-vegetarians change to a vegetarian diet, they experience a reduction in blood pressure levels.<sup>8</sup>

A vegetarian diet is considered healthier than a non-vegetarian diet based on the idea that a vegetable-rich diet is necessarily low in fat. The possible health benefits from such a diet are related to the low intake of saturated fats. However, lacto and lacto-ovo vegetarian diets include dairy products (milk, cheese, butter, eggs, etc.), which are rich in saturated fats.<sup>4,9</sup> A vegetarian diet differs from a non-vegetarian diet in aspects that go beyond the mere elimination of meat products. Vegetarians have a higher intake of fruit, vegetables, grains, legumes and nuts, which are rich in antioxidants and phytochemicals that have properties that are able to slow down or may impede the development of chronic diseases. A vegetarian diet most often has a lower amount of saturated fatty acids and a relatively greater amount of unsaturated fatty acids and fibre.<sup>10</sup>

There are no prevalence studies involving vegetarians in Brazil and, as with other developing nations, the number of vegetarians in the country is unknown.<sup>11</sup> The aim of the present study was to compare lipid profile and dietary intake in Brazilian lacto-ovo vegetarians and non-vegetarians.

## Subjects and methods

### Subjects

A cross-sectional study was carried out involving male and female adult and elderly lacto-ovo vegetarian and

non-vegetarian volunteers. All participants signed terms of informed consent. The study received approval from the ethics committee of the Centre for Health Sciences of the Universidade Federal de Pernambuco (UFPE) (Brazil) in compliance with Resolution 196/96 of the Brazilian National Health Council (process n° 053/07).

Data were collected between July 2007 and August 2009. Individuals who reported not consuming red or white meat in at least the previous year were classified as vegetarians and those with no meat restrictions were classified as non-vegetarians. The sample size was determined by spontaneous demand. Vegetarians were invited to participate through the divulgation of the study objectives at natural and/or vegetarian restaurants in the neighbourhoods surrounding the UFPE. Non-vegetarians were recruited from the neighbourhoods surrounding the UFPE and included in the study when fulfilling the eligibility criteria. Two non-vegetarians were selected for each vegetarian (paired for age and gender) in order to enhance the power of the statistical tests. Individuals with temporary or permanent physical impairments that rendered the anthropometric and/or biochemical evaluations impossible and those with chronic diseases who took medications that might influence the lipid profile were excluded from the study.

### Dietary intake

Data on dietary intake were collected using a three-day food log (two weekdays and one weekend day). The Dietpro5i program (Agromidia Software Ltda, 2007) was used for the analysis of the diet logs. Mean values from the three days of the dietary intake of each participant were considered for the analyses.

### Biochemical analysis

Five ml of blood was collected through a deep vein puncture following twelve hours of fasting. The LABTEST DIAGNOSTICA system (Brazil) was used for the determination of circulating lipids. The enzyme test determined total cholesterol total (TC), high-density lipids (HDL) and serum triglycerides (TG). Low-density lipid (LDL) concentration was determined using the Friedwald formula:  $LDL = TC - (HDL + TG/5)$ . The abnormality criteria defined by the 4<sup>th</sup> Brazilian Guidelines on Dyslipidemia and Atherosclerosis Prevention were used for plasma lipids: TC  $\geq$  200 mg/dl; HDL  $\leq$  40 mg/dl and  $\leq$  50 mg/dl for men and women, respectively; LDL  $\geq$  100 mg/dl; and TG  $\geq$  150 mg/dl.<sup>12</sup> All analyses were performed at the UFPE Nutrition Biochemistry Laboratory.

### Anthropometrics

Anthropometrics consisted of the determination of height and weight following method recommended by

**Table I**  
General characteristics of the sample

Characteristics	Groups			
	Vegetarians		Non-vegetarians	
	n	%	n	%
<i>Physical activity</i>				
Yes	14	48.3	20	34.5
No	15	51.7	38	65.5
<i>Use of supplements</i>				
Yes	8	27.6	7	12.1
No	21	72.4	51	87.9
<i>Smoking habits</i>				
Yes	1	3.4***	29	50.0***
No	28	96.6	29	50.0
<i>Alcohol consumption</i>				
Yes	–	–	7	12.1
No	29	100.0	51	87.9
<i>BMI</i>				
Malnourished	2	6.9	4	6.9
Ideal range	18	62.1	28	48.3
Overweight	8	27.6	22	37.9
Obese	1	3.4	4	6.9
Total	29	100.0	58	100.0

\*\*\*significantly different % values between vegetarians and non-vegetarians;  $p < 0.001$ .

Lohman et al.<sup>13</sup> Weight was determined using a platform scale (FILIZOLA<sup>®</sup>) with a capacity of 150 kg and precision of 100 g. Height was determined using a portable wooden stadiometre (WCS<sup>®</sup>, WOOD model) with a capacity of 2.20 m and precision of 1 cm. Nutritional status was classified using the body mass index (BMI) based on the values recommended by the World Health Organisation<sup>14</sup> for adults and the Lipschitz<sup>15</sup> classification for elderly individuals.

#### Blood pressure

Blood pressure (BP) was determined and classified in accordance with the 6<sup>th</sup> Brazilian Arterial Hypertension Guidelines.<sup>16</sup> BP was measured by a single observer trained in using a digital sphygmomanometer (Geratherm desktop<sup>®</sup>). Hypertension was defined as systolic arterial pressure (SAP)  $\geq 140$  mmHg and/or diastolic arterial pressure (DAP)  $\geq 90$  mmHg.

#### Statistical analysis

The databank was constructed using the Excel program and calculations were carried out using the Statistical Package for Social Sciences, version 15.0 (2006; SPSS, Inc., USA). Absolute and percentage distributions and mean and standard deviation values

were used for the data analysis. Pearson's chi-square test, Fisher's exact test (when the chi-square test was not applicable), the paired Student's t-test, the Student's t-test with equal or unequal variances were used in the comparisons and the Student's t-test was used for the hypothesis of null correlation in the population. Levene's F test was used for the determination of the hypothesis of equality of variance and the mean values of the two non-vegetarians paired for each vegetarian were used for the paired Student's t-test. The level of significance for all statistical tests was set at 5.0%.

#### Results

Eighty-seven volunteers participated in the present study (29 lacto-ovo vegetarians and 58 non-vegetarians). Mean age was 40 [standard deviation (SD) = 13] years; 58.6% were males. Mean duration of adherence to the lacto-ovo vegetarian diet was 16 (SD = 12) years. Table I displays the general characteristics of the sample. The groups only differed with respect to smoking habits ( $p = 0.00$ ); 29 non-vegetarians (50%) smoked, whereas only one vegetarian smoked. There were no differences in the classification of nutritional status, as assessed using the BMI; the majority of individuals were within the ideal range. There was no significant difference in mean BMI ( $p = 0.55$ ), which was 23.98 (SD = 3.57) kg/m<sup>2</sup> among the vegetarians and 24.42 (SD = 3.62) kg/m<sup>2</sup> among the non-vegetarians. Table II displays the dietary intake indicators. Nearly all the parameters analysed were different between groups, with the exception of energy intake and the intake of polyunsaturated fat.

Table III displays the levels of serum lipids and arterial pressure. There were significant differences between groups regarding mean TC, LDL and TG, which were higher than the acceptable values recommended by the 4<sup>th</sup> Brazilian Guidelines on Dyslipidemia and Atherosclerosis Prevention.<sup>12</sup> TC and LDL levels were higher among the non-vegetarians ( $p = 0.00$ ), whereas serum TG was higher among the vegetarians ( $p = 0.04$ ). No difference in HDL was found between groups.

Regarding blood pressure parameters, the only statistically significant difference between groups was in systolic arterial pressure (SAP) ( $p = 0.02$ ), which was higher among the non-vegetarians. The vegetarian group had a mean SAP value below 8.9 mmHg and DAP of 3.95 mmHg. However, both groups had mean SAP and DAP values with the range recommended by the 6<sup>th</sup> Brazilian Arterial Hypertension Guidelines.<sup>16</sup> The analysis of possible correlations between lipid profile and intake of total lipids, saturated fatty acids and dietary cholesterol revealed only positive correlations in the non-vegetarian group: between total lipid intake and HDL ( $r = 0.391$ ) and between saturated fatty acids and HDL ( $r = 0.447$ ) (Figs 1 and 2, respectively).

**Table II**  
Food intake indicators according to type of diet

Intake variables	Groups				CI
	Vegetarians		Non-vegetarians		
	Mean	SD	Mean	SD	
Energy (kcal)	2,296.50	726.12	2,382.43	548.32	-85.93 (-369.31 to 197.45)
Carbohydrates(% TEV)	59.15***	5.72	49.73***	4.13	9.42 (6.69 to 11.87)
Proteins (% TEV)	15.06***	2.53	18.16***	1.74	-3.10 (-4.11 to -2.10)
Lipids (% TEV)	25.79***	5.45	32.10***	3.74	-6.31 (-8.49 to -4.15)
SFA (% TEV)	8.37***	2.51	10.22***	1.85	-1.85 (-3.02 to -0.68)
Polyunsaturated fat (% TEV)	6.69	3.02	7.55	1.18	-0.86 (-1.87 to 0.13)
Monounsaturated fat (% TEV)	8.34***	1.98	10.55***	1.67	-2.21 (-3.02 to -1.40)
Dietary cholesterol (mg)	158.58***	108.51	367.24***	159.61	-208.66 (-283.82 to -133.50)
Total fibres (g)	32.02*	13.99	24.26*	9.41	7.76 (1.61 to 13.90)

\*p < 0.05, \*\*\*p < 0.001 significantly different mean values between vegetarians and non-vegetarians.  
SD: standard deviation; CI: confidence interval to difference of means. TEV: total energy value; SFA: saturated fatty acids.

## Discussion

As factors that have a positive influence on health and specifically on serum lipids and blood pressure, the nature and composition of vegetarian diets is one of the most speculated issues in nutrition. Epidemiological studies often report that vegetarians are thinner than non-vegetarians.<sup>17,18,19</sup> However, this difference was not found among the participants of the present study, as the classification of nutrition status (as determined by the BMI) was similar and the majority was within the ideal range. This similarity may be explained by the similar energy intake and degrees of physical activity in both groups.

While energy intake was similar, the distribution of macronutrients differed significantly between groups. In general, energy intake was more in the form of carbohydrates among the vegetarians (approximately 60% of the total caloric value) than among the non-vegetarians. Fibre intake tends to be higher among vegetarians (on average, 41% greater than among non-vegetarians) due

to the preference for non-refined cereals.<sup>11,20</sup> The greater consumption of carbohydrates among the vegetarians was reflected in the higher serum triglyceride levels in comparison to those among the non-vegetarians, which corroborates the findings of previous studies.<sup>18,21</sup> Vegetarians generally have lower protein intake in comparison to individuals who eat meat, but still within an adequate intake range.<sup>18,20,22</sup> Vegetal protein can supply an individual's needs when a variety of foods of a vegetal origin is consumed and the energy needs are met.<sup>23</sup> In the present study, protein intake was lower among the vegetarians than the non-vegetarians, but within the recommended range, which corroborates the findings of the aforementioned studies.

Analysing the three-day diet logs of 34 non-vegetarians, 52 lacto-ovo vegetarians and 38 vegans of both genders, Draper et al. found similar fat intake between the lacto-ovo vegetarians and non-vegetarians and lower fat intake among the vegans.<sup>24</sup> The elimination of meat from the diet may only slightly reduce the consumption of fat

**Table III**  
Serum lipid and blood pressure levels according to type of diet

Variables	Groups				CI
	Vegetarians		Non-vegetarians		
	Mean	SD	Mean	SD	
Cholesterol total (mg/dL)	160.06***	48.53	207.11***	34.73	-47.05 (-70.75 to 23.26)
LDG (mg/dL)	87.40***	50.38	143.79***	34.09	-56.39 (-80.44 to 32.35)
HDL (mg/dL)	44.57	12.40	40.07	7.42	4.50 (-0.55 to 9.56)
Triglycerides (mg/dL)	150.25*	86.89	115.86*	35.56	34.39 (2.51 to 66.27)
SAP (mmHg)	114.86*	16.69	123.76*	12.47	-8.90 (-16.40 to -1.39)
DAP (mmHg)	73.24	11.54	77.19	8.18	-3.95 (-8.74 to 0.84)

\*p < 0.05, \*\*\*p < 0.001 significantly different mean values between vegetarians and non-vegetarians.  
SD: standard deviation; CI: confidence interval to difference of means. LDL: low-density lipids; HDL: high-density lipids; SAP: systolic arterial pressure; DAP: diastolic arterial pressure.

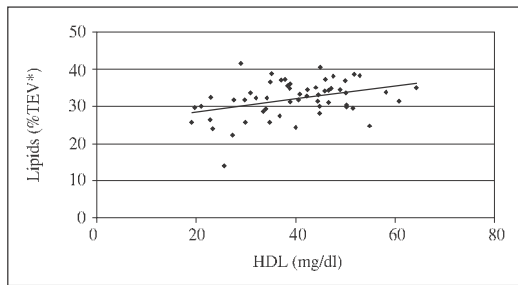


Fig. 1.—Positive correlation between percentage of lipids consumed and HDL in the non-vegetarian group ( $r = 0.391$ ).

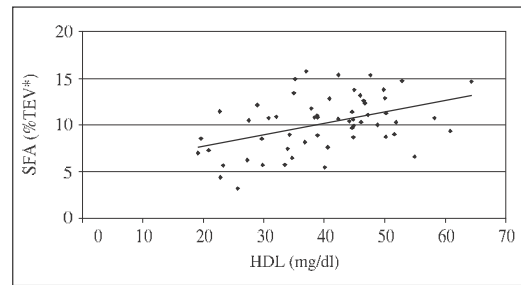


Fig. 1.—Positive correlation between percentage of saturated fatty acids consumed and HDL in the non-vegetarian group ( $r = 0.447$ ).

and saturated fatty acids.<sup>25</sup> In the present study, however, cholesterol intake and the percentage of energy derived from lipids and saturated fatty acids were significantly lower in the vegetarian group in comparison to the non-vegetarian group, despite the fact that the vegetarian diet included foods of an animal origin, such as milk products and eggs. For a number of decades, a reduction in fat intake has been the main focus of dietary recommendations. In common thinking, the term “dietary fat” is closely related to obesity and heart disease, whereas the expressions “low in fat” and “fat free” have become synonymous with cardiovascular health. In response to campaigns directed at lowering fat intake, the food industry has offered a large number of products with low fat content, but with high amount of refined carbohydrates.<sup>26</sup> Thus, while the percentage of dietary fat has been declining in the United States, total calorie intake has not reduced and the prevalence of obesity and type 2 diabetes mellitus has been rising drastically.<sup>26,27,28</sup> The lacto-ovo vegetarians analysed consumed less fat than the non-vegetarians, but the classification of nutritional status, as determined by BMI values, did not differ between groups, as the majority were within the ideal range. Therefore, dietary fat did not appear to be a determinant of body weight in the present study.

With regard to polyunsaturated fat intake, in a study carried out in the United Kingdom involving 33,883 male and female individuals who ate meat and 31,546 who did not eat meat, Davey et al. report similar results to those of the present study, in which polyunsaturated fat intake was similar between omnivores and vegetarians, accounting for an average of 6% of the total calorie intake.<sup>18</sup>

Regarding monounsaturated fat, however, studies have demonstrated a greater intake of this type of fat among omnivores in comparison to vegetarians.<sup>29</sup> The present study corroborates this finding. A plausible explanation for this would be the preparation of the typical western diet among omnivores, involving partially hydrogenated vegetable oils, red meat and dairy fat, which are sources of both saturated and monounsaturated fat.<sup>9</sup>

Regarding blood pressure parameters, the vegetarians had lower SAP values than the non-vegetarians, even while exhibiting similar BMI values and degrees

of physical activity. This finding corroborates a number of studies that demonstrate that vegetarians have lower blood pressure than non-vegetarians (between 5 mmHg and 10 mmHg), even when BMI values are similar between groups.<sup>8</sup> Thus, the lower blood pressure levels among vegetarians appears not to stem from a lower BMI, the regular practice of physical exercise, abstinence from meat, type of dietary fat, fibre intake or differences in the intake of a specific nutrient such as potassium, magnesium, sodium and calcium, but rather to the set of nutrients found in foods of a vegetal origin.<sup>30</sup>

An analysis of diet and lipid profile reveals that the largest difference between groups was the consumption of meat, as lacto-ovo vegetarians also consume dairy products. Although all products of animal origin have a greater amount of protein, fat and saturated fatty acids, the absence of meat from the diet may have accounted for the better serum levels of TC and LDL among the vegetarians. The better lipid profile among the lacto-ovo vegetarians may also stem from the high intake of fibre, antioxidants and other classes of active biological compounds, such as phytosterols, which act in the modulation of cholesterol synthesis. The absence of the harmful effects of tobacco may also have contributed toward the better profile.

The hypocholesterolemic action of fibre depends on each type of fibre and the amount consumed. The possible mechanisms involved are an increase in the faecal excretion of bile acids, neutral sterols, cholesterol and fatty acids as well as the indirect effects of replacing foods rich in cholesterol and fat with those rich in fibre.<sup>31</sup> The action of the phytosterols found in foods of a vegetal origin occurs due to their structural similarity to cholesterol.<sup>32</sup> The mechanism proposed for the action of phytosterols involves competition with dietary cholesterol in the interior of the micelle at the moment of the fat emulsification. This competition is thought to lead to the expulsion of cholesterol from the micelle and subsequent faecal excretion.

HDL was only positively correlation with total lipid and saturated fat intake in the non-vegetarian group. This may be explained by the greater consumption of saturated fatty acids in this group, as the increase in HDL in the plasma is proportional to saturated fatty acid

intake.<sup>26</sup> In order for free cholesterol to be transported by HDL, esterification must occur by the action of lecithin cholesterol acyltransferase (LCAT), which is facilitated by apoprotein A-1 (APOA-1).<sup>33</sup> In both humans and animals, the type of dietary fat modulates HDL levels.<sup>34</sup> Diets rich in saturated fatty acids increase levels of HDL and APOA-1, its main apolipoprotein, which potentiates the action of LCAT, raising the amount of esterified cholesterol and consequently raising HDL levels.<sup>35</sup>

A healthy diet does not stem merely from eliminating meat and fat. Despite the difficulty in intervening in the change of eating habits, it is of fundamental importance to stress the benefits of a diversified diet rich in vegetables, fibre and antioxidants for a desirable lipid profile and adequate blood pressure, which are important factors in the prevention of cardiovascular disease.

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