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Prevalence of dyslipidemias and food consumption: a population-based study

Silvia Eugênia Oliveira Valença (https://orcid.org/0000-0003-3592-9867) [1]
Alice Divina Melo Brito (https://orcid.org/0000-0002-6698-4802) [1]
Danielle Cristina Guimarães da Silva (https://orcid.org/0000-0001-5456-0853) [2]
Fabrícia Geralda Ferreira (https://orcid.org/0000-0001-9836-4176) [3]
Juliana Farias Novaes (https://orcid.org/0000-0003-3616-5096) [1]
Giana Zarbato Longo (https://orcid.org/0000-0001-7666-5007) [4]

Abstract *This study aimed to assess the prevalence of dyslipidemia and its association with an adequate intake of carbohydrates, saturated, monounsaturated, trans, and omega-3 fats among adults living in Viçosa, Minas Gerais, Brazil. This is a cross-sectional study with 884 adults aged 20 to 59 years. Sociodemographic, food intake, anthropometric, and biochemical data were collected. Associations between study variables were investigated by the chi-square test. There was a high prevalence of dyslipidemia in the study population (64.25%), with most individuals having abnormal levels of at least one serum lipid component. Inadequate intakes of saturated, trans, and monounsaturated fats and carbohydrates were predominant. It is noteworthy that omega-3 intake levels were adequate in most individuals. Eutrophic adults showed a higher prevalence of excessive intake of saturated and trans fats. It was found that 38.7% of individuals with low levels of High Density Lipoprotein cholesterol (HDL-c) had an excessive intake of saturated fat. Most individuals with high triglyceride levels or high triglyceride/HDL-c ratios had an insufficient intake of monounsaturated fat. Further studies are needed to evaluate other factors that may influence dietary patterns.*

Key words *Dyslipidemias, Eating, Adults, Nutritional epidemiology*

[1] Universidade Federal de Viçosa. Av. Peter Henry Rolfs s/n, Campus Universitário. 36570-900 Viçosa MG Brasil. silviavalenca1@gmail.com
[2] Universidade Federal do Oeste da Bahia. Barreiras BA Brasil.
[3] Escola Preparatória de Cadetes do Ar. Barbacena MG Brasil.
[4] Universidade Federal de Santa Catarina. Florianópolis SC Brasil.

Introduction

Dyslipidemia is defined as changes in plasma concentration of lipoproteins, such as low-density lipoprotein cholesterol (LDL-c), high-density lipoprotein cholesterol (HDL-c), and triglycerides (TG)[1]. Increased serum TG and LDL-c concentrations, as well as reduced HDL-c concentrations, are independent risk factors for the development of atherosclerotic diseases[2]. These conditions contribute to the occurrence of coronary events, including infarction, angina, and cardiovascular death[3], and to the status of atherosclerotic diseases as the first cause of death in Brazil and worldwide[4,5].

The global cardiovascular mortality rate associated with hypercholesterolemia is 1.7 per 100,000 inhabitants, whereas, in Brazil, the rate is equivalent to 2.5 deaths per 100,000 inhabitants, according to 2010 data[6]. Marinho et al.[7] found that high total cholesterol (TC) was the eighth risk factor that most contributed to the morbidity and mortality of women and men in Brazil and should, therefore, be the focus of public policies.

Given its high prevalence in Brazil, dyslipidemia may be an important health indicator. Population-based observational studies revealed that dyslipidemia prevalence ranges from 60%[8,9] to 75%[10] in obese individuals. National studies investigating self-reported dyslipidemia also produced worrisome results. According to the 2013 National Health Survey (NHS)[11], dyslipidemia has a prevalence of 12.5% in individuals aged 18 years and older. The 2016 Surveillance System for Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL)[12] found that the prevalence of medically diagnosed dyslipidemia was 24.8% in the 26 Brazilian capitals and the Federal District.

Early identification of dyslipidemia risk factors may be an effective strategy for the prevention and reduction of cardiovascular mortality. Although the determinants of dyslipidemia vary considerably between individuals, the main factors are diet, level of physical activity, and genetic inheritance[13]. Serum concentrations of TC and TG are increased by high intake of cholesterol, carbohydrates, saturated fat, trans fatty acids, and high-energy foods[14]. A highly atherogenic dietary pattern may contribute by up to 62% to the occurrence of deaths before the age of 70 years in Brazil[15].

Considering the presence of dyslipidemia in Brazil and the aggravating effects of an inadequate diet, this study aimed to assess the prevalence of dyslipidemia and its association with dietary levels of carbohydrates, saturated, monounsaturated, trans, and omega-3 fats in adults living in Viçosa, Minas Gerais State, Brazil.

Methods

Study design

This is a cross-sectional, population-based study with a descriptive and analytical approach analyzing data collected as part of the research project entitled "Metabolic syndrome and associated factors: a population-based study of adults in Viçosa, MG", conducted by the Health and Food Study (ESA) group between 2012 and 2014 in Viçosa, Minas Gerais, Brazil. The study population included female and male individuals aged 20-59 years living in the urban area of Viçosa.

In the first phase of the study, a structured questionnaire containing socioeconomic and demographic questions was administered to the population during home visits. The second phase included the use of a validated Food Frequency Questionnaire (FFQ)[16], anthropometric assessment, and blood collection.

Calculation of sample size and participant selection

The recommended sample size was calculated using the online software OpenEpi® version 3.03a, considering the 2010 census population estimate for Viçosa (43,431 individuals), an expected prevalence of 60.3%[9], a sampling error of 4.5%, and a design effect of 1.7. This gave a total of 765 individuals. To this value, we added 10% for sample losses and 10% for control of confounding variables, resulting in an estimated sample size of 918 individuals.

Individuals were selected by conglomerate two-stage sampling, where the first stage was the census unit (according to the Brazilian Institute of Geography and Statistics, IBGE) and the second stage was the household. Thirty census units were randomly chosen out of the 99 units located in the urban area of Viçosa. Then, city blocks and corners were randomly selected. Home visits for data collection were performed in a clockwise fashion from the selected city corners. The sampling procedure is described in detail in Segheto et al.[17].

Exclusion criteria were as follows: pregnancy, being bedridden, mental disabilities that preclud-

ed answering the questionnaire, and inability to perform anthropometric measurements.

Socioeconomic and demographic characteristics

Age, categorized into the age groups 20-29, 30-39, 40-49, and 50-59 years, was used as a demographic variable. Level of education and socioeconomic status were treated as socioeconomic variables. Level of education was categorized into ≤8, 9-11, and ≥12 years of study. Socioeconomic status was classified according to the economic classification of the Brazilian Association of Research Companies (ABEP)[18] into high (classes A1, A2, B1, and B2), middle (classes C1 and C2), and low (classes D and E).

Anthropometric and biochemical evaluation

The following anthropometric variables were evaluated: body weight, height, and waist circumference (WC). Body weight (kg) was measured using a portable anthropometric scale (Tanita, maximum load of 200 kg), and height (m) was measured using a 2.5 m long stadiometer (Welmy) fixed on the wall. Body mass index (BMI) was calculated from these data, and individuals were classified into overweight (BMI≥25 kg/m²) and normal weight (BMI≤24.9 kg/m²)[19]. WC (cm) was measured using a 1.5 m long inelastic tape at the midpoint between the last rib and the iliac crest. WC values were classified as high (≥80 cm in women and ≥90 cm in men) and normal (<80 cm in women and <90 cm in men) and used as a predictive factor of increased risk for cardiovascular diseases[20].

A registered nurse was responsible for blood collection. Participants were instructed to engage in a 12 h fast prior to collection and not change their normal daily habits. For biochemical analysis, blood was stored in vacuum tubes containing gel separator and clot activator, and the material was centrifuged for 15 min at 3000 rpm (2000 G). TC, TG, and HDL-c levels were measured using enzymatic reagents and quantified photometrically using a Cobas Mira Plus autoanalyzer (Roche Diagnostics Systems). LDL-c concentration was calculated using the Friedewald[21] equation. Blood samples were analyzed in the Health Division of the Federal University of Viçosa.

TC/HDL-c, LDL-c/HDL-c, and TG/HDL-c ratios were calculated and classified as adequate according to the following values: TC/HDL-c of ≤5 for men and ≤4.5 for women, LDL-c/HDL-c of ≤3.5 for men and ≤3.0 for women, and TG/HDL-c of <4 for both sexes[22,23].

Dyslipidemia diagnosis was based on the cut-off points established by the Brazilian Guideline for Dyslipidemia and Atherosclerosis prevention, as follows: isolated hypercholesterolemia, isolated high LDL-c (≥160 mg/dL); isolated hypertriglyceridemia, isolated high serum TG (≥50 mg/dL); mixed hyperlipidemia, high LDL-c (≥160 mg/dL) and TG (≥150 mg/dL); low HDL-c, low HDL-c (men, <40 mg/dL; women <50 mg/dL) alone or in association with high LDL-c or TG[24].

Food consumption

The quantitative FFQ used in this study included information on the consumption of 95 food items, distributed in 26 food groups. Intake of carbohydrates, omega-3, monounsaturated, saturated, and trans fats was estimated on the basis of FFQ information and food tables using the Brazil-Nutri software, developed for the 2008-2009 Brazilian Consumer Expenditure Survey carried out by IBGE[25,26].

Daily consumption of nutrients was quantified using Excel spreadsheets (version 2010, Microsoft Corporation, United States of America) and the following formula: number of servings consumed at a meal × weight/serving size × frequency of consumption × nutritional composition of the serving. Individuals whose estimated energy intake surpassed 6000 Kcal were considered outliers and were excluded from the analysis[27].

Inadequacy of saturated fat, trans fat, monounsaturated fat, and omega-3 fatty acid intake was determined according to the I Guideline on Fat Consumption and Cardiovascular Health[3], as follows: saturated fat, >10% of the total energy intake; trans fat, >1% of the total energy intake; monounsaturated fat, <15% of the total energy intake; and omega-3 fatty acid, <1 g/day. Dietary carbohydrate intake was considered inadequate when greater than 130 g/day, as determined by Dietary Reference Intakes of the Institute of Medicine[28].

Statistical analyses

Statistical analyses were performed using STATA software version 13.1. The effects of sample expansion were accounted for by applying the survey command (svy), which adjusts estimates for sampling effects. Data were weighted by sex,

age group, and education level. Weights were calculated as proportions of individuals, according to IBGE data and sample characteristics.

All variables were treated categorically and described using absolute and relative frequencies. Associations between study variables were assessed by Pearson's chi-square test. The level of significance was set at 5% ($\alpha \leq 0.05$).

Ethics statement

The project was approved by the Research Ethics Committee of the Federal University of Viçosa. All participants signed an informed consent form and were aware of the purpose of the study.

Results

The final sample consisted of 884 individuals, 52.31% of which were male. The mean age was 37.7 years. Most individuals belonged to the 20-29 years age group (31.80%), and 46.32% had excess weight (Table 1). Dyslipidemic subjects had higher education level, BMI, and WC than individuals without dyslipidemia ($p<0.001$).

The prevalence of dyslipidemia was 64.25%. No significant differences in fat and carbohydrate intake were observed between individuals with and without dyslipidemia (Table 2).

Sociodemographic, biochemical, and clinical variables were compared taking into account the adequacy of saturated fat, trans fat, and carbohydrate intake, as determined by nutritional guidelines (Table 3). The intake of saturated ($p=0.012$) and trans ($p<0.001$) fats was above the recommended mainly in the lower age group (20-29 years). Education level was also associated with inadequate intake of saturated ($p<0.001$) and trans ($p=0.009$) fats, which were higher among individuals with more than 12 years of schooling. Regarding socioeconomic level, most individuals with inadequate intake of trans fat belonged to class C ($p=0.027$).

Inadequate intake of saturated fat was higher among individuals with normal WC, TC/HDL-c ratio, and TG/HDL-c ratio ($p=0.038$, $p=0.025$, and $p=0.047$, respectively); the same was observed for trans fat intake ($p=0.010$, $p=0.033$, and $p=0.011$, respectively). Subjects with low HDL-c had high intake of saturated fat ($p=0.022$) and those with normal TG consumed trans fat above the recommended level ($p=0.001$). Individuals with high LDL-c/HDL-c ratio had higher saturated fat intake, as shown in Table 3. The overall prevalence of inadequate intake of saturated and trans fats among the study population was 61.2 and 74.2%, respectively.

Except for TC ($p=0.004$) and TG/HDL-c ratio ($p=0.014$), which were inversely proportional to carbohydrate intake, no other variable was associated with high carbohydrate intake (Table 3). Nevertheless, the majority of the sample (99.1%) had an excessive intake of carbohydrates (343.30±14.24 g), much higher than that recommended by Dietary Reference Intakes (130 g).

Table 4 shows that individuals aged 30-39 years with normal TG levels and normal TG/HDL-c ratio had a higher intake of monounsaturated fat ($p=0.024$, $p=0.015$, and $p=0.020$, respectively). The average daily consumption of monounsaturated fat was 32.20±1.96 g. Most individuals (96.6%) consumed less monounsaturated fat than the recommended. On the other hand, omega-3 was the only nutrient consumed at the recommended levels by most of the population (91.5%, 1.97±0.6 g/day), that is, more than 1 g/day. Adequate intake of omega-3 was more frequent among individuals with normal TC ($p=0.015$).

Discussion

The overall prevalence of dyslipidemia (64.25%) among adults in Viçosa, Minas Gerais, was higher than that observed by Souza et al.[29] (24.2%) in Campos dos Goytacazes, Rio de Janeiro State, and by Fernandez et al.[1] (12.2%) in eight cities of São Paulo State. Our results were similar to those of Moraes et al.[8], who found a prevalence of 61.9% in Ribeirão Preto, São Paulo, and Garcez et al.[9], who reported 60.3% dyslipidemia prevalence in São Paulo. Differences in prevalence between studies can be attributed to the use of different cut-off points, age groups, and socioeconomic levels of the investigated populations. The form of dyslipidemia diagnosis (whether self-reported or tested) might also have influenced the results.

Dyslipidemia, as diagnosed in this study by alteration of at least one serum fat component, was mainly observed among overweight individuals with high WC in the 40-59-year age group. According to Oliveira et al.[30], individuals with excess weight and abdominal fat, regardless of sex, are at a higher risk of chronic alterations. This is because accumulation of intra-abdominal adipose tissue increases the amount of free fatty acids transported to the liver. Excess free fatty ac-

Table 1. Socioeconomic, demographic, and anthropometric characteristics of dyslipidemic and non-dyslipidemic adults (age 20 to 59 years, n=884) in Viçosa, Minas Gerais, Brazil (2012-2014).

Variable	Total (%)	Dyslipidemic		p*
		Yes (%)	No (%)	
Sex				
Female	47.69	34.09	13.61	0.263
Male	52.31	32.56	19.75	
Age group (years)				
20-29	31.80	16.58	15.22	<0.001
30-39	26.50	16.65	9.85	
40-49	22.78	17.62	5.16	
50-59	18.91	15.79	3.13	
Level of education (years)				
0-4 anos	15.92	10.95	4.97	0.337
5-8 anos	14.27	10.31	3.96	
9-11 anos	20.74	14.52	6.22	
≥12 anos	49.07	30.86	18.21	
Socioeconomic status				
A/B	27.33	18.86	8.47	0.489
C	65.81	42.81	23.00	
D/E	6.86	5.03	1.83	
Weight status				
Normal weight (<25 kg/m^2)	53.68	30.12	23.56	<0.001
Overweight/obese (≥25 kg/m^2)	46.32	36.47	9.86	
Waist circumference				
Normal (men, <80 cm; women, <90 cm)	56.32	30.48	25.83	<0.001
High (men, ≥80 cm; women, ≥90 cm)	43.68	36.16	7.52	

*Significant at p<0.05 by Pearson's chi-square test.

Source: Elaborated by the authors.

ids impact lipoprotein secretion, altering TG and HDL-c blood levels[31].

According to the 2008-2009 Brazilian Consumer Expenditure Survey, which included a representative sample of the Brazilian population, the prevalence of inadequate saturated fat intake among adults is 87%[26], much higher than that found for the Viçosa population (61.2%). The 2013 NHS revealed that 37.2 and 62% of the population regularly consumes meat containing excess fat and whole milk, respectively[32]. Consumption of these highly saturated foods was more frequent among men, young people, and individuals with a low education level.

Inadequate consumption of saturated, trans, and monounsaturated fats was more frequent among adults aged 20 to 29 years. Castro et al.[33] found that trans fatty acid consumption decreased with increasing age in a sample of adolescents, adults, and the elderly in São Paulo, São Paulo State, in 2003. This finding was attributed to dietary patterns rich in ultraprocessed foods. Food and nutrition education actions are crucial for stimulating healthy food choices, such as reduced fat intake, particularly in young adults, regardless of the presence of dyslipidemia. Such actions may prevent the development of diseases.

High intake of saturated and trans fats was more frequent among individuals having more than 12 years of formal education. Among participants of the Pelotas birth cohort study, consumption of ultraprocessed foods rich in saturated and trans fats was 4.8 times higher in individuals with more than 12 years of education than in those with 4 years. The association between education and consumption of fatty foods was believed to stem from a greater access to and demand for these products among more educated individuals[34].

For the same reason as that given for education level, there seems to be a direct relationship between socioeconomic status and fat intake[34,35], although this was not observed in the present study among adults living in Viçosa. Trans fat

Table 2. Daily fat and carbohydrate intake of dyslipidemic and non-dyslipidemic adults (age 20 to 59 years, n=884) in Viçosa, Minas Gerais, Brazil (2012-2014).

Variable	Total (%)	Dyslipidemic		p*
		Yes (%)	No (%)	
Saturated fat intake (% of total energy)				
Adequate (<10)	6.53	4.55	1.98	0.633
Inadequate (≥10)	93.47	62.09	31.38	
Trans fat intake (% of total energy)				
Adequate (<1)	25.80	18.24	7.57	0.191
Inadequate (≥1)	74.20	25.79	25.79	
Monounsaturated fat intake (% of total energy)				
Adequate (>15)	3.41	2.00	1.41	0.261
Inadequate (≤15)	96.59	64.65	31.95	
Omega-3 intake (g)				
Adequate (≥1)	91.49	60.77	30.72	0.688
Inadequate (<1)	8.51	5.87	2.64	
Carbohydrate intake (g)				
Adequate (≤130)	0.67	0.34	0.33	0.295
Inadequate (>130)	99.33	66.30	33.03	

*Significant at p<0.05 by Pearson's chi-square test.

Source: Elaborated by the authors..

consumption was significantly higher in individuals in socioeconomic class C. Nevertheless, it is important to highlight that consumption of high-fat and high-carbohydrate foods has increased in Brazil, particularly among the economically vulnerable[36].

Dyslipidemia status was not associated with diet variables, but serum lipid ratios were significantly influenced by dietary fat and energy intakes. High consumption of saturated and trans fats was more frequent among subjects with normal values of TC/HDL-c and TG/HDL-c. These findings may be explained by the fact that dyslipidemia is manifested in the long term. Because the majority of participants were young, the effects of inadequate nutrition might not have been clinically evident[36].

Research in the country has shown that, even after diagnosis of dyslipidemia, individuals might not adopt healthy habits (diet, physical activity, pharmacotherapy) and tend to seek assistance only when serious clinical complications occur[37].

In this study, individuals with low HDL-c and high LDL-c/HDL-c ratio were more frequently found to have inadequate intake of saturated fat (>10% of total energy intake). According to Mensink et al.[38], the effect of saturated fats on HDL-c should be interpreted with caution, as it depends greatly on the type of saturated fatty acid consumed (carbon chain size) and the proportion of saturated fat in relation to other dietary nutrients. The authors found that HDL-c increased when saturated fats were replaced by monounsaturated fats or lauric acid. The opposite was observed when dietary saturated fats were replaced by carbohydrates or other long-chain fatty acids.

Souza et al.[39], in their systematic review, identified that trans fats have an established relationship with global mortality, cardiovascular diseases, and type 2 diabetes, independent of other factors. The same, however, cannot be said for saturated fats, whose relationship with cardiovascular diseases is inconclusive[40]. For decades, nutritional guidelines have recommended reducing saturated fat intake for prevention of cardiovascular diseases, but the effect of this component should be evaluated together with that of other dietary nutrients. Thus, analysis of dietary patterns, rather than nutrient intake alone, is more appropriate for investigation of the relationship between saturated fat and cardiovascular diseases[41,42].

Carbohydrate intake was high among the study population, regardless of dyslipidemia status. The mean carbohydrate intake was about 343 g, 164% higher than the recommended (130 g). The observed intake was also much higher than those reported in the 2008–2009 Consumer Expenditure Survey, which showed that women and men aged 19–59 years consume 240 to 290 g of carbohydrates/day. Carbohydrate-rich diets based on processed foods and foods with high glycemic index contribute to hypertriglyceridemia, favoring the formation of small dense LDL particles and reduction of plasma HDL-c concentrations[43].

Low intake of monounsaturated fats was mainly observed in subjects with normal serum TG and TG/HDL-c ratio. In a previous study in Viçosa, TG/HDL-c ratio was positively correlated with unfavorable health outcomes[44]. Even when their blood parameters are normal, individuals with low consumption of monounsaturated fats are at risk, because moderate intake of these fats

Table 3. Sociodemographic characteristics and biochemical profile of adults aged 20 to 59 years (n=884) in Viçosa, Minas Gerais, Brazil (2012-2014), stratified by daily intake of saturated fat, trans fat, and carbohydrates.

Variables	Saturated fat intake			Trans fat intake			Carbohydrate intake		
	<10% energy	≥10% energy	p*	<1% energy	≥1% energy	p*	≤130g	>130g	p*
	(%)	(%)		(%)	(%)		(%)	(%)	
Sex									
Female	16.49	31.20	0.374	11.33	36.36	0.568	52.05	47.29	0.497
Male	22.30	30.00		14.47	37.84		0.26	0.41	
Age group (years)									
20-29	7.96	23.84	0.012	4.59	27.21	<0.001	0.45	31.36	0.205
30-39	9.53	16.96		5.97	20.52		0.11	26.38	
40-49	10.36	12.43		6.96	15.82		0.00	22.78	
50-59	10.95	7.97		8.28	10.64		0.10	18.81	
Level of education (years)									
0-4	9.91	6.01	<0.001	6.42	9.51	0.009	0.00	15.92	0.670
5-8	7.02	7.24		4.77	9.50		0.00	14.27	
9-11	8.41	12.33		5.32	15.42		0.17	20.57	
≥12	13.45	35.62		9.30	39.77		0.50	48.57	
Socioeconomic status									
A/B	8.96	18.37	0.161	6.22	21.11	0.027	0.19	27.14	0.728
C	26.64	39.17		16.35	49.46		0.48	65.33	
D/E	3.23	3.63		3.26	3.60		0.00	6.86	
Weight status									
Normal weight (<25 kg/m^2)	19.80	33.87	0.254	12.78	40.89	0.259	0.50	53.17	0.259
Overweight/obese (≥25 kg/m^2)	18.95	27.37		12.89	33.43		0.17	46.16	
Waist circumference									
Normal (men, <80 cm; women, <90 cm)	18.88	37.44	0.038	12.24	44.08	0.010	0.50	55.82	0.256
High (men, ≥80 cm; women, ≥90 cm)	19.92	23.77		13.56	30.12		0.17	43.52	
TC									
Normal (<200 mg/dL)	22.72	39.23	0.327	13.66	48.29	0.068	0.67	61.28	0.004
High (≥200 mg/dL)	16.08	21.98		12.15	25.91		0.00	38.06	
HDL-c									
Normal (men, ≥40 mg/dL; women, ≥50 mg/dL)	17.53	22.50	0.022	10.26	29.78	0.918	59.64	39.69	0.454
Low (men, <40 mg/dL; women <50 mg/dL)	21.27	38.70		15.55	44.42		0.33	0.34	
LDL-c									
Normal (<160 mg/dL)	34.49	54.26	0.932	23.14	65.60	0.730	0.67	88.08	0.239
High (≥160 mg/dL)	4.31	6.95		2.66	8.60		0.00	11.26	
TG									
Normal (<150 mg/dL)	27.43	46.16	0.270	15.41	58.19	0.001	0.56	73.03	0.539
High (≥150 mg/dL)	11.37	15.04		10.39	16.01		0.10	26.30	
TC/HDL-c ratio									
Normal (men, ≤5; women, ≤4.5)	25.92	46.33	0.025	16.37	55.89	0.033	0.58	71.68	0.306
High (men, >5; women, >4.5)	12.88	14.87		9.44	18.31		0.00	27.66	
LDL-c/HDL-c ratio									
Normal (men, ≤3.5; women, ≤3)	29.25	9.54	0.048	19.41	58.74	0.423	0.58	7.758	0.505
High (men, >3.5; women, >3)	48.90	12.30		6.39	15.46		0.00	21.76	
TG/HDL-c ratio									
Normal (<4)	27.51	49.60	0.047	17.61	59.49	0.011	0.67	76.44	0.014
High (≥4)	11.29	11.61		8.19	14.71		0.00	22.89	

*Significant at p<0.05 by Pearson's chi-square test.

Source: Elaborated by the authors.

Table 4. Sociodemographic characteristics and biochemical profile of adults aged 20 to 59 years (n=884) in Viçosa, Minas Gerais, Brazil (2012–2014), stratified by daily intake of monounsaturated fat and omega-3 fatty acids.

Variables	Monounsaturated fat intake			Omega-3 intake		
	≤15% energy	>15% energy	p*	≤1 g	>1 g	p*
	(%)	(%)		(%)	(%)	
Sex						
Female	50,82	1,49	0,282	3,38	48,93	0,111
Male	45,77	1,92		5,13	42,56	
Age group (years)						
20-29	31,10	0,71	0,024	2,17	29,63	0,179
30-39	25,22	1,27		2,12	24,37	
40-49	21,71	1,08		1,37	21,42	
50-59	18,57	0,35		2,85	16,06	
Level of education (years)						
0-4	15,81	0,11	0,313	1,37	14,56	0,943
5-8	13,70	0,57		1,14	13,13	
9-11	20,04	0,70		1,54	19,19	
≥12	47,05	2,02		4,47	44,61	
Socioeconomic status						
A/B	26,15	1,17	0,618	1,75	25,58	0,197
C	63,87	1,94		5,61	60,20	
D/E	6,57	0,30		1,16	5,70	
Weight status						
Normal weight (<25 kg/m^2)	51,75	1,92	0,794	4,54	49,14	0,934
Overweight/obese (≥25 kg/m^2)	44,84	1,49		3,99	42,34	
Waist circumference						
Normal (men, <80 cm; women, <90 cm)	54,31	2,01	0,799	4,73	51,59	0,897
High (men, ≥80 cm; women, ≥90 cm)	42,28	1,40		3,78	39,90	
TC						
Normal (<200 mg/dL)	59,67	2,27	0,618	3,93	58,01	0,015
High (≥200 mg/dL)	36,92	1,14		4,58	33,48	
HDL-c						
Normal (men, ≥40 mg/dL; women, ≥50 mg/dL)	38,88	1,16	0,464	2,78	37,25	0,223
Low (men, <40 mg/dL; women <50 mg/dL)	57,72	2,25		5,73	54,24	
LDL-c						
Normal (<160 mg/dL)	85,68	3,06	0,848	7,54	81,20	0,961
High (≥160 mg/dL)	10,91	0,35		0,97	10,29	
TG						
Normal (<150 mg/dL)	70,41	3,18	0,015	6,30	67,30	0,951
High (≥150 mg/dL)	26,18	0,23		2,21	24,19	
TC/HDL-c ratio						
Normal (men, ≤5; women, ≤4.5)	69,52	2,73	0,315	6,11	66,15	0,941
High (men, >5; women, >4.5)	27,07	0,68		2,40	25,34	
LDL-c/HDL-c ratio						
Normal (men, ≤3.5; women, ≤3)	75,58	21,01	0,637	6,69	71,46	0,936
High (men, >3.5; women, >3)	2,57	0,83		1,82	20,03	
TG/HDL-c ratio						
Normal (<4)	73,82	3,28	0,020	6,63	70,48	0,899
High (≥4)	22,77	0,12		1,88	21,01	

*Significant at p<0.05 by Pearson's chi-square test.

Source: Elaborated by the authors.

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can reduce serum TG and increase HDL-c[45]. A clinical trial observed that, by replacing 1% of energy from trans fats with energy from monounsaturated fat, individuals can reduce the TC/HDL-c ratio by 0.54[46].

Adequate omega-3 intake was higher among subjects with TC levels below 200 mg/dL. Consumption of omega-3 fatty acids seems to reduce TC[47]. Although the prevalence of other markers did not differ in the sample, it is known that omega-3 activates systemic and intracellular mechanisms responsible for a reduction in serum TG and a modest increase in HDL-c. This fatty acid also has important anti-inflammatory, antimicrobial, and vasodilating properties, resulting in cardiovascular and atherosclerotic protection[48].

The cross-sectional nature of this study may be seen as a limitation, as it precludes establishment of temporal relationships between variables. Food frequency questionnaires are highly effective and have high correlation with true intake; however, their efficacy depends on participants' memory[49]. We aimed to reduce this limitation by showing participants a food photo album during administration of the questionnaire to help them estimate more accurately the size of portions normally consumed.

In this representative sample of the adult population of Viçosa, Minas Gerais State, Brazil, we observed a high prevalence of dyslipidemia, excessive intake of saturated fats, trans fats, and carbohydrates, and low intake of monounsaturated fats. Inadequate consumption of saturated and trans fats was higher among individuals with elevated HDL-c and TG/HDL-c, TC/HDL-c, and LDL-c/HDL-c ratios, whereas individuals with normal TC levels had a more adequate intake of omega-3. Further studies are needed to elucidate the association between fat and carbohydrate intake and changes in serum lipid levels.

Collaborations

SEO Valença and ADM Brito: conception, design, analysis and interpretation of data and paper writing. DCG Silva: planning, conception, design, analysis and interpretation of data and paper writing. FG Ferreira and JF Novaes: writing and critical review of the manuscript. GZ Longo: planning, data collection and critical review of the paper. All authors read and approved the final version of the manuscript.

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References

1. Fernandes RA, Christofaro DGD, Casonatto J, Codogno JS, Rodrigues EQ, Cardoso ML, Kawaguti SS, Zanesco A. Prevalence of Dyslipidemia in Individuals Physically Active During Childhood, Adolescence and Adult Age. *Arq Bras Cardiol* 2011; 97(4):317-323.
2. Siri PW, Krauss RM. Influence of Dietary Carbohydrate and Fat on LDL and HDL Particle Distributions. *Curr Atheroscler Rep* 2005; 7(6):455-459.
3. Sociedade Brasileira de Cardiologia (SBC). I Diretriz sobre o Consumo de Gorduras e Saúde Cardiovascular. *Arq Bras Cardiol* 2013; 100(1):1-40.
4. Herrington W, Lacey B, Sherliker P, Armitage J, Lewington S. Epidemiology of Atherosclerosis and the Potential to Reduce the Global Burden of Atherothrombotic Disease. *Circ Res* 2016; 118(4):535-546.
5. Ribeiro ALP, Duncan BB, Brant LCC, Lotufo PA, Mill JG, Barreto SM. Cardiovascular Health in Brazil: Trends and Perspectives. *Circulation* 2016; 133(4):422-433.
6. Barquera S, Pedroza-Tobías A, Medida C, Hernandez-Barrera L, Bibbins-Domingo K, Lozano R, Moran AE. Global Overview of the Epidemiology of Atherosclerotic Cardiovascular Disease. *Arch Med Res* 2015*;* 46(5):328-338.
7. Marinho F, Passos VMA, França EB. Novo século, novos desafios: mudança no perfil da carga de doença no Brasil de 1990 a 2010. *Epidemiol Serv Saude* 2016; 25(4):713-724.
8. Moraes VER, Checchio MV, Freitas, ICM. Dislipidemia e fatores associados em adultos residentes em Ribeirão Preto, SP: resultados do Projeto EPIDCV. *Arq Bras Endocrinol Metabol* 2013; 57(9):691-701.
9. Garcez MR, Pereira JL, Fontanelli MM, Marchioni DML, Fisberg RM. Prevalence of dyslipidemia according to the nutritional status in a representative sample of São Paulo. *Arq Bras Cardiol* 2014; 103(6):476-484.
10. Loureiro NSL, Amaral TLM, Amaral CA, Monteiro GTR, Vasconcellos MTL, Bortolini MJS. Relação de indicadores antropométricos com fatores de risco para doença cardiovascular em adultos e idosos de Rio Branco, Acre. *Rev Saude Publica* 2020; 54:24.
11. Instituto Brasileiro de Geografia e Estatística (IBGE). *Pesquisa Nacional de Saúde 2013. Percepção do estado de saúde. Estio de vida e doenças crônicas*. Rio de Janeiro: IBGE; 2014.
12. Brasil. Ministério da Saúde (MS). *Vigitel Brasil 2016 Saúde Suplementar: vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico*. Brasília: MS; 2017.
13. Estruch R. Mortalidad cardiovascular: como prevenirla? *Nefrología* 2014; 34(5):561-569.
14. Dearborn JL, Urrutia VC, Kernan WN. The Case for Diet: A Safe and Efficacious Strategy for Secondary Stroke Prevention. *Front Neurol* 2015; 6(2):1-8.
15. Otto MCO, Afshin A, Micha R, Khatibzades S, Fahimi S, Singh G, Danaei G, Monteiro CA, Louzada MLC, Ezzati M, Mozaffarian D. The Impact of Dietary and Metabolic Risk Factors on Cardiovascular Diseases and Type 2 Diabetes Mortality in Brazil, Global Burden of Diseases, Injuries, and Risk Factors Metabolic Risk Factors of Chronic Diseases Expert Group and Nutrition and Chronic D. *PloS One* 2016; 11(3):e0151503.

16. Silva DCG, Segheto W, Lima MFC, Pessoa MC, Peluzio MCG, Marchioni DML, Cunha DB, Longo GZ. Using the method of triads in the validation of a food frequency questionnaire to assess the consumption of fatty acids in adults. *J Hum Nutr Die* 2018; 31(1):85-95.
17. Segheto W, Silva DCG, Coelho FA, Reis VG, Morais SHO, Marins JCB, Ribeiro AQ, Longo GZ. Body adiposity index and associated factors in adults: method and logistics of a population-based study. *Nutr Hosp* 2015; 32(1):101-109.
18. Associação Brasileira de Empresas de Pesquisa (ABEP). *Critério de classificação econômica Brasil – Dados com base no levantamento socioeconômico*. Rio de Janeiro: IBOPE; 2012
19. World Health Organization (WHO). *Preventing and managing the global epidemic: Report of a WHO Consultation*. Genebra: WHO; 2000.
20. International Diabetes Federation (IDF). *The IDF consensus worldwide definition of the metabolic syndrome*. Bruxelas: IDF; 2006.
21. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin Chem* 1972; 18(6):499-502.
22. Bhalodkar NC, Blum S, Enas EA. Accuracy of the Ratio of Triglycerides to High-Density Lipoprotein Cholesterol for Predicting Low-Density Lipoprotein Cholesterol Particle Sizes, Phenotype B, and Particle Concentrations Among Asian Indians. *JAMA Cardiol* 2006; 97(7):1007-1009.
23. Millán J, Pintó X, Muñoz A, Zúñiga M, Rubiés-Prat J, Pallardo LF, Masana L, Mangas A, Hernández-Mijares A, González-Santos P, Ascaso JF, Pedro-Botet J. Lipoprotein ratios: Physiological significance and clinical usefulness in cardiovascular prevention. *Vasc Health Risk Manag* 2009; 5:757-765.
24. Sociedade Brasileira de Cardiologia (SBC). Atualização da Diretriz Brasileira de Dislipidemias e Prevenção da Aterosclerose – 2017. *Arq Bras Cardiol* 2017; 109(2 Supl. 1):1-76.
25. Barufaldi LA, Abreu GA, Veiga GV, Sichieri R, Kuschnir MCC, Cunha DB, Pereira RA, Bloch KV. Programa para registro de recordatório alimentar de 24 horas: aplicação no Estudo de Riscos Cardiovasculares em Adolescentes. *Rev Bras Epidemiol* 2016; 19(2):464-468.
26. Instituto Brasileiro de Geografia e Estatística (IBGE). *Pesquisa de Orçamentos Familiares 2008-2009: Análise do Consumo Alimentar Pessoal no Brasil*. Rio de Janeiro: IBGE; 2011.
27. Andrade GA, Pereira RA, Sichieri R. Consumo alimentar de adolescentes com e sem sobrepeso do Município do Rio de Janeiro. *Cad Saude Publica* 2003; 9(5):1485-1495.
28. Institute of Medicine (IOM). *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients)*. Washington, D.C.: The National Acadmies Press; 2005.
29. Souza LJ, Filho JTDS, Souza TF, Reis AFF, Neto CG, Bastos DA, Côrtes VA, Chalita FEB, Teixeira CL. Prevalência de Dislipidemia e Fatores de Risco em Campos dos Goytacazes – RJ. *Arq Bras Cardiol* 2003; 81(3):249-256.
30. Oliveira LPM, Assis AMO, Silva MCM, Santana MLP, Santos NS, Pinheiro SMC, Barreto ML, Souza CO. Fatores associados a excesso de peso e concentração de gordura abdominal em adultos na cidade de Salvador, Bahia, Brasil. *Cad Saude Publica* 2009; 25(3):570-582.
31. Ebbert J, Jensen M. Fat Depots, Free Fatty Acids, and Dyslipidemia. *Nutrients* 2013; 5(2):498-508.
32. Claro RM, Santos MAS, Oliveira TPO, Pereira CA, Szwarcwald CL, Malta DC. Consumo de alimentos insalubres relacionados a enfermidades crónicas no transmisibles en Brasil: Encuesta Nacional de Salud, 2013. *Epidemiol Serv Saude* 2015; 24(2):257-265.
33. Castro MA, Barros RR, Bueno MB, César CLG, Fisberg RM. Trans fatty acid intake among the population of the city of São Paulo, Brazil. *Rev Saude Publica* 2009; 43(6):991-997.
34. Bielemann RM, Motta JVS, Minten GC, Horta BL, Gigante DP. Consumo de alimentos ultra processados e impacto na dieta de adultos jovens. *Rev Saude Publica* 2015; 49(28):1-10.
35. Levy RB, Claro RM, Mondini L, Sichieri R, Monteiro CA. Distribuição regional e socioeconômica da disponibilidade domiciliar de alimentos no Brasil em 2008-2009. *Rev Saude Publica* 2012; 46(1):6-15.
36. Martins APB, Levy RB, Claro RM, Moubarac JC, Monteiro CA. Increased contribution of ultra-processed food products in the Brazilian diet (1987-2009). *Rev Saude Publica* 2013; 47(4):656-665.
37. Secretaria de Saúde do Estado de São Paulo. *Prevenção de Doenças Crônicas Não Transmissíveis (DCNT) e de seus Fatores de Risco*. São Paulo: SES/CVE/DDCNT, 2008.
38. Mensink RP, Zock PL, Kester AD, Katan MB. Effects of dietary fatty acids and carbohydrates on the ratio of serum total to HDL cholesterol and on serum lipids and apolipoproteins: a meta-analysis of 60 controlled trials. *Am J Clin Nutr* 2003; 77(5):1146-1155.
39. Souza RJ, Mente A, Maroleanu A, Cozma AI, Ha V, Kishibe T, Uleryk E, Budylowski P, Schünemann H, Beyene J, Anand SS. Intake of saturated and trans unsaturated fatty acids and risk of all cause mortality, cardiovascular disease, and type 2 diabetes: systematic review and meta-analysis of observational studies. *BMJ* 2015; 351:h3978.
40. Siri-Tarino PW, Sun Q, Hu FB, Krauss RM. Meta-analysis of prospective cohort studies evaluating the association of saturated fat with cardiovascular disease. *Am J Clin Nutr* 2010; 91(3):535-546.
41. Lottenberg AMP. Importance of the dietary fat on the prevention and control of metabolic disturbances and cardiovascular disease. *Arq Bras Endocrinol Metab* 2009; 5353(55):595-607.
42. Mozaffarian D, Aro A, Willet WC. Health effects of trans-fatty acids: experimental and observational evidence. *Eur J Clin Nutr* 2009; 63:S5-S21.

43. Polacow VO, Lancha AHJ. Dietas Hiperglicídicas: Efeitos da Substituição Isoenergética de Gordura por Carboidratos Sobre o Metabolismo de Lipidios, Adiposidade Corporal e Sua Associação com Atividade. *Arq Bras Endocrinol Metab* 2007; 53(3):389-400.
44. Martins MV, Souza JD, Martinho KO, Franco FS, Tinôco ALA. Association between triglycerides and HDL-cholesterol ratio and cardiovascular risk factors among elderly persons receiving care under the family health strategy of Viçosa, Minas Gerais. *Rev Bras Geriatr Gerontol* 2017; 20(2):236-243.
45. Baum SJ, Kris-Etherton PM, Willett WC, Lichtenstein AH, Rudel LL, Maki KC, Whelan J, Ramsden CE, Block RC. Fatty acids in cardiovascular health and disease: A comprehensive update. *J Clin Lipidol* 2012; 6(3):216-234.
46. Mozaffarian D, Clarke R. Quantitative effects on cardiovascular risk factors and coronary heart disease risk of replacing partially hydrogenated vegetable oils with other fats and oils. *Eur J Clin Nutr* 2009; 63(S2):S22-S33.
47. Jain AP, Aggarwal KK, Zhang P-Y. Omega-3 fatty acids and cardiovascular disease. *Eur Ver Med Pharmacol Sci* 2015; 19(3):441-445.
48. Raposo HF. Efeito dos ácidos graxos n-3 e n-6 na expressão de genes do metabolismo de lipídeos e risco de aterosclerose. *Rev Nutr* 2010; 23(5):871-879.
49. Costa AGV, Priore SE, Sabarense CM, Franceschini SCC. Questionário de frequência de consumo alimentar e recordatório de 24 horas: aspectos metodológicos para avaliação da ingestão de lipídeos. *Rev Nutr* 2006; 19(5):631-641.

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