The study aimed to associate the consumption of trans and saturated fats with dyslipidemia in overweight and obese adolescents who participated in the Study of Cardiovascular Risks in Adolescents (ERICA) from February 2013 to November 2014. Anthropometry, food consumption data, and the lipidogram of 9,538 overweight Brazilian adolescents from macro-regions and Teresina were used in the study. We found an association between saturated fats and HDL-c in Teresina and in the Northeastern macro-region (p-value= 0.002 and p-value= 0.033, respectively), showing that adolescents in Teresina who consumed less than 10% of saturated fats were 2.04-fold more likely to have desirable HDL-c (OR= 2.04), while northeastern adolescents were 0.625 less likely to have desirable HDL-c (OR= 0.625). In Teresina, there was an association between saturated fat consumption and total cholesterol (p-value= 0.045), showing that adolescents consuming less than 10% of saturated fats had a 0.543-fold lower odds of having desirable total cholesterol levels (OR= 0.543). Lipid profile was not associated with consumption of trans fats, but with the consumption of saturated fats. It is important to monitor the lipid profile of adolescents, especially in the presence of overweight.

Key-words: Adolescent; Dyslipidemia; Obesity; Overweight; Saturated fatty acids; Trans fatty acids.
INTRODUCTION

The increase in the prevalence of overweight and obesity in childhood and adolescence has been pointed out as a cause of concern because metabolic alterations and consequences of obesity, evident only in adults in former times, can already be observed in younger age groups. In Brazil, approximately 8.4% of adolescents are affected by obesity, a multifactorial condition associated with morbidities such as dyslipidemia, diabetes, arterial hypertension and other chronic diseases. Among the risk factors for obesity in adolescence are sedentary lifestyle, inadequate diet, genetic factors, and socioeconomic status.

Dyslipidemia is caused by changes in lipid metabolism that affect serum lipid and lipoprotein concentrations and can be classified as hyperlipidemia (high levels of LDL-c, triglycerides and total cholesterol) and hypolipidemia (low plasma levels of HDL-c).

Among complications resulting from changes in plasma lipids, especially in relation to high levels of total cholesterol and LDL-cholesterol, are the progression of atherosclerosis, a higher risk of stroke and coronary diseases, thus contributing to the main causes of morbidity and mortality in Brazil and in the world.

In Brazil, there is a high prevalence of lipid disorders during childhood and adolescence. In Campina Grande, authors identified a prevalence of 85.3% of dyslipidemia in 217 overweight children and adolescents since the preschool stage. Low HDL-c was the most frequent alteration (80.6%), and its value was significantly lower among the severely obese.

The Study of Cardiovascular Risks in Adolescents (ERICA) showed a high prevalence of changes in plasma lipids, especially in the North and Northeast regions of Brazil. Research identified low HDL-c (46.8%), high LDL-c (3.5%), hypercholesterolemia (20.1%) and hypertriglyceridemia (7.8%).

Thus, the objective of this study was to investigate the association between consumption of trans and saturated fats and lipid profile of obese and overweight adolescents from the macro-regions of Brazil and, specifically, Teresina, the regional capital of Piauí who participated in ERICA.

MATERIAL AND METHODS

This is a complementary project of the Study of Cardiovascular Risks in Adolescents (ERICA), submitted and approved by its Publications Committee. This is a cross-sectional, analytical and descriptive, multicenter, school-based study with a national scope conducted from February 2013 to November 2014.

The total sample of the ERICA was divided into 32 geographic strata and conglomerates of schools and classes, representing the population of school adolescents at the national and regional level, and for the capitals. In the sampling process, 1251 schools were selected in 124 municipalities.

The sample consisted of adolescents between 12 and 17 years of age, enrolled in the last three grades of elementary school (seventh, eighth and ninth grade) or in the first, second or third year of high school, in public and private schools of municipalities with more than 100,000 inhabitants of these five macro-regions of Brazil, who agreed to participate in the study.

In the study, adolescents who were outside the age group of 12 to 17 years, pregnant adolescents and those with physical, temporary or permanent disabilities, which did not allow the measurement of anthropometric measures with the instruments used in the research were excluded from the analysis.

It is important to note that ERICA data were grouped into a subset of data according to the degree of integrity of the information collected. Thus, subsets of adolescents were constructed based on the set of information obtained to allow the calculation of sample weights.

The criteria for inclusion and exclusion of study participants eligible for the establishment of the complete sets of information were: Questionnaire: included when all questions included in the 11 thematic blocks of the student questionnaire were answered; Anthropometry: included when at least measures of weight and height were recorded; Blood pressure: excluding measures considered to be invalid (systolic blood pressure equal to or less than diastolic blood pressure); 24-hour food recall: excluding those with an energy consumption of less than 100 kcal.

In this context, of the 102,327 adolescents eligible for the study, 52,300 answered the 24-hour food recall, 52,802 participated in anthropometry and 40,732 participated in blood collection. Thus, 37,023 adolescents presented complete data on anthropometry, 24-hour food recall and blood collection. However, only overweight adolescents with data from these three stages were considered for this study (n=9,538).

Data were collected by a team of evaluators previously trained using standardized techniques. The dietary investigation consisted of an interview about diet in the previous 24 hours. Two 24-hour recalls were performed: the first was performed with all adolescents and the second with a subsample of six adolescents per school.

In order to analyze the adequacy of consumption of saturated and trans fats, cut-off points were used as recommended by the World Health Organization, which establishes tolerable limits of trans fat intake of up to 1% of daily energy consumption, and of saturated fats up to 10%.

Nutritional status was established by the calculation of the Body Mass Index (BMI= weight/height²) and its classification by the World Health Organization BMI curves specific for age and sex, by z-score.

Collection of blood samples was the responsibility of clinical analysis laboratories. All participants were instructed to abstain from food for at least 10-12 hours prior to collection of blood samples. Total Cholesterol (TC) and Triglycerides (TG) were analyzed by Enzymatic Kinetics; High Density Lipoproteins (HDL-c), by Enzymatic Colorimetric Assay;
and Low Density Lipoproteins (LDL-c) was calculated by the Friedewald equation.

For lipid profile classification, the presence of dyslipidemia was defined by elevated levels of TC, LDL-c or TG, or low levels of HDL-c, according to the reference values of the Brazilian Directive on Dyslipidemias and Atherosclerosis Prevention - 2017, which determines the following desirable cut-off points for adolescents: TC < 170mg/dL; LDL-c < 110mg/dL; TG < 90mg/dL; and HDL-c > 45 mg/dL.

Statistical analysis was done in the Nucleus of Statistical Support to Research (NAEP), using the database of the ERICA Publications Committee, and the Stata 15 software, version 14. Tables with crossing data on trans and saturated fat consumption and levels of plasma lipids were generated for adolescents living in Brazil, in the macro-regions, and in the capital Teresina-PI, where simple frequencies (n) and relative frequencies (%) were presented.

Due to the complex sampling design of the ERICA, the Rao-Scott chi-square test, an adjusted version of Pearson’s chi-square test, was used. For the variables that obtained significance in the test, a logistic regression was performed to investigate the odds ratio (OR), considering the same design. The level of significance was 5%.

The ERICA was approved by the Research Ethics Committees of the Institute of Collective Health Studies of the Federal University of Rio de Janeiro (Report nº 01/2009, Process 45/2008) and from the institutions responsible for conducting the study in each Brazilian state and in the Federal District.

All the participants interviewed and examined signed written authorization and parents provided signed informed consent.

RESULTS

Data on saturated and/or trans fat intake and lipid profile (LDL-c, HDL-c, Triglycerides and Total Cholesterol) were analyzed from 9,538 overweight Brazilian adolescents participating in the ERICA.

No association was observed between fat intake (saturated or trans) and lipid profile among Brazilian adolescents. However, there was evidence of an association between HDL-c level and the consumption of saturated fats (p-value= 0.082) (Table 1).

When analyzing the data per region, it was observed that there was an association between saturated fat intake and HDL-c level (p-value= 0.002) among overweight adolescents residing in the Northeast region. Northeastern adolescents consuming less than 10% of saturated fat presented a 0.625 odds of having desirable HDL-c levels when compared to adolescents consuming more than 10% of this type of fat (OR= 0.625, 95% CI= 0.463 - 0.845) (Table 2).

For the other macro-regions of Brazil (Central-West, North, Southeast, and South), there was no association between fat consumption (saturated or trans) and lipid profile.

In the capital Teresina, the Rao-Scott chi-square test indicated an association between consumption of saturated fat and HDL-c level (p-value= 0.033) for overweight or obese adolescents (Table 3).

In this association, the odds ratio OR= 2.04 (95% CI= 1.06-3.94) was obtained, implying that adolescents consuming less than 10% of total calories from saturated fats had 2.04-fold higher odds of having desirable HDL-c levels when compared to adolescents who consumed more than 10% of saturated fats.

Among adolescents of Teresina, an association between saturated fat consumption and total cholesterol level was observed (p-value= 0.045). Adolescents who consumed less than 10% of total calories from saturated fats have 0.543-fold lower odds of having desirable total cholesterol when compared to adolescents who consumed more than 10% of saturated fats.

Table 1. Association between saturated and trans fat intake and plasma lipid levels in overweight Brazilian adolescents (n= 9,538). ERICA, 2013-2014.

| D | LDL-c | ND | N (%) | p | HDL-c | D | ND | N (%) | p | TG | D | ND | N (%) | p | TC | D | ND | N (%) | p |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TRANS FATS | | | | | | | | | | | | | | | | | | | | | | | | |
| <1% of total calories | 4857 (80,1) | 1260 (19,9) | 0,107 | 2559 (39,2) | 3565 (60,8) | 0,533 | 3630 (61,1) | 2493 (38,9) | 0,653 | 4450 (73,5) | 1674 (26,5) | 0,662 |
| >1% of total calories | 2721 (83,1) | 700 (16,9) | 1404 (41,0) | 2019 (59,0) | 2055 (62,2) | 1367 (37,8) | 2484 (74,6) | 939 (25,4) |
| SATURATED FATS | | | | | | | | | | | | | | | | | | | | | | | | |
| <10% of total calories | 3595 (81,2) | 887 (18,8) | 1819 (37,5) | 2668 (62,5) | 2618 (61,7) | 1868 (38,3) | 3293 (74,8) | 1194 (25,2) | 0,993 | 0,878 | 0,546 |
| >10% of total calories | 3983 (81,2) | 1073 (18,8) | 2144 (41,7) | 2916 (58,3) | 3067 (64,1) | 1992 (38,6) | 3641 (73,2) | 1419 (26,8) |

D: Desirable, ND: Not desirable, LDL-c: Low-Density Lipoprotein cholesterol, HDL-c: High-Density Lipoprotein cholesterol, TG: Triglycerides, TC: Total Cholesterol, Rao-Scott chi-square test: p<0.05.
DISCUSSION

Components from the diet, especially fats, have a relevant role in the repercussion of the lipid profile, including the HDL-c fraction. Studies have shown that the consumption of foods low in trans fatty acids and saturated fats promotes beneficial effects on serum cholesterol concentrations. In contrast, consumption of trans fats has been related to increased LDL-c, reduced HDL-c, increased systemic inflammation, oxidative stress, insulin resistance, and impairment of endothelial function.

The World Health Organization recommends maximum trans fat consumption up to 1% of the total daily energy value. In Brazil, a representative study showed that the average trans fat intake by adolescents is within WHO recommendations. Specifically, in the North and South, the consumption exceeds this percentage, reaching 1.1% and 1.3% of the total daily caloric value, respectively.

Despite the high trans fat intake among adolescents in these regions, the present study showed no association between such consumption and plasma lipids. However, it is known that the effect of trans fat intake on LDL-c, VLDL-c, TG and other fractions may depend on several factors, such as the ingestion of polyunsaturated fatty acids.

In relation to saturated fat intake, the average consumption by adolescents in Brazil and in the Northeast region is similar (11.5% of the total daily caloric intake among girls aged 14 to 17 years and 10.8% among boys in the same range age). This is a cause for concern because the WHO recommendation is up to 10% of daily calories.

Individuals who consume large amounts of fats, especially saturated fats, have higher serum cholesterol levels than those who consume smaller amounts, and this relation is directly proportional. However, this study showed an inverse association between saturated fat intake and total

Table 2. Association between saturated and trans fat intake and plasma lipid levels in overweight adolescents living in the Northeast region of Brazil (n= 2,864), ERICA, 2013-2014.

| LDL-c | HDL-c | TG | TC |
|-------|-------|----|----|
| D N (%) | ND N (%) | p | D N (%) | ND N (%) | p | D N (%) | ND N (%) | p |
| TRANS FATS | TRANS FATS | TRANS FATS | TRANS FATS | TRANS FATS | TRANS FATS | TRANS FATS | TRANS FATS | TRANS FATS |
| <1% of total calories | 1498 (82,4) | 398 (17,6) | 729 (35) | 1169 (65) | 3630 (61,1) | 2493 (38,9) | 4450 (73,5) | 1674 (26,5) |
| >1% of total calories | 759 (84,5) | 209 (15,5) | 369 (35,6) | 599 (64,4) | 2055 (62,2) | 1367 (37,8) | 2484 (74,6) | 939 (25,4) |
| SATURATED FATS | SATURATED FATS | SATURATED FATS | SATURATED FATS | SATURATED FATS | SATURATED FATS | SATURATED FATS | SATURATED FATS | SATURATED FATS |
| <10% of total calories | 1050 (85,3) | 252 (14,7) | 477 (29,5) | 825 (70,5) | 737 (56,1) | 565 (43,9) | 972 (78,6) | 438 (21,4) |
| >10% of total calories | 1207 (81,1) | 355 (18,9) | 621 (40,1) | 943 (59,9) | 940 (55,5) | 624 (44,5) | 1126 (74,2) | 768 (25,8) |

D: Desirable, ND: Not desirable, LDL-c: Low-Density Lipoprotein cholesterol, HDL-c: High-Density Lipoprotein cholesterol, TG: Triglycerides, TC: Total Cholesterol, Rao-Scott chi-square test: p<0,05.

Table 3. Association between saturated and trans fat intake and plasma lipid levels in overweight adolescents living in the capital Teresina, PI, (n= 203), ERICA, 2013-2014.

| LDL-c | HDL-c | TG | TC |
|-------|-------|----|----|
| D N (%) | ND N (%) | p | D N (%) | ND N (%) | p | D N (%) | ND N (%) | p |
| TRANS FATS | TRANS FATS | TRANS FATS | TRANS FATS | TRANS FATS | TRANS FATS | TRANS FATS | TRANS FATS | TRANS FATS |
| <1% of total calories | 96 (81,8) | 20 (18,2) | 38 (31,5) | 78 (68,5) | 73 (56,5) | 43 (43,5) | 87 (73,9) | 29 (26,1) |
| >1% of total calories | 66 (82,6) | (17,4) | 22 (23,8) | 65 (76,2) | 52 (46,3) | 35 (53,7) | 64 (77,3) | 23 (22,7) |
| SATURATED FATS | SATURATED FATS | SATURATED FATS | SATURATED FATS | SATURATED FATS | SATURATED FATS | SATURATED FATS | SATURATED FATS | SATURATED FATS |
| <10% of total calories | 63 (79,3) | 17 (20,7) | 27 (36,7) | 53 (63,3) | 46 (50,9) | 34 (49,1) | 53 (68,5) | 27 (31,5) |
| >10% of total calories | 99 (83,9) | 24 (16,1) | 33 (22,1) | 90 (77,9) | 79 (52,1) | 44 (48) | 98 (80) | 25 (20,0) |

D: Desirable, ND: Not desirable, LDL-c: Low-Density Lipoprotein cholesterol, HDL-c: High-Density Lipoprotein cholesterol, TG: Triglycerides, TC: Total Cholesterol, Rao-Scott chi-square test: p<0,05.
cholesterol among adolescents in the capital Teresina.

In relation to HDL-c, the consumption of saturated fatty acids may be related to the increase of this lipoprotein, and this effect is more pronounced in medium-chain saturated fatty acids compared to long chain saturated fatty acids,

24 since the effects of HDL-c are increased as the length of the chain is reduced. A meta-analysis has confirmed the increase of HDL-c by the consumption of saturated fatty acids.

Thus, the results found in the present study in relation to the Northeast region confirm the findings of the literature. However, when analyzing the data for Teresina, an inverse association between the two variables was found.

Several factors may explain our results, including those that influence the metabolism of HDL-c, such as: obesity, type 2 diabetes, inflammation, smoking, hormonal action, and physical exercise. In addition, it is worth noting the influence of high consumption of carbohydrates, polyunsaturated and monounsaturated fats,

27,29,30 The lack of investigation of the mentioned variables and the complexity of the sampling design of the ERICA represent limitations of the present study.

It is known that the degree of obesity plays an important role in the appearance of metabolic alterations,

31,32 and that obese adolescents are more likely to have a reduction in the HDL-c fraction, dysregulation of endothelial function, and also more atherogenic lipoproteins.

Furthermore, characterized as a chronic inflammatory process of low intensity, obesity is responsible for triggering the activation of the signaling pathway of the Toll-4 receptor, one of the main triggers of the inflammatory response induced by obesity. This pathway responds to increased exposure to saturated fatty acids.

This metabolic inflammation prevents insulin signaling and reverse cholesterol transport, reflecting in the reduction of metabolic control and a higher risk for development of dyslipidemia and cardiovascular diseases.

Evidence suggests that saturated fats may have little effect on LDL-c in obese people. A randomized clinical trial with 322 obese subjects demonstrated that a diet rich in saturated fats and low in carbohydrates compared to others was considered the most effective because it increased the HDL/LDL ratio. In this trial, there was an increase in HDL-c during weight loss in all groups.

The results of the present study showed that the cardiovascular risk factor related to dyslipidemia was not related to the consumption of trans fats, but rather of saturated fats by overweight adolescents from the Northeast region of the country and from the capital Teresina. This finding may be due to the differences between stages of the epidemiological and nutritional transitions of the different regions and the different eating habits across Brazil.

Stratification by macro-regions is important considering different lifestyles and eating habits. There is evidence that stratifying by macro-regions can illustrate important differences in the prevalence of consumption of some foods and nutrients.

A cross-national study investigating the pattern of food consumption among Brazilian adolescents, showed a higher prevalence of healthy food patterns in the Southeast (31.5%), South (33.9%) and Central-West regions (34.5%). On the other hand, the North and Northeast regions presented lower proportions for this food pattern (20.6 and 18.6%, respectively).

Thus, different patterns of food consumption in these regions, in addition to portraying the usual consumption of food and nutrients, may reflect differentiation in the emergence of chronic diseases and health status of the study population. In this sense, the ERICA results point to important regional contrasts, which need to be better explored in the planning of effective public health interventions and to redirect food and nutrition policies.

It is important to point out that there is no isolated ingestion of saturated or trans fats in the diet. Thus, both the HDL-c profile and the other blood lipid fractions in this population are also the result of the interaction between the other macronutrients and micronutrients resulting from the food matrix. Other non-dietary factors, such as nutritional status, lifestyle, genetic profile, and the complexity of the sample of the ERICA should be considered.

CONCLUSIONS

The imbalance in the consumption of macronutrients, specifically excessive consumption of fats, can cause damage to metabolic processes and changes in lipid profile. In this study, consumption of saturated fat was associated with HDL-c level among overweight adolescents living in the Northeast region of Brazil and in the capital Teresina.

In addition, the importance of moderate consumption of trans fatty acids and saturated fat from early childhood is emphasized, taking into account that these habits may affect cardiovascular health and increase obesity in adult life. Furthermore, the high prevalence of dyslipidemia among adolescents reinforces the need to monitor lipid profile, especially in the presence of excess weight.

Other studies should be conducted on the subject in order to elucidate the gaps related to the role of dietary fats in the blood lipid profile in this population because the results on their consumption remain inconsistent and complex, as levels involve several genetic, dietary and of lifestyle factors.

REFERENCES

1. National Heart Lung and Blood Institute. Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents: summary report. Pediatrics. 2011;128: S213-S256.

2. Güngör NK. Overweight and obesity in children and adolescents. J Clin Res Pediatr Endocrinol 2014; 6(3): 129-143.

3. Carvalho RBN, Nobre RS, Guimarães MR, Teixeira SXM, Silva ARV. Risk factors associated with the development of metabolic syndrome in children and adolescents. Acta Paul Enferm 2016; 29(4): 439-445.
4. Bloch KV, Klein CH, Szkl M, Kaschnir MCC, Abreu GA, Barufalda LA et al. ERICA: prevalence of hypertension and obesity in Brazilian adolescents. Rev Saúde Pública 2016; 50(Suppl 1): 9s.
5. Araújo ESS, Guedes MVC, Almeida PC. Overweight and obesity among adolescents in public schools. Enferm Foco 2013; 4(3,4): 202-206.
6. Bonifácio BS, Oliveira NC, Portes LA, Gomes EP. Prevalence of overweight and obesity in adolescents from the south zone of the city of São Paulo - SP. EFR. 2014; 8(1): 54-59.
7. Breviđelli MM, Coutinho RM, Costa LFV, Costa LC. Prevalence and factors associated with overweight and obesity among adolescents of a public school. RBPS. 2015; 28(3): 379-386.
8. Xavier HT, Iza MC, Faria Neto JR, Assad MH, Rocha VZ, Sposito AC et al. V Brazilian guideline on dyslipidemias and prevention of atherosclerosis. Arq Bras Cardiol 2013; 101(4 Suppl 1): 1-20.
9. Faludi AA, Iza MCO, Saraiva JFK, Chacra APM, Bianco HT, Alíune Neto A et al. Prevalence of the Brazilian Directive on Dyslipidemias and Prevention of Atherosclerosis – 2017. Arq Bras Cardiol 2017; 109(2 Suppl 1): 1-76.
10. 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.
11. Ramos AT, Carvalho DF, Gonzaga NC, Cardoso AS, Noronha JAF, Cardoso MAA. Lipid profile in overweight children and adolescents. J. Hum. Growth Dev. 2011; 21(3): 780-788.
12. Faria Neto JR, Bento VFR, Raça EP, Olandoski M, Gonçalves LGO, Abreu GA et al. ERICA: prevalence of dyslipidemia in Brazilian adolescents. Rev Saúde Pública 2016; 50(Suppl 1): 10s.
13. Bloch KV, Szkl M, Kuschnir MC, Abreu GA, Barufalda LA, Klein CH. The Study of Cardiovascular Risk in Adolescents-ERICA: rationale, design and sample characteristics of a national survey examining cardiovascular risk factor profile in Brazilian adolescents. BMC Public Health 2015; 15(94): 1-10.
14. Vasconcellos MTL, Silva PLN, Szkl M, Kaschnir MCC, Klein CH, Abreu GA et al. Sampling design for the Study of Cardiovascular Risks in Adolescents (ERICA). CSP. 2015; 31(5): 921-930.
15. World Health Organization (WHO), Food and Agriculture Organization (FAO). Expert Consultation on Diet, Nutrition and the prevention diseases. Diet Nutrition and the prevention diseases. Diet Nutrition and the prevention of chronic diseases: report of a joint WHO/FAO expert consultation. Geneva: WHO, FAO; 2003.
16. Cureau FV, Bloch KV, Henz A, Schaon CW, Klein CH, Oliveira CL et al. Challenges for conducting blood collection and biochemical analysis in a large multicenter school-based study with adolescents: lessons from ERICA in Brazil. CSP. 2017; 33(4):e00122816.
17. Hidematu Y, Hisayuki K, Hidetaka H, Shinichi A, Norio T, Akahito S. Effects of dietary fat intake on HDL metabolism. J Clin Med Res 2015; 7(3):145-149.
18. Chen M, Li Y, Sun Q, Pan A, Manson JE, Rexrode KM, Willett, WC, Rimm EB, Hu FB. Dairy fat and risk of cardiovascular disease in 3 cohorts of US adults. Am. J Clin Nutr 2016; 104(5): 1209-1217.
19. Guasch-Ferré M, Babio N, Martínez-González MA, Corella D, Ros E, Martín-Peláez S, Estruch R, Arós F, Gómez-Gracia E, Fiol M, Santos-Lozano JM, Serra-Majem L, Bulló M, Toledo E, Barragán R, Fitó M, Gea A, Salas-Salvadó J. Dietary fat intake and risk of cardiovascular disease and all-cause mortality in a population at high risk of cardiovascular disease. Am. J Clin Nutr 2015; 102(6): 1563-1573.
20. Brouwer IA, Wanders AJ, Katman MB. Triglycerides and cardiovascular health: research completed? Eur J Clin Nutr 2013; 67(5): 541-547.
21. Souza AM, Barufalda LA, Abreu GA, Giannini DT, Lacroix CO. ERICA: Intake of macro and micronutrients of Brazilian adolescents. Rev Saúde Pública 2016; 50(supl 1): 1-15.
22. Kabagambe EK, Orдовas JM, Hopkins PN, Tsai MY, Arnett DK. The relation between erythrocyte trans fat and triglyceride, VLDL- and HDL-cholesterol concentrations depends on polyunsaturated fat. Plos One 2012; 7(10): 1-6.
23. Bortoli C, Bonatto S, Bruscaturo NM, Siviero J. Intake of saturated fat and carbohydrates among adult and elderly patients with dyslipidemia in the Veranópolis Project. Rev Bras Cardiol 2011; 24(1): 33-41.
24. Panth N, Abbott KA, Dias CB, Wynne K, Garg ML. Differential effects of medium- and long-chain saturated fatty acids on blood lipid profile: a systematic review and meta-analysis. Am J Clin Nutr 2018; 108 (4): 675-687.
25. Micha R, Mozafarian D. Saturated fat and cardiometabolic risk factors, coronary heart disease, stroke, and diabetes; a fresh look at the evidence. Lipids 2010; 45(10): 893-905.
26. Mensink RP, Zock PL, Kester AD, Brouwer IA, 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.
27. Fattore E, Bosetti C, Brighenti F, Agostoni C, Fattore G. Palm oil and blood lipid-related markers of cardiovascular disease: a systematic review and meta-analysis of dietary intake trials. Am. J Clin Nutr 2014; 99(6): 1331-1350.
28. Rader DJ, Hovingh GK. HDL and cardiovascular disease. Lancet 2014; 384(9943): 618-625.
29. Sini-Tarino PW, Sun Q, Hu FB, Krauss RM. Saturated fat, carbohydrate, and cardiovascular disease. Am J Clin Nutr 2010; 91(3): 502-509.
30. Forouhi NG, Krauss RM, Taulbee W, Willett W. Dietary fat and cardiometabolic health: evidence, controversies, and consensus for guidance. Br Med J 2018; 361: k2139.
31. Lavrador MSF, Abbes PT, Escrivão MAMS, Taddei JAAC. Cardiovascular risks in adolescents with different degrees of obesity. Arq Bras Cardiol 2011; 96(3): 205-211.
32. Rank M, Siegrist M, Wolfrath B, Koegn W, Halle M. The cardio-metabolic risk of moderate and severe obesity in children and adolescents. J Pediatr. 2013; 163: 137-142.
33. Matsuo Y, Oberbach A, Till H, Inge TH, Wabitsch M, Moss AK, Jehlich N, Vollker U, Müller U, Siegrist M, Kanewaza N, Karubayashi M, Schulter G, Linke A, Adams V. Impaired HDL function in obese adolescents: impact of lifestyle intervention and bariatric surgery. Obesiy 2013; 21(12): E687-695.
34. Musso C, Graffigna M, Soutelo J, Honfi M, Ledesma L, Míksztoñicz V, Pazos M, Migliano M, Schreier LE, Berg E687-695.
35. Rogero MM, Calder PC. Obesity, Inflammation, Toll-Like Receptor 4 and Fatty Acids. Nutrients 2018; 10(4): 432.
36. Kirwan AM, Lenighan YM, O’Reilly ME, McGillicuddy FC, Roche HM. Nutritional modulation of metabolic inflammation. Biochem Soc Trans 2017; 45(4): 979-983.
37. Barbalho SM, Bechara MD, Quesada K, Gabaldi MR, Goulart RA, Tofano RJ, Gasparini RG. Metabolic syndrome, atherosclerosis and inflammation: an inseparable triad? J Vasc Bras 2015; 14(4): 319-327.
38. Shai I, Schwarzfuchs D, Henkin Y, Shahar DR, Witkow S, Greenberg I, et al. Weight loss with a low-carbohydrate, Mediterranean, or low-fat diet. N Engl J Med 2008; 359(3): 229-241.
39. Tavares LF, Castro JRR, Levy RB, Cardoso LO, Claro RM. Dietary patterns of Brazilian adolescents: results of the Brazilian National School-Based Health Survey (PeNSE). Cad Saúde Pública 2014; 30(12): 2679-269.