Dietary fat Intake Had a Different Influence on Body Mass Index in Active and Inactive Subjects: a Cross-Sectional Study

O Consumo de gordura Alimentar Influenciou Diferentemente no Índice de Massa Corporal de Indivíduos Ativos e Inativos: um Estudo Transversal

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1 Introduction

This work stands out for assessing the frequency of risk factors for cardiovascular disease (CVD) in active and inactive people and associating them with food intake, since this approach in literature is scarce.1

Non-communicable chronic diseases (NCDs), especially CVD, are the leading cause of death worldwide, and also responsible for public health care spending growth, especially in low- and middle-income countries.2 In Brazil, CVDs have been identified as the main cause of death since the 1990s, and the risk factors with the highest attributable risk are hypertension, overweight, physical inactivity and dietary factors.3

With regards to being overweight, this increases the risk of heart disease, diabetes mellitus and hypertension.4 In Brazil, according to body mass index (BMI), one in two adults is overweight and 24.1% of individuals over 18 years old are hypertensive.5

Despite the BMI being widely used to assess the body weight of a population, the assessment of body fat percentage (BF%) and waist circumference (WC) are necessary to improve the diagnosis made through the BMI.6

An inappropriate nutrition increases the chance of being overweight and hypertensive.7 Specifically considering the consumption of fat, a higher mortality rate for coronary artery disease were found among individuals who ingested excessive amounts of total and saturated fat.8

Abstract

The understanding of cardiovascular disease (CVD) risk factors and their association with food and physical activity is not yet completely clear. This study aimed to evaluate the association between CVD risk factors with dietary intake, according to the physical activity level. A cross-sectional study was conducted with Brazilian individuals attended by the Public Health System. Demographic, blood pressure, physical activity practice, anthropometry and food intake data were collected and evaluated. Of the 83 participants, 61.4% were active. No difference were observed in the frequency of CVD risk factors, anthropometric data, blood pressure, estimated energy requirement, energy and nutrient intake between the active and inactive subjects (p ≥ .05). There was also no difference in the frequency of energy and nutrient intake adequacy between groups (p ≥ .05). Among the inactive subjects, it was found that the consumption of total (OR: 1.021, p = .035) and saturated (OR: 1.060, p = .033) fat was predictor of being overweight, with no relationship between food intake and the risk factors for CVD when the total participants or active individuals were considered (p ≥ .05). No difference was observed in the frequency of CVD risk factors between active and inactive individuals, however, total and saturated fat consumption increased the chance of being overweight among the inactive individuals.

Keywords: Cardiovascular Diseases. Food Consumption. Exercise. Body Weight. Health Systems.
Physical inactivity increases the prevalence of CVD and their risk factors, such as hypertension and overweight. Conversely, the benefits of physical activity include the reduction of fat in the abdominal area and improvements regarding respiratory capacity, lipid profile and insulin sensitivity.9

There is no scientific evidence that food inadequacy influences less on the development of a CVD risk factor in active when compared to inactive individuals.

Therefore, the hypothesis of this study was that an inadequate food intake influences more on the development of CVD risk factors in inactive than active people, and the aim of this study was to evaluate the association between CVD risk factors with dietary intake, according to the physical activity level.

2 Material and Methods

2.1 Study design, sampling and selection criteria

This observational analytical cross-sectional study was developed with adults and older adults attended by the Public Health Service (PHS) of Santo Antônio de Goiás, located in the west central region of Brazil. Data collection occurred during two health promotion campaigns carried out by the Health Department of the city, in October and November 2014.

A total of 154 people were present, with 83 individuals of both genders, aged between 24 and 85 years, being included in this study (Figure 1).

Figure 1 - Flowchart of recruitment and selection of study participants

The inclusion criteria of the subjects for the study were: to be an adult (20 to 59 years) or an older adult (over 60 years). Children, adolescents, pregnant women and people with special needs (physical and/or cognitive disabilities) were excluded.

The sample size (n = 83) of the study presented an effect size of 0.57, determined from a sample power of 0.80, α = 0.05 and β = 0.20, according to the sample calculation performed in the G*Power program version 3.0.

2.2 Ethical aspects

The Research Ethics Committee of the Federal University of Goiás (protocol n° 784.446/2014) approved this study. All participants were previously informed about the aim and procedures of the study and signed the consent form. Due to being a research project involving human subjects, all the procedures followed the recommendations of resolution 466/2012 of the National Health Council.

2.3 Evaluation protocols

Socio-demographic and economic characterization. Data about gender, age, marital status, schooling and income were collected from a specific questionnaire.

2.4 Practice of physical activity

For the classification of the practice of physical activity in the free time, individuals that had performed, in the last three months, at least 150 minutes of moderate-intensity activity (eg: bodybuilding, walking, swimming) per week, or at least 75 minutes of vigorous-intensity activity (eg: jogging, football, aerobics) per week were considered active. Participants who reported less time practicing physical activity were classified as inactive.9

2.5 Evaluation of blood pressure

To obtain the systolic (SBP) and diastolic blood pressure (DBP) values, the Omron® (HEM-705 CP model, Hoofddorp, Netherlands) electronic digital equipment was used. For the first measurement, the subject was previously sitting by 10 minutes, and another measurement was performed 5 minutes later, considering the average of the two values obtained. Subjects that presented values of SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg, or who reported using antihypertensive medications, were considered hypertensive, one of the risk factors for CVD.

2.6 Anthropometric assessment

The BMI, WC and BF%, considered risk factors for CVD, were evaluated. All anthropometric measurements were collected according to the recommendations of the International Society for the Advancement of Cineanthropometry (ISAK).11 Weight was measured using a Plenna® (acqua model, São Paulo, Brazil) electronic scale and height with a Seca® (213 model, Hamburg, Germany) portable stadiometer, allowing the BMI to be calculated. The classification of BMI for adults is: low weight for values < 18.50 kg/m², eutrophy between 18.50 and 24.99 kg/m² and overweight ≥ 25.00 kg/m².12
Among older adults, a BMI $\leq 22$ kg/m$^2$ is indicative of low weight, between 22 and 27 kg/m$^2$ eutrophy and $\geq 27$ kg/m$^2$ overweight.\textsuperscript{13}

The WC was measured with a Cescorf® (Porto Alegre, Brazil) anthropometric inextensible tape. The cut-off points were: normal WC for values $< 94$ cm and $80$ cm and high WC for values $\geq 94$ cm and $80$ cm for men and women, respectively.\textsuperscript{14}

The body composition of individuals with BMI $< 30$ kg/m$^2$ was obtained by calculating the body density estimated by the equation proposed by Petroski.\textsuperscript{15} To calculate the body density, the skinfolds were obtained from the triceps, subscapular, iliac crest and medial calf with a Cescorf® (traditional model, Porto Alegre, Brazil) adipometer, considering the mean of three values of each measurement.\textsuperscript{15}

For individuals with BMI $\geq 30$ kg/m$^2$ the Tran and Weltman protocol\textsuperscript{16} was used, considering the mean of two measurements of abdominal circumference, obtained by an anthropometric tape (Cescorf®, Porto Alegre, Brazil). For the classification of BF%, the cut-off points for obesity were $\geq 26$% for men and $\geq 39$% for women up to 39 years, $\geq 29$% for men and $\geq 41$% for women aged 40-59 years and $\geq 31$% for men and $\geq 43$% for women over 60 years.\textsuperscript{17}

2.8 Estimated Energy Requirement (EER)

To obtain the EER for each individual, specific equations were selected according to gender and age group, using the values of age (years), body weight (kg), height (m) and the physical activity coefficient. To assess the adequacy of energy consumption the estimated standard deviation, according to age, BMI and gender, were considered.\textsuperscript{19}

2.9 Data analysis

The normality of the distribution of the data for each variable was evaluated using the Kolmogorov-Smirnov test. The variables with normal distribution were expressed as mean and standard deviation and those that did not have normal distribution as median and interquartile range (25 and 75 percentiles). Categorical variables were presented as relative frequency.

The comparison of blood pressure, anthropometric data, DEC, nutrients intake and EER between active and inactive subjects was performed using Student’s t-test for independent samples with normal distribution variables and the Mann- Whitney test with the non-parametric variables.

Pearson’s chi-square test was used to compare the frequency of CVD risk factors and food intake adequacy between active and inactive individuals.

The binary logistic regression analysis was used to investigate whether the anthropometric variables and hypertension were associated to DEC and daily intake of carbohydrates, proteins, total fat, saturated fat, cholesterol, sodium and fiber. The BMI, WC, BF% and hypertension were categorized into: being overweight or not, normal or increased WC, normal or increased BF% and with or without hypertension, respectively. Considering the multicollinearity among the nutrients ($r \geq 0.80$), each variable of food consumption was analyzed separately with the dependent variables (risk factors for CVD).

A database was developed using Microsoft Excel® 2013 and data analysis was performed using the software SPSS (Statistical Package for the Social Sciences), 21.0 version. $P$ values $<.05$ were considered significant.

3 Results and Discussion

The study was conducted with 83 participants who had a mean age of 47.81 ($\pm 13.22$) years, 55.4% were men, 75.9% adults and 24.1% older adults.

Of the total individuals, 65.1% were married and 13.2% were single; 47.0% had completed kindergarten or elementary education and 31.3% completed high school; 54.2% had a monthly income of up to one minimum wage and 32.5% up to two minimum wages (R$ 788.00).

In relation to the practice of physical activity in the free time, 61.4% were active and 38.6% inactive. No difference
was observed in anthropometric and blood pressure values between groups (Table 1). Among active, 47.1% had hypertension and 56.9%, 54.9% and 31.4% had high BMI, WC and BF%, respectively. Among inactive, 50.0% had hypertension and 68.8%, 62.5% and 40.6% had high BMI, WC and BF%, respectively. Also, no difference was observed on the frequency of hypertension and anthropometric inadequacies between the active and inactive subjects (p ≥ .05).

In relation to food consumption, no difference was observed on EER, DEC and nutrients intake between groups (p ≥ .05) (Table 2). Regardless of the practice of physical activity, more than 50.0% of the individuals presented DEC, carbohydrate, protein, saturated fat, cholesterol and sodium intake above the recommendations, however, the consumption of dietary fiber was adequate. Among the inactive subjects, 71.9% had a total and saturated fat intake above the recommendations. There was no difference in the frequency of energy and nutrients intake adequacy between the active and inactive individuals (p ≥ .05) (Table 3).

The binary logistic regression analysis indicated that DEC and nutrients intake were not related to the occurrence of high values of BMI, WC, BF% or hypertension when considering all participants or the active subjects (p ≥ .05). However, it was
observed that the consumption of total (OR: 1.021, p = .035) and saturated fat (OR: 1.060, p = .033) among the inactive subjects increased the chance of being overweight (Table 4), according to BMI, with no association between food intake and WC, BF% or hypertension (p ≥ .05).

**Table 4 - Binary logistic regression analysis between being overweight and total and saturated fat intake in inactive individuals**

<table>
<thead>
<tr>
<th></th>
<th>OR t (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total fat</td>
<td>1.021 (1.001-1.041)</td>
<td>.035</td>
</tr>
<tr>
<td>Saturated fat</td>
<td>1.060 (1.005-1.117)</td>
<td>.033</td>
</tr>
</tbody>
</table>

95% CI: 95% confidence interval.  t Odds ratio.  
Source: Research data.

The main finding of this study was that only among the inactive individuals the consumption of total and saturated fat increased the chance of being overweight.

Among the individuals who participated in this study, 61.4% practiced physical activity in the free time. This finding was higher than that published by the Health Ministry of Brazil, in which the prevalence of people considered to be active in the free time, in Goiânia (capital of the state where this study took place) and Brazil, was 37.2% and 33.8%, respectively.1 The higher number of active people found in this study, when compared with the above data, can be attributed to the actions of the City Council of Santo Antônio de Goiás that contribute to the practice of physical activity, such as the construction of hiking trail and squares equipped for sports and leisure activities.

In relation to risk factors for CVD, no difference was observed between active and inactive individuals. Similar data was found by Oliveira et al.21 who did not observe any difference in the prevalence of obesity and hypertension between active and inactive adults and older adults of São Paulo, Brazil.

Although the practice of physical activity did not influence the frequency of CVD risk factors, more than 50.0% of the active and inactive individuals presented high BMI and WC values. This finding suggests that another life habit, such as inadequate diet, may have contributed more expressively to the high frequency of these risk factors for CVD, in both groups.7

In relation to the assessment of food intake, the mean DEC was higher than the mean EER, in both groups, probably contributing to more than half of the participants presenting BMI and WC above the recommendations. Data from the Brazilian Institute of Geography and Statistics (IBGE) of 2008 and 2009 revealed that, in Brazil, among the foods that presented increased acquisition per capita, compared to 2002 and 2003, were soft drinks, beer and bakery products, and all contribute to an energy intake above adequate, as found in this study.22

No difference was found in EER, DEC and nutrient intake between active and inactive subjects. Similar results were observed in other studies, in which the DEC, carbohydrate, protein, total fat, saturated fat, cholesterol and fiber intake did not differ in relation to the practice of physical activity.23-25

Previously, a systematic review also confirmed that an increase in the practice of physical activity may did not influence the energy and macronutrients intake.26 The data obtained in this study could indicate that the practice of physical activity in the free time did not increase the energy expenditure enough to promote differences in nutrient intake among active and inactive individuals. Therefore, a regular and more intense physical activity would be recommended to increase the energy expenditure, and consequently lead an increase in energy intake.27

In relation to added vegetable oil, salt and sugar, the individuals ingested quantities above the recommendation. The mean daily consumption of vegetable oil was 33.2 and 44.5 mL/day/person, for active and inactive subjects respectively, however, the United States Department of Agriculture (USDA) suggests that the total vegetable oil consumption for adults and older adults varies from 23.3 to 32.6 mL/day, according to age group.28 The World Health Organization (WHO) recommends that added salt should not exceed 5.0 g/day, a value lower than the mean found in both groups (7.3 g/day among active and 9.2 g/day among inactive).29 The daily consumption of sugar should be a maximum of 5.0% of EER (which equates to a mean of 29.0 g for active and 27.4 g for inactive subjects), with both groups exceeding this recommendation considering only the added sugar (40.1 and 42.5 g/day, respectively).30

Regarding the food consumption, it was observed that the adequacy of carbohydrate, total and saturated fat and cholesterol intake where higher in studies with North American and French active and inactive people than in individuals attended by the Brazilian PHS, however, in both groups the adequacy of fiber intake was higher in this study.23,31 This percentage of appropriate consumption (62.7% and 56.2% among active and inactive, respectively) seems to be mainly related to the ingestion of beans, one of the main food of Brazilian meal, which presented a mean of 189 g (2.2 portions) at lunch and dinner daily, which represents 8.5 g fiber/100 g of food.32,33

Regardless the practice of physical activity, a high percentage of individuals with protein intake above the recommendation was identified, which was also identified in other studies.34,35 However, for a more accurate assessment of this appropriate consumption an evaluation of the quality of protein would be necessary, adjusting the amount ingested for the score of essential amino acids and the digestibility values of different protein sources,36 a limitation of this study.

In relation to sodium consumption, in both groups more than 90.0% presented consumption above the recommended level. When the tolerable upper intake level was considered, it was observed that 68.6% of the active and 75.0% of the

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**Source:** Research data.
inactive subjects consumed quantities above 2300 mg/day. This is relevant because the excessive consumption of this nutrient can increase blood pressure and consequently cause coronary artery disease, myocardial infarction, renal disease and left ventricular hypertrophy. It was observed, through the binary logistic regression analysis, that total and saturated fat intake increased the chance of being overweight among the inactive people. A study conducted with Portuguese older men found a direct association between total fat intake and BMI (p < .05), similar to the result observed in this study. This finding was probably found only among inactive subjects because the fat consumed would be stored in the adipose tissue instead of being oxidized due to the increase in the energy expenditure caused by the practice of physical exercise. In addition, regarding saturated fat, Casas-Agustench et al. found that saturated fat intake interacts with genes related to obesity, which influenced the increase of BMI of North Americans adults and older adults, corroborating the relationship between BMI and saturated fat identified in this study.

4 Conclusions

In this study, no difference was observed in the frequency of CVD risk factors between active and inactive adults and older adults. However, in both groups an energy intake above the recommendation was found, which probably contributed to the high frequency of subjects with high BMI and WC. In addition, total and saturated fat intake was predictor of being overweight among inactive individuals.

The above findings allow the inference that, although there was no difference in overweight between groups, the practice of physical activity in the free time played a protective role in the increase of body weight among the active individuals, since there was no difference in total and saturated fat intake between the active and inactive subjects.

From a practical perspective, the results can subsidize actions, mainly related to food and practice of physical activity, that promote improvements in the monitoring of adults and older adults attended by the Brazilian National Health System, aiming for the prevention of risk factors for CVD.

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