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Balance of macronutrient intake among Brazilian elderly: analysis of the National Dietary Survey 2008–2009

Balanço de macronutrientes na dieta de idosos brasileiros: análises da Pesquisa Nacional de Alimentação 2008-2009

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ABSTRACT: ***Objective:*** This study aimed at evaluating the balance in the intake of protein, carbohydrate, and fat among the Brazilian elderly population. ***Methods:*** The data analyzed were taken from the National Dietary Survey 2008–2009, from a total of 4,286 Brazilian elders (60–104 years old). Based on the dietary intake obtained from two food records, the Multiple Source Method (MSM) was used to evaluate the macronutrients and saturated fat. The AMDR (Acceptable Macronutrient Distribution Range), by the Institute of Medicine (IOM), was used to evaluate the macronutrient energy percentage (%E). Linear regression models identified differences between macronutrients %E and household location (urban or rural), Brazilian macro-regions and gender. ***Results:*** Protein intake showed higher agreement with the AMDR reference value (99.86%). It was observed that in 9.2% of the population, fat intake was higher than the reference value, almost twice as high as the carbohydrate-energy percentage (4.9%) and nine times higher than protein (1.0%). Among those with low carbohydrate-energy percentage, 14.5% had higher fat-energy percentage ($\beta = 8.19$; $p < 0.001$), which means that 50% of the elderly whose carbohydrate intake was above the recommendation presented an overconsumption of fat. According to the macro-regions, the Midwest region was the only one to show differences for carbohydrate-energy percentage, which was lower than the others regions (51.6%; $p < 0.05$). The South region presented the lowest protein-energy percentage (17.9%; $p < 0.01$) and the highest fat-energy percentage (28.7%; $p < 0.01$). ***Conclusion:*** Higher prevalence of inadequate fat intake among the Brazilian elderly may indicate an important public health problem that is associated with an increased risk of chronic diseases.

Keywords: Macronutrients. Fats. Food Consumption. Elderly Nutrition. Diet. Recommended Dietary Allowances.

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RESUMO: ***Objetivo:*** Analisar a contribuição de proteína, lipídio e carboidrato no total de energia da dieta de idosos das diferentes regiões brasileiras. ***Métodos:*** Foram analisados dados de 4.286 idosos (60 a 104 anos) provenientes da Pesquisa de Orçamentos Familiares 2008/2009. Baseado no consumo obtido por dois registros alimentares, o programa *Multiple Source Method* estimou o consumo habitual de macronutrientes e gordura saturada. As recomendações do *Institute of Medicine* (IOM), segundo os *Acceptable Macronutrient Distribution Ranges* (AMDR), foram utilizadas para avaliar a participação relativa dos macronutrientes de acordo com percentual energético (PE). Modelos de regressão linear identificaram diferenças entre PE dos macronutrientes, situação do domicílio, macrorregiões e gênero. ***Resultados:*** A proteína foi o macronutriente que apresentou maior concordância com o AMDR (99,8%). Com relação ao PE lipídico, observou-se que 9,2% da população ficaram acima da recomendação, sendo o dobro do encontrado para carboidrato (4,9%) e nove vezes o percentual de idosos, cujo PE-proteico (1,0%) foi acima do recomendado. Em 14,5% dos idosos a ingestão de carboidratos foi abaixo da AMDR, sendo que essas dietas apresentaram maior PE lipídico ($\beta = 8,19$; $p < 0,001$), revelando que 50% dos idosos que consumiam carboidratos abaixo do PE recomendado apresentou um consumo excessivo de lipídio. Segundo macrorregiões, o Centro-Oeste foi o único a apresentar diferença para carboidrato, sendo esta de menor percentual (51,6%; $p < 0,05$). A região Sul (17,9%; $p < 0,01$) apresentou o menor PE proteico e o maior de lipídios (28,7%; $p < 0,01$). ***Conclusões:*** A elevada frequência de inadequação da ingestão de lipídio pode significar uma pior qualidade da dieta, contribuindo com o aumento no risco de desenvolvimento de doenças crônicas.

Palavras-chave: Macronutrientes. Gorduras. Consumo alimentar. Nutrição do Idoso. Dieta. Recomendações Nutricionais.

INTRODUCTION

The last decades have been characterized by the growth of the elderly population. In Brazil, the last study carried out by the Brazilian Institute of Geography and Statistics (IBGE) indicated that, in 2050, at least 30% of the Brazilian population will be composed of elders[1]. This scenario is a reflex of the epidemiological transition, mainly characterized by the increasing life expectancy of Brazilians, which should reach 81 years of age[1].

Dietary intake is known to be an essential factor in the promotion and maintenance of health throughout life[2]. Concerning the elderly population, the literature acknowledges that these people are vulnerable, especially regarding nutritional deficiencies[3]. Healthy diets, with balanced proportions of macronutrients, have been associated with low levels of inflammatory markers and with better glycemic control, besides reducing the risk of dyslipidemia and the development of chronic diseases[4].

With regard to the consumption of macronutrients, the adequate intake of proteins is associated with the attenuation and/or prevention of fat-free mass loss, which is an important risk factor for fragility, besides improving the physical and mental function[5-8]. The high intake of fat – total, saturated and trans fats – plays an essential role in the etiology of dyslipidemia, obesity, diabetes, heart disease, and macular degeneration, some

of which are also associated with the high intake of carbohydrates[9-11]. Evidence suggests that the higher the intake, or the higher proportion, of carbohydrates is compensated by the lower intake of lipids[9,4].

Data on the proportion of macronutrient intake are scarce, especially epidemiological studies including the elderly population. In Brazil, analyses about the acquisition of foods have been conducted since 1986, but the dietary intake at a population level was only conducted in 2008, through a diagnosis of the dietary and nutritional status of the population[12].

Therefore, this study aims at analyzing the contribution of proteins, lipids, and carbohydrates in the total energy of the Brazilian elderly dietary habits according to the Brazilian macro-regions, gender, and household status – urban or rural. These results can be used with other data to plan public strategies aiming at improving the diet, the health and the quality of life of Brazilian elders.

METHODS

STUDY POPULATION

Data from Brazilian elders aged 60 years or more, from both genders, were analyzed. They took part in the National Food Survey (INA), corresponding to a module in the Consumer Expenditure Survey 2008–2009[12], whose database is public domain. This sample was obtained by a two-stage cluster sampling plan. In the first stage, the census sectors, which are stratified by geographic status and mean income of the sector, were selected by probability sampling proportional to the number of households in each sector. In the second stage, 68,373 households were selected by simple random sampling without replacement. Out of these, a subsample of 24.5% was selected to take part in INA, accounting for 16,764 households. In the end, 13,569 households answered the survey, resulting in the data of 34,032 individuals, out of whom 4,322 were 60 years old or older. More details about the study population are available in the manuscript by Fisberg et al.[13].

DIETARY INTAKE

Dietary intake was assessed by two dietary records applied in non-consecutive days, with the objective of increasing the representativeness of the diet.

A standardized protocol ensured the quality of the information collected in the households, being directly inserted in a software developed for the project, providing the nutritional value of each food/beverage[12]. The database in this software was based on information from the Nutrition Data System for Research (NDS-R, version 2008)[14] and on the Brazilian Food Composition Table (TACO)[15].

DATA ANALYSIS

The statistical modeling software Multiple Source Method (MSM) was used to estimate the intake of macronutrients and energy. This software, developed by the European Prospective Investigation Cancer and Nutrition (EPIC) was chosen due to its ability to estimate the habitual intake of nutrients, foods and food groups, eliminating intrapersonal variance of consumption, besides enabling the estimation in population and individual levels[16,17].

The MSM requires at least two days of dietary intake (as a food record), that is, a repetition of consumption data should be collected in a random subsample of the population. The dietary record data provide information about the amount consumed by each individual on each collected day[16,17].

The intake of protein, carbohydrate, fat, and saturated fat, assessed according to the amount in grams, was used by the software to estimate the habitual total intake of each macronutrient per elderly person, calculating their energy value and the total habitual energy intake.

Afterwards, the relative participation of macronutrients and saturated fats in relation to the total of energy was calculated. The macronutrients were assessed according to the values of the Acceptable Macronutrient Distribution Ranges (AMDR)[18], allowing the comparison with international data. These values correspond to the following intervals: protein (10 to 35%), lipid (20 to 35%), and carbohydrate (45 to 65%). The saturated fat was assessed according to the document from the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO), which recommends maximum intake of up to 10% of the total energy in saturated fats[19].

STATISTICAL ANALYSIS

The analyses were stratified according to the co-variables household status (urban or rural), macro-regions (north, south, center-west, northeast, and southeast), gender (male or female), and nutritional status.

The nutritional status was based on body mass index values (BMI), according to the cut-off points proposed for individuals aged 60 years or more: low weight (< 23 kg/m²), eutrophic (23 to 28 kg/m²), excess weight (28 to 30 kg/m²), and obesity (≥ 30 kg/m²)[20].

Linear regression models identified the differences between the energy percentage of macronutrients and the co-variables of the study. The consumption of energy, macronutrients (grams), and energy percentage (EP) of the macronutrients were demonstrated as mean (g/day) and 95% confidence interval (95%CI).

The analyses were conducted using the software Stata (version 11.0, College Station, Texas). A 0.05 probability value was considered to be statistically significant.

This study was approved by the Research and Ethics Committee at Universidade São Judas Tadeu, n° 618.451/2014.

RESULTS

The mean age of the population was 69.59± 0.13 years (from 60 to 104 years old), there was no difference between genders ($p > 0.05$) and most elderly people live in the urban area (73.38%).

Tables 1 and 2 present total energy intake (kcal) and energy percentage (EP) of the macronutrients, according to gender, household status, and macro-regions. Men presented higher energy consumption than women (1,690 versus 1,423 kcal; $p < 0.001$). Lower energy consumption was observed in the center-west region, whereas higher consumption was found in the north region ($p < 0.001$).

The mean protein intake was 75.5 g. Regarding energy percentage, the protein was the macronutrient presenting higher agreement with reference values (98.8%), and women had mean protein intake lower than men (83.6 versus 68.3 g; $p < 0.001$). The north region presented the highest protein-energy percentage (21.5 E%; 95%CI $p < 0.05$), and the south region had the lowest one (17.9 E%; $p < 0.01$). The protein-energy percentage was higher in the rural zone in comparison to the urban zone (20.2 PE *versus* 19.8 PE; $p < 0.05$).

With regard to the energy percentage of carbohydrates, the center-west region was the only one with a difference, and with the lowest percentage in Brazil (51.6 E%; $p < 0.05$).

The EP of lipids was higher than the reference value for about 10% of the elderly. On the other hand, except for the northeast, the north region had the lowest EP for lipids (25.7%; $p < 0.01$), with no differences between genders ($p = 0.47$). For saturated fat, EP was higher in the urban area, among women, and lower in the north region ($p < 0.05$).

Regarding sex, as expected, men presented higher mean calorie intake (1,690 versus 1,423 kcal; $p < 0.01$). For macronutrients, women had lower protein-energy percentage than men (19.5 *versus* 19.9%; $p < 0.01$).

For 14.5% of the elderly, the EP of carbohydrates was below the reference interval. By analyzing the impact of the low carbohydrate intake on the intake of fats, it was possible to observe an inverse relationship between these nutrients, that is, an increased lipid percentage ($\beta = 8.19$, $p < 0.001$). Besides, among the individuals whose consumption of carbohydrates was below the reference value, 50% presented excessive fat consumption.

According to nutritional status, even though 42.9% of the elderly people are eutrophic, 37.6% present excess weight. The only macronutrient related to energy percentage that was associated with nutritional status was the lipid, and also the saturated fat, being significantly higher among the obese elders – $\beta = 0.56$; $p = 0.0326$ and $\beta = 1.08$; $p = 0.001$, respectively (data not shown in tables).

Regarding the proportion of elders whose EP of macronutrients was higher than recommended, it is important to mention that 9.2% of the population was above the recommendation for lipids, and this value was practically twice as high as that found for carbohydrate (4.9%), and nine times higher the percentage of elders with protein intake (1.0%) above recommended.

Table 1. Mean and 95% confidence interval of energy intake and energy percentage provided by macronutrients according to gender and location of household. Brazil, 2008–2009.

	Reference value	Brazil		Urban area		Rural area	
	(%)	Mean	95%CI	Mean	95%CI	Mean	95%CI
Total							
Energy (kcal)	–	1.546	[1.529 – 1.564]	1.520	[1.501 – 1.539]	1.619	[1.579 – 1.657]
Carbohydrate (EP)	45 to 65	52.9	[52.7 – 53.2]	52.9	[52.6 – 53.2]	53.0	[52.4 – 53.5]
Protein (EP)	10 to 35	19.7	[19.5 – 19.8]	19.5	[19.4 – 19.7]	20.1	[19.7 – 20.4]
Lipid (EP)	20 to 30	27.4	[27.2 – 27.6]	27.5	[27.3 – 27.7]	27.0	[26.5 – 27.4]
Saturated fat (EP)	< 10	9.6	[9.5 – 9.7]	9.7	[9.6 – 9.8]	9.3	[9.1 – 9.5]
Men							
Energy (kcal)	–	1.691	[1.666 – 1.715]	1.623	[1.634 – 1.691]	1.753	[1.703 – 1.801]
Carbohydrate (EP)	45 to 65	52.6	[52.3 – 53.0]	52.7	[52.3 – 53.1]	52.5	[51.8 – 53.2]
Protein (EP)	10 to 35	19.9	[19.7 – 20.1]	19.8	[19.5 – 20.0]	20.2	[19.8 – 20.7]
Lipid (EP)	20 to 30	27.4	[27.2 – 27.7]	27.5	[27.2 – 27.8]	27.3	[26.7 – 27.8]
Saturated fat (EP)	< 10	9.4	[9.3 – 9.5]	9.5	[9.4 – 9.6]	9.2	[8.9 – 9.4]
Women							
Energy (kcal)	–	1.423	[1.405 – 1.441]	1.411	[1.391 – 1.431]	1.462	[1.420 – 1.504]
Carbohydrate (EP)	45 to 65	53.2	[52.9 – 53.5]	53.1	[52.8 – 53.5]	53.5	[52.8 – 54.2]
Protein (EP)	10 to 35	19.5	[19.3 – 19.7]	19.4	[19.1 – 19.6]	19.8	[19.4 – 20.3]
Lipid (EP)	20 to 30	27.3	[27.1 – 27.6]	27.5	[27.3 – 27.8]	26.7	[26.1 – 27.2]
Saturated fat (EP)	< 10	9.7	[9.6 – 9.8]	9.8	[9.7 – 9.9]	9.4	[9.1 – 9.6]

EP: energy percentage; 95%CI: 95% confidence interval.

Table 2. Mean and 95% confidence interval of energy intake and energy percentage provided by macronutrients according to gender and regions of the country. Brazil, 2008–2009.

	Reference value	North		Northeast		Southeast		South		Center-West	
	(%)	Mean	95%CI	Mean	95%CI	Mean	95%CI	Mean	95%CI	Mean	95%CI
Total											
Energy (kcal)	–	1.638	[1.572 – 1.704]	1.515	[1.488 – 1.543]	1.564	[1.530 – 1.599]	1.557	[1.515 – 1.599]	1.514	[1.467 – 1.561]
Carbohydrate (EP)	45 to 65	52.8	[51.9 – 53.7]	53.4	[53.0 – 53.9]	52.8	[52.2 – 53.3]	53.4	[52.7 – 54.1]	51.6	[50.8 – 52.4]
Protein (EP)	10 to 35	21.5	[20.8 – 22.2]	20.2	[19.9 – 20.5]	18.9	[18.6 – 19.2]	17.9	[17.6 – 18.2]	19.9	[19.5 – 20.3]
Lipid (EP)	20 to 30	25.7	[25.0 – 26.4]	26.4	[26.1 – 26.7]	28.3	[27.9 – 28.7]	28.7	[28.2 – 29.2]	28.6	[28.0 – 29.2]
Saturated fat (EP)	< 10	8.7	[8.4 – 9.0]	9.3	[9.2 – 9.5]	9.9	[9.7 – 10.2]	10.3	[10.0 – 10.6]	9.6	[9.4 – 9.8]
Men											
Energy (kcal)	–	1.776	[1.690 – 1.861]	1.652	[1.612 – 1.693]	1.714	[1.666 – 1.761]	1.698	[1.637 – 1.759]	1.669	[1.602 – 1.735]
Carbohydrate (EP)	45 to 65	52.3	[51.2 – 53.5]	53.3	[52.7 – 53.8]	52.7	[52.0 – 53.5]	52.8	[51.9 – 53.7]	51.1	[50.1 – 52.1]
Protein (EP)	10 to 35	21.7	[21.0 – 22.4]	20.4	[20.0 – 20.7]	19.1	[18.7 – 19.4]	18.2	[17.8 – 18.7]	20.2	[19.6 – 20.7]
Lipid (EP)	20 to 30	26.0	[25.0 – 26.9]	26.4	[26.0 – 26.8]	28.2	[27.7 – 28.7]	28.9	[28.2 – 29.6]	28.8	[28.1 – 29.5]
Saturated fat (EP)	< 10	8.7	[8.2 – 9.1]	9.1	[8.9 – 9.3]	9.7	[9.4 – 9.9]	10.2	[9.9 – 10.6]	9.6	[9.3 – 9.9]
Women											
Energy (kcal)	–	1.498	[1.431 – 1.565]	1.407	[1.379 – 1.436]	1.441	[1.404 – 1.479]	1.438	[1.394 – 1.481]	1.355	[1.308 – 1.402]
Carbohydrate (EP)	45 to 65	53.3	[52.3 – 54.3]	53.5	[53.0 – 54.0]	52.8	[52.2 – 53.4]	53.9	[53.1 – 54.7]	52.1	[51.1 – 53.1]
Protein (EP)	10 to 35	21.3	[20.4 – 22.1]	20.0	[19.7 – 20.3]	18.8	[18.4 – 19.1]	17.6	[17.2 – 18.0]	19.6	[19.1 – 20.0]
Lipid (EP)	20 to 30	25.4	[24.6 – 26.2]	26.4	[26.1 – 26.8]	28.4	[28.0 – 28.9]	28.5	[27.9 – 29.1]	28.3	[27.6 – 29.0]
Saturated fat (EP)	< 10	8.7	[8.4 – 9.1]	9.5	[9.3 – 9.7]	10.2	[9.9 – 10.4]	10.3	[9.9 – 10.6]	9.6	[9.3 – 9.9]

EP: energy percentage; 95%CI: 95% confidence interval.

DISCUSSION

For the first time, the relative participation of macronutrients has been analyzed among the Brazilian elderly belonging to a population-based study.

About the total energy consumption, as expected, men presented higher mean calorie intake (1,690 versus 1,423 kcal; $p < 0.01$). Women consumed slightly more energy coming from proteins in comparison to men (19.5% versus 19.9%, respectively) ($p < 0.01$). This consumption pattern was also observed by Araújo et al. [21], who assessed the data in the Brazilian adult population participating in the same study (POF 2008/2009).

About the participation of EP, the protein was the macronutrient that presented the highest agreement with the reference values (98.8%). Regardless of gender, the household status, and the region, the mean value observed was of approximately 20%, being in agreement with the recommendations from the Institute of Medicine[18]. This observation can be justified by the dietary habits of the Brazilians, whose diet is based on the intake of meats, rice, and beans, considered as sources of protein[13]. Among the elderly, the adaptation of protein intake is essential to prevent diseases such as sarcopenia and osteoporosis[22].

The north region presented higher protein-energy percentage, and also higher total energy consumption. These results reflect the regional habits of this population, characterized by the intake of fish, birds, and eggs, also sources of protein[23]. Enes and Silva[24] assessed the POF 2002–2003 data and observed that the lower the per capita family income, the lower the energy intake, and the north region was mostly influenced by the income.

Unlike the Brazilian adult population, energy consumption was higher in the rural area than in the urban area, both for men and women ($p < 0.05$)[21]. This result is a result of higher average intake of macronutrients in the rural zone. Coelho et al.[25] analyzed food consumption in Brazil and observed that the rural area has more chances of acquiring basic products, besides the possibility of producing their own milk and vegetables. The food pattern of Brazilians living in the urban area is characterized by the acquisition of foods rich in polyunsaturated fat (e.g. vegetable oil) and hydrogenated fat (e.g. cakes, cookies, butter, margarine, and meat fat)[22], justifying the high total intake of lipids and saturated fat. The consumption of high fat level, especially saturated fat, is associated with the increased risk of dementia, diabetes, and heart disease, which affect mainly the elderly population[10]. The I Brazilian Guideline about the Intake of Fats and Heart Health reinforces the importance of reducing saturated fatty acids in the diet[26], and it was observed that, regardless of gender, situation of the household and macro-region, the intake of saturated fat was close to or higher than the recommended limit of 10% of the total energy consumed.

These results are in agreement with the last recommendation from FAO/WHO[19], regarding the role of lipids on human nutrition. The organizations emphasized that countries need to know not only the total lipids consumed, but also the local availability of their fractions, as well as the dietary pattern of the population, in order to elaborate and provide effective diet guides to promote health in the population.

In the center-west region, besides the "rice and beans" pattern, another consumption pattern was the "mixture", which contains foods such as vegetables, tubers, and fruits, but also includes cakes, cookies, butter, and margarine, thus explaining the high percentage of energy coming from lipids and higher prevalence of obesity[23].

The low EP coming from carbohydrates was associated with the higher intake of lipids, risk factor for the development of diabetes and heart disease[27]. In this study, diets characterized by the lower EP of carbohydrates present higher percentage of lipids, and 50% of the individuals who consumed carbohydrates below the reference value presented excessive consumption of lipids ($p < 0.01$). This scenario is also observed in Europe, where the higher proportion of lipids in the diet is associated with a reduction in the intake of carbohydrates[28].

Johnston et al.[29] observed a growing tendency in the intake of carbohydrates (43 to 49%) among American elders between 1977 and 2010, being both lower than the observed among Brazilian elders (52.9%).

The consumption of macronutrients is directly related with that of micronutrients. A study with the same population revealed an alarming situation: the high prevalence of inadequacy (more than 50% of calcium, magnesium, and vitamins A, D, E, and pyridoxine, worse (more than 70%) in the north, northeast, and center-west regions[13]. This scenario can be associated with a food pattern characterized by the inadequate intake of milk and derivatives, fruits, vegetables, and whole grains.

Regarding nutritional status, about 40% of the elders presented with excess weight. The lipid was the only macronutrient associated with nutritional status, and it is higher among the elderly with excess weight ($\beta = 0.56$; $p = 0.026$). It is known that there is an inverse association between the energy density and the cost of the diet, indicating that the price of the food may lead to the adoption of inadequate diets. In the case of the elderly, this situation is aggravated by the frequent observation of low salaries associated with the inadequate retirement policy in Brazil[30]. Besides, excess weight has a significant impact on the health of the elderly, increasing the incidence of complications resulting from diabetes, heart disease, and other chronic conditions[29].

Since the diet is an important modifiable risk factor that can cause improvements in the quality of life of the elderly, further studies should assess the impact of the intake of macronutrients – carbohydrate, lipid, and protein – with the inadequate intake of micronutrients.

CONCLUSION

The relative participation of protein in EP was within the values recommended for practically all elders. However, diets characterized by the low EP coming from carbohydrates can influence the higher percentage coming from fats. The high prevalence of inadequacy of lipids and saturated fat (in EP), regardless of gender, location of the household, and macro-region, showed a major public health issue, which is associated with the increasing risk of chronic diseases. Studies that can evaluate the sources of macronutrients and the types of fat with the quality of the diet are essential for the development of public health policies addressed to the Brazilian elderly population.

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