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ORIGINAL ARTICLE / *ARTIGO ORIGINAL*

Hypertriglyceridemic waist phenotype and nutritional factors: a study with participants of ELSA-Brasil

Fenótipo da cintura hipertrigliceridêmica e fatores nutricionais: um estudo com participantes do ELSA-Brasil

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ABSTRACT: ***Objective:*** To investigate the association between fat and fiber intakes and the hypertriglyceridemic waist phenotype (HWP). ***Methods:*** Cross-sectional survey conducted from the baseline of Brazilian Longitudinal Study of Health Adult (ELSA-Brasil). Anthropometric measurements were conducted and the body mass index was calculated (BMI). Participants were classified according to the presence of HWP when waist circumference ≥ 102 and ≥ 88 cm, respectively, in men and women, and triglycerides ≥ 150 mg/dL. Fat and fiber intakes were assessed using a validated food frequency questionnaire, and socioeconomic, demographic and behavioral variables were collected through a questionnaire. The χ^2 test, Mann-Whitney and Poisson regression were performed with significance level of 5%. ***Results:*** There was no association between fiber and fat intakes with HWP. A lower prevalence of HWP among men was observed (IRR = 0.959; 95%CI 0.948 – 0.969). A higher prevalence of HWP was observed in participants with low physical activity (OR = 1.039, 95%CI 1.021 – 1.057), smoking history (OR = 1.044, 95%CI 1.031 – 1.057), lower per capita income (IRR = 1.035; 95%CI 1.022 – 1.049) and obesity (OR = 1.32, 95%CI 1.305 – 1.341). Fat and fiber intakes were not associated with HWP. ***Conclusion:*** A higher prevalence of HWP was found in obese, but no association was found between intake of fat and fiber and phenotype.

Keywords: Waist circunference. Abdominal obesity. Triglycerides. Hypertrigliceridemic waist. Dietary fiber. Dietary fats.

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RESUMO: ***Objetivo:*** Investigar a associação entre consumo de gorduras e fibras e o fenótipo da cintura hipertrigliceridêmica (FCH). ***Métodos:*** Pesquisa de corte transversal conduzida a partir da linha de base do Estudo Longitudinal de Saúde do Adulto (ELSA-Brasil). Foi realizada avaliação antropométrica e calculado o Índice de Massa Corporal (IMC). Os participantes foram classificados segundo presença do FCH quando circunferência da cintura ≥ 102 e ≥ 88 cm, respectivamente, em homens e mulheres, e triglicerídeos ≥ 150 mg/dL. O consumo de gorduras e fibras foi avaliado a partir de um Questionário de Frequência Alimentar validado e as variáveis socioeconômicas, demográficas e características comportamentais foram coletadas por meio de questionário. Foram realizados testes do χ^2, Mann-Whitney e regressão de Poisson com significância de 5%. ***Resultados:*** Homens apresentaram menor prevalência do FCH (RP = 0,959; IC95% 0,948 – 0,969). Maiores prevalências de FCH foram observadas em indivíduos com atividade física fraca (RP = 1,039; IC95% 1,021 – 1,057), histórico de tabagismo (RP = 1,044; IC95% 1,031 – 1,057), menor renda *per capita* (IRR = 1,035; IC95% 1,022 – 1,049) e obesidade (RP = 1,32; IC95% 1,305 – 1,341). Consumo de gorduras e fibras não foi associado ao FCH. ***Conclusão:*** Maior prevalência do FCH foi encontrada em obesos, porém não foi observada associação entre o consumo de gorduras e fibras e o fenótipo.

Palavras-chave: Circunferência da cintura. Obesidade abdominal. Triglicerídeos. Cintura hipertrigliceridêmica. Fibra na dieta. Gorduras na dieta.

INTRODUCTION

Considering the complexity of cardiovascular risk assessment (CVRA) by direct method, studies such as the Framingham[1], *Prospective Cardiovascular Münster* (PROCAM)[2] *Study* and The Systematic Coronary Risk Evaluation Project (The SCORE Project)[3] have developed specific protocols in order to facilitate this measurement, both clinical practice and population studies. However, the diversity of protocols used to evaluate CVRA and the difficulties for full implementation in different populations have stimulated researchers to identify and test less complex proposals for performing this procedure.

In a study carried out in Canada, Lemieux and collaborators[4] developed a low cost protocol with high predictive capacity for important changes in atherogenic markers, facilitating the screening of individuals at risk for coronary diseases. This proposal takes into account only the measurement of abdominal circumference and triglyceride levels, both routine exams performed in health services.

Therefore, the hypertriglyceridemic waistline[4], also known as the hypertriglyceridemic waist phenotype (HWP)[5], has been used to identify individuals who are susceptible to cardiovascular risk and who frequently present other altered markers, such as Body Mass Index (BMI), C-reactive protein, total cholesterol, and high density lipoprotein (HDL) and low density lipoprotein (LDL) fractions[6]. Several associated factors are involved in hypertriglyceridemic waist development, such as: sedentary lifestyle, smoking, obesity, schooling, race/color and family income[7].

Adequate fiber consumption, especially from cereals, fruits, vegetables, whole grains and dried fruit, is a protective factor against cardiovascular diseases, obesity, dyslipidemias and diabetes, and also reduces the anthropometric measures such as the waist circumference (WC)[8]. On the other hand, a diet high in fat has been associated with the disease process, especially cardiovascular diseases[9]. Thus, the objective of this study was to evaluate the association between fat and fiber consumption and the occurrence of the hypertriglyceridemic waist phenotype in participants of the baseline Longitudinal Study of Adult Health (ELSA-Brazil).

METHODS

A cross-sectional study conducted from the baseline of ELSA-Brazil, composed of 15,105 active and retired employees, both genders, aged 35 – 74 years old, from five public higher education institutions - Universidade de São Paulo (USP), Universidade Federal de Minas Gerais (UFMG), Universidade Federal da Bahia (UFBA), Universidade Federal do Rio Grande do Sul (UFRGS) e Universidade Federal do Espírito Santo (UFES) — and a research project of the Oswaldo Cruz Foundation (FIOCRUZ). The research was approved in the Research Ethics Committees in each institution where the project was carried out and all participants signed a Free and Informed Consent Form.

EXCLUSION CRITERIA

Participants with missing data, who presented BMI values above 40 kg/m^2 and triglycerides (TG) above 800 mg/dL, considered as hypertriglyceridemia of genetic and familiar etiology[10], were excluded from the sample. Individuals who underwent bariatric surgery, who reported caloric value <500 kcal or > 6,000 kcal, and who used drugs that reduced TG values, such as resins, niacins and fibrates, were also excluded[11].

ANTHROPOMETRIC EVALUATION

Weight and height were measured and the BMI was calculated to classify the participants' nutritional status, according to cut-off points recommended by the World Health Organization (WHO)[12]. To measure body weight, an electronic scale (Toledo®, model 2096PP), with a capacity of 200 kg and a precision of 50 g, was used. Height was measured using a wall stadiometer (Seca®, Hamburg, BRD) with an accuracy of 1 mm[13].

The WC was measured with the participant fasted and with the bladder empty, in an upright position, breathing normally, with the feet together, with the clothes raised and the arms crossed in front of the chest. The measurement was made with an inextensible tape measure at the midpoint between the iliac crest and the lower border of the costal arch[13].

BIOCHEMICAL VARIABLES

Blood samples were obtained by venipuncture, with the participant fasted, respecting the period of 12 to 14 hours. Subsequently, the samples were duly stored and transported to the Central Laboratory of ELSA-Brazil. The method used to evaluate the TG variable was the colorimetric enzyme[14].

EVALUATION OF FAT AND FIBER CONSUMPTION

The evaluation of fat and fiber consumption of was assessed using the Food Frequency Questionnaire (FFQ), created and validated for this population[15]. This instrument is semi-quantitative, with 114 food items, structured in four sections:

1. food/preparations;
2. measures of portions of consumption;
3. consumption frequencies, with eight response options, ranging from "More than 3x/day" to "Never/Almost never";
4. reported seasonal consumption.

Participants were asked about their usual consumption in the last 12 months and asked to respond how many times per day, week or month they consumed the items described. In the spontaneous reports of consumption, the option of seasonal consumption was only marked in the season itself. A response card with consumption frequency options was used to facilitate the participant's choice without the need for memorization, and a kit of utensils was incorporated at the time of application of the FFQ to facilitate the identification of home measures[15].

SOCIODEMOGRAPHIC VARIABLES

The sociodemographic variables and behavioral characteristics evaluated were collected through a questionnaire in an interview conducted at each research center. Schooling was reported during the interview and *per capita* income was calculated from the approximate net family income information of the month prior to the interview, and the number of people who depend on it. With regard to smoking, questions about current and past smoking were asked. In this study, the following indicators were used: schooling (middle, high, superior and post-graduate), *per capita* income (in tertiles) and smoking (never smoked, ex-smoker and smoker).

EVALUATION OF PHYSICAL ACTIVITY

Physical activity was estimated from the long version of the International Physical Activity Questionnaire (IPAQ), in the domains of leisure time physical activity (LTPA) and

physical activity of displacement (PAD)[16]. The physical activity pattern was reported in minutes/week for at least 10 minutes/week. The variable was later categorized as weak, moderate and strong.

EVALUATION OF HYPERTRIGLYCERIDEMIC WAIST PHENOTYPE

To assess the presence of HWP, WC and TG were evaluated using the parameters established by the National Cholesterol Education Program (NCEP)[17], with WC for men ≥ 102 cm and for women ≥ 88 cm. For TG, the recommendation is ≥ 150 mg/dL. The values were later categorized in the absence and presence of HWP.

TREATMENT OF VARIABLES

The nutritional composition of the American Nutritional Data System Research (NDSR)[18] table was used to analyze the food reported in the FFQ. After this, the initial treatment of the variables consisted in identifying extreme values of food items (in g/day) considered as not plausible[19].

Consumption values (g/day) that were above the 99 percentile were considered to belong to the 99 percentile itself. In addition, foods referred to as seasonal consumption had total daily consumption value of this item multiplied by 0.25. The estimation of fat and fiber intake was adjusted by energy consumption, a method proposed by Willett et al.[20]. Consumption values were presented in the table as mean + SD. To evaluate the association between HWP and fat and fiber intake, the values were categorized into quintiles for entry into the Poisson regression model.

STATISTICAL ANALYSIS

Data were analyzed using the statistical program Statistical Package for Social Sciences (SPSS) 17.021. The χ^2, Mann-Whitney and Kruskal Wallis tests as well as a Poisson regression model were adjusted for age, sex, nutritional status, smoking and physical activity. The significance level adopted for all tests was $p < 0.05$.

RESULTS

The final sample consisted of 11,762 participants (Figure 1) with mean age of 52 ± 9 years. The prevalence of HWP was 16.4%. Table 1 shows the sociodemographic variables according to the presence of HWP. It was observed association with sex ($p < 0.001$), age group ($p < 0.001$), schooling ($p = 0.014$) and *per capita* income ($p < 0.001$).

In the lifestyle characteristics presented in Table 2, associations with nutritional status ($p < 0.001$), physical activity ($p < 0.001$), alcohol consumption ($p < 0.001$) and smoking ($p < 0.001$) were found.

Table 3 shows the means and standard deviations of energy consumption, fat and fiber, according to sex and the presence of HWP. Associated with sex: energy ($p < 0.001$), trans

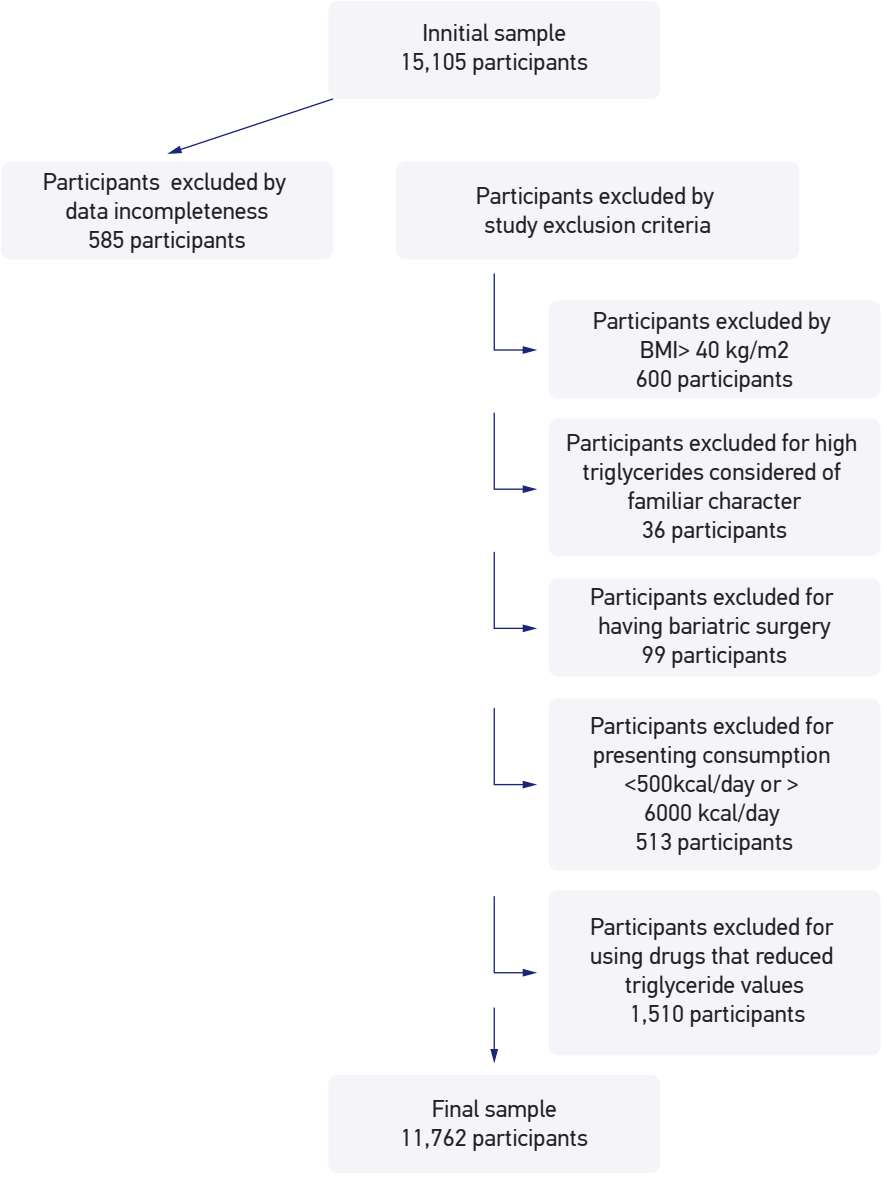

Figure 1. Definition of the sample of ELSA-Brazil participants, 2008-2010.

fat ($p < 0.001$), polysaturated fat ($p < 0.001$), omega 3 ($p < 0.001$) and total and soluble fiber ($p < 0.001$). Associated with HWP: energy ($p < 0.001$), trans fat ($p < 0.001$), polysaturated fat ($p < 0.001$) and soluble fiber ($p = 0.005$).

The following variables were considered in the Poisson regression model: sex, *per capita* income, nutritional status, physical activity, smoking and age for adjustment (Table 4).

There was a lower prevalence of HWP among men (IRR = 0.959, 95%CI 0.948 – 0.969). They were also associated with HWP: weak physical activity (IRR = 1.039, 95%CI, 1,021 – 1,057); smoking history (IRR = 1.044; 95%CI 1.031 – 1.057); smokers (IRR = 1.039; 95%CI 1.022 – 1.056); income tertiles - 1º (IRR = 1.035, 95%CI 1.022 – 1.049) and 2º (IRR = 1.028, 95%CI 1.015 – 1.041); overweight (IRR = 1.114, 95%CI, 1.102 – 1.177); and obesity (IRR = 1.32, 95%CI, 1.305 – 1.341). The data are presented in Table 4.

Table 1. Socio-demographic characteristics according to the presence of hypertriglyceridemic waist phenotype in ELSA-Brazil, 2008-2010.

Variables	Hypertriglyceridemic waist phenotype				p-value*	Total	
	Absence		Presence				
	n	%	n	%		n	%
Sex							
Male	4.878	49,4	526	27,3	< 0,001	5.404	46,0
Female	4.957	50,6	1.401	72,7		6.358	54,0
Age (years)							
35 to 44	2.244	23,0	290	15,0	< 0,001	2.534	21,5
45 to 54	3.872	39,3	772	40,1		4.644	39,5
55 to 64	2.664	27,0	646	33,5		3.310	28,2
65 to 74	1.055	10,7	219	11,4		1.274	10,8
Schooling							
Middle incomplete	526	5,4	105	5,4	0,014	631	5,4
Middle complete	671	6,8	96	5,0		767	6,5
High complete	3.382	34,4	647	33,6		4.029	34,3
Superior/post-graduate	5.256	53,4	1.079	56,0		6.335	53,8
Per capita income (tertile)							
1º	3.144	32,0	727	37,9	< 0,001	3.871	32,9
2º	3.150	32,0	623	32,3		3.773	32,1
3º	3.541	36,0	575	29,8		4.116	35,0

*χ^2 Test.

DISCUSSION

There was no association between fat consumption and HWP, even after adjustment for socioeconomic and health variables. Recent meta-analysis[22] showed a clear relationship between a high fat diet, disease development and CVD mortality, although there is still controversy regarding this issue[23]. Possibly, these contradictory results are related to the participation of different types of fats in the diet, with mechanisms of action and diverse effects on the health still little clarified. An example is lauric acid[24], present in saturated fats, since it is related to the reduction of serum and anthropometric lipids, contrary to the expected effect. There was also no association of HWP with fiber consumption, despite the recognized relation of this exposure with TG and WC[6,8].

In this study, the physical activity of weak intensity was associated with a higher prevalence of HWP, as observed by Haack and collaborators[7] in Pelotas (RS). A higher prevalence

Table 2. Characteristics of lifestyle and health according to the presence of the hypertriglyceridemic waist phenotype in the ELSA-Brazil population, 2008-2010.

Variables	Hypertriglyceridemic waist phenotype				p-value*	Total	
	Absence		Presence				
	n	%	n	%		n	%
Nutritional status							
Eutrophy	4.654	47,3	121	6,3	< 0,001	4.775	40,6
Overweight	3.193	32,5	582	30,2		3.775	32,1
Obesity	1.988	20,2	1.224	63,5		3.212	27,3
Physical activity							
Weak	7.404	75,3	1.557	80,8	< 0,001	8.961	76,2
Moderate	1.444	14,7	244	12,7		1.688	14,3
Strong	987	10,0	126	6,5		1.113	9,5
Alcohol							
Never used	1.138	11,6	163	8,4	< 0,001	1.301	11,1
Ex-user	1.955	19,9	392	20,3		2.347	19,9
User	6.742	68,5	1.372	71,3		8.114	69,0
Smoking							
Never smoked	5.855	59,5	883	45,8	< 0,001	6.738	57,3
Ex-smoker	2.715	27,6	761	39,5		3.476	29,5
Smoker	1.265	12,9	283	14,7		1.548	13,2

*χ^2 Test.

of HWP in overweight and obese individuals was also found, as well as in participants with lower *per capita* income and with a history of smoking. Excess weight is the most important predictor of the endpoint studied, a result also found in a comprehensive study conducted in the United Kingdom by Arsenault and collaborators[6], which identified an increased risk for coronary heart disease among individuals with HWP.

There is also evidence of the relationship between unfavorable socioeconomic status and cardiovascular outcomes[25,26]. Unhealthy living habits are associated with increased cardiovascular risk, such as the smoking habit demonstrated in the Frahmigham study[1]. In a follow-up study carried out in France, Czernichow and collaborators[27] observed that individuals who presented the phenotype smoked frequently, were physically inactive, and were more frequently overweight.

The caloric intake of the diet was lower in individuals with HWP, who in turn presented higher intake of soluble fiber. The evaluation of dietary intake performed by dietary surveys is quite complex and subject to sub-reports. Scagliusi and Lancha Júnior[28] state that this underestimation occurs consciously due to embarrassment and fear of non-acceptance.

The FFQ is a useful and frequently used instrument in epidemiological studies with large samples, since it allows estimating habitual consumption by classifying individuals at levels of consumption, besides presenting low cost[29]. This instrument was constructed and validated for this population[15], which increases accuracy and minimizes possible biases. The energy adjustment was performed using the residual method in order to minimize the variability of the diet[20].

Table 3. Consumption of energy, fat and fiber, according to the presence of the hypertriglyceridemic waist phenotype, 2008-2010.

Variables	Hypertriglyceridemic waist phenotype		p-value*
	Absence (n = 9835)	Presence (n = 1927)	
	Mean ± SD	Mean ± SD	
Energy (kcal)	2.882 ±989	2.763 ± 942	**< 0,001**
Total fat (g)	85,7 ± 15,8	86,3 ± 15,6	0,089
Trans fat (g)	2,8 ± 1,0	2,9 ± 1,0	**< 0,001**
Monounsaturated fats (g)	27,3 ± 6,1	27,4 ± 5,9	0,304
Polyunsaturated fats (g)	20,5 ± 4,1	20,1 ± 4,1	**< 0,001**
Cholesterol (g)	319 ± 102	323 ± 103	0,115
Omega 3 (g)	3,5 ± 1,3	3,5 ± 1,3	0,574
Total fibers (g)	35,0 ± 10,7	35,0 ± 10,3	0,762
Soluble fiber (g)	8,9 ± 3,1	9,1 ± 3,3	**0,005**
Insoluble fiber (g)	25,7 ± 8,3	25,6 ± 7,9	0,771

*Mann-Whitney Test.

Table 4. Gross and adjusted model of hypertriglyceridemic waist phenotype, 2008-2010.

Variables	Hypertriglyceridemic waist phenotype	
	Gross model	Adjusted model[a]
Sex		
Female	1	1
Male	0,899 (0,889 – 0,909)	0,959 (0,948 – 0,969)
Per capita income (tertile)		
3º	1	1
2º	1,022 (1,008)	1,028 (1,015 – 1,041)
1º	1,042 (1,028 – 1,057)	1,035 (1,022 – 1,049)
Nutritional status		
Eutrophy	1	1
Overweight	1,125 (1,113 – 1,137)	1,114 (1,102 – 1,127)
Obesity	1,346 (1,329 – 1,364)	1,324 (1,305 – 1,341)
Physical activity		
Strong	1	1
Moderate	1,028 (1,005 – 1,051)	1,014 (0,994 – 1,036)
Weak	1,054 (1,035 – 1,073)	1,039 (1,021 – 1,057)
Smoking		
Never smoked	1	1
Ex-smoker	1,077 (1,063 – 1,092)	1,044 (1,031 – 1,057)
Smoker	1,045 (1,027 – 1,064)	1,039 (1,022 – 1,056)

[a]Model adjusted for gender, age, nutritional status, *per capita* income, physical activity and smoking; *Poisson regression.

Another positive point of this study is the performance of quality control and quality assurance activities and procedures at all stages of the research, as described by Schmidt and collaborators[30]. This process confers methodological rigor to the present research, a necessary and important condition in large studies, of a multicentric nature and with a diversity of measures.

CONCLUSION

No association was found between HWP and consumption of fats and fiber, although studies have already demonstrated this effect, as well as their relationship with cardiovascular

health. In this study, HWP was associated with overweight, lower *per capita* income, history of smoking and poor physical activity.

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