# What the Cardiologist Should Know About Trans Fats

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According to the World Health Organization[1], 80% to 90% of people who die of coronary heart diseases have one or more risk factors directly associated with their lifestyle, eating habits, physical activities and others that could be changed. Data relative to the years 2002 and 2003 published by the *Instituto Brasileiro de Geografia e Estatística - IBGE*[2] (Brazilian Institute of Geography and Statistics) paint a worrisome picture of Brazilian eating habits, and the risk these represent for the incidence of cardiovascular diseases, particularly coronary artery diseases. In a universe with 96 million people above 20 years of age, 41% are overweight, and out of this 10.5 million are considered obese. The publication shows that people eat very small amounts of fruits and vegetables, and that most proteins come from animal products[2]. High consumption of foods containing trans-isomer fats, such as margarines, ice creams, biscuits and potato chips produced in our country, which is increasing specially among young people, was also observed.

Trans fats are a current concern for a healthy cardiovascular diet. The characteristics of this type of fat - its longer shelf life, its stability during frying and its semi-solidity, which increases the palatability of sweet and baked products – stir food industry interest. Therefore, it is a subject that involves huge economic interests, represented by food manufacturers and fast-food chains. Within this context, it is essential that the cardiologist be familiar with the characteristics and effects of this kind of food to be able to provide adequate nutritional orientation to his/her patients. This subject has been thoroughly reviewed in international literature[3]. This article presents a summary of important information about trans fats and their implications for clinical practice.

## Trans-fatty acids

Trans-fatty acids are synthesized during the process of partial hydrogenation of vegetable oils, by converting double bonds (inexistent in saturated fats) into single ones what makes its configuration similar to that of saturated fatty acids. It is for this reason that trans fats increase low-density lipoprotein (LDL) cholesterol levels, such as saturated fatty acids, with the additional effect of reducing the levels of high-density lipoprotein (HDL)[4] cholesterol thus raising the HDL/total cholesterol ratio. Trans fats act also by increasing triglycerides comparatively to the ingestion of other fats, but such alteration may depend on the degree of absorption and the extent of oxidation of long-chain fatty acids; they also raise the levels of lipoproteins(a)[5] and reduce the size of LDL particles[6]. The mechanisms responsible for these alterations seem to be associated with the modulation of cell membrane receptors, by incorporating phospholipids, as well as with the regulation of gene transcription. *In vitro* studies show that trans-fatty acids may alter the secretion, lipid composition and size of apolipoprotein B-100 particles produced in the liver, besides increasing the buildup of cholesterol and cholesterol esters in the cells. The ingestion of trans-fatty acids increases the activity of the cholesterol ester-transfer protein, an enzyme responsible for the transfer of cholesterol esters from HDL molecules to LDL, and to very low density lipoprotein (VLDL), which explains the changes that take place in the lipid profile in humans[3].

Small quantities of these fatty acids are present also in beef and dairy products from cow and sheep milk, as well as from other ruminant animals; these acids are naturally produced by the action of bacteria in the guts of these animals. Trans-fatty acids from meat or dairy products from ruminant animals seem not to cause major problems to public health, perhaps due to the small quantity ingested (1% to 8% of total fats or less than 0,5% of total calories ingested) or maybe due to the biological differences when compared to those produced by hydrogenation[7]. Table 1 exhibits a few foods with high trans-fatty acid contents.

**Table 1 - Foods high in trans fats**

| | |
|---|---|
| Ice creams | Diet chocolate |
| Salty packaged snacks | Commercially baked cakes and pies |
| Cookies | Commercially fried foods |
| Cream-filled cookies | Bottled salad dressings |
| Puff pastes | Hardened margarines |
| Pastries | Chocolate-covered bars |
| Mayonnaise | Crystallized cane sugar icing |
| Microwave popcorn | Canned soups |

*According to Stachowska et al*[8].

The major sources of trans fats are: fried fast foods, baked products, packaged snacks, margarines and cookies. However, the contents of trans fats vary a lot among the different brands of industrialized foods. For instance, a study showed a large difference of trans fats contents among a few brands of chocolate-covered bars, ranging from 0.3 $\mu$g/g to 2.94 $\mu$g/g; in margarines, the difference ranged from 0.12

## Key words

Diet; dyslipidemias; risk factors; trans fatty acids.

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μg/g to 87.6 μg/g, whereas in potato chips the difference ranged from 0.09 μg/g to 3.5 μg/g[8]. A large serving of potato chips or 100 g of microwave popcorn, cookies, waffers, ready-made pies[9] or creams crackers[10] is considered a diet rich in this kind of fat. Canned soups and sauces also exceed the maximum daily values recommended, and may reach up to 9 g/100 g. An interesting study compared the trans-fatty acid contents of 43 foods served in two fast-food chains in 20 countries, from November 2004 and September 2005[8]. The contents ranged from minus 1 g in Denmark and Germany to 10 g in the United States (New York) and 24 g in Hungary, and 50% of the foods evaluated had more than 5 g of trans fats per serving. The difference in trans-fatty acid contents varied a lot within the same country. For instance, the contents of trans-fatty acids in oils used in fried potatoes was 23% in the United States and 24% in Peru, whereas in most European countries it was just 10%, 5% in Spain and 1% in Denmark[8].

The average consumption of industrialized foods containing trans-fatty acids in the United States ranges from 2% to 3% of the total amount of calories ingested[11]. Adverse effects may be detected even with a consumption of 1% to 3% of the total calories ingested, what means approximately 20 to 60 calories (2g to 7g) for a person with a 2,000-calorie-a-day diet. The American *Dietary Guidelines Advisory Committee* recommends that trans fats should be less than 1% of the total amount of calories ingested[12]. It is noteworthy to keep in mind that American food manufacturers are allowed to list zero trans fat contents on nutrition fact labels of food items containing up to 500 mg[12] of trans fats. In Brazil, a few food products were recently compared for differences of trans fat contents; it was noticed, for instance, that the concentration of trans fats is higher in whole milk than in semi-skimmed milk and, in the latter one, more than in skimmed milk. The same thing was noticed in yellow cheeses as compared to white ones, and hot dog sausages as compared to peperoni. When butter was compared to margarine, the latter showed to have a better saturated fat profile and should be preferred to the former. However, the margarines evaluated did not contain trans fats[13]. It should be kept in mind that this composition is not to be taken as representative of all margarines found in the market, as some of them do have trans fats. These data show the large variability of trans fat contents in industrialized foods commonly consumed by the population, mainly children, and the significant role of national laws play on eating habits.

## Consumption of trans fats and cardiovascular risks

The relationship between the consumption of trans fats and the increase of inflammatory markers has already been described in several studies. One of these studies evaluated, by means of a survey, the eating habits of 667 Dutch men, between 64 and 84 years of age, with no coronary artery disease. After a ten-year follow-up, the conclusion was that there is an association between an increased consumption of trans fats and the incidence of coronary atherosclerosis[14]. Some studies showed also that trans fats can increase the levels of serum inflammatory and endothelial dysfunction markers, as well as worsen the nitric-oxide mediated vessel dilation response[15,16]. A study conducted with healthy volunteers compared the effects of replacing saturated fats with trans fats and observed a greater reduction of HDL levels and vessel dilation response, which was not observed when saturated fats were replaced with monounsaturated, which also decreased HDL[17]. This reduction in vessel dilation seems to be time-dependent and not an acute effect[18]. The inflammatory alterations associated with the consumption of trans fats do not seem to be directly associated with their action on the lipids, but rather through a modulating effect on monocytes and macrophages, which increases the production of tumor necrosis factor-alpha, interleukin-6 and leukocyte chemoattractant protein-1[3].

Based on results from very well-documented cohort observational studies[14] and on the calculation of the number of calories ingested, trans-fatty acids seem to increase the risk of coronary artery disease more than any other macronutrient, by substantially increasing the risk even with low levels of consumption (1% to 3% of total energy intake). A meta-analysis of 4 prospective cohorts, involving approximately 140 thousand individuals, showed that a 2% increase in the consumption of trans fats was associated with a 23% relative increase in the incidence of coronary artery disease[19,20]. In absolute terms, these data represent an approximate 2% to 2.5% increase in the incidence of myocardial infarction or death due to cardiac causes in a population of healthy individuals followed during two decades[3]. In a population with greater cardiovascular risks, let's say 15% in ten years, the increase in trans fat consumption could raise the risk to approximately 18.5%[14]. The follow-up of the nurse cohort during 16 to 20 years showed a relationship between the consumption of trans fats and the incidence of diabetes and coronary artery disease[21,22]. In a meta-analysis of 12 randomized trials conducted with 524 individuals of 39 groups of studies or periods, the comparison of the same amount of calories from saturated fats and trans fats showed that the latter ones increase more the levels of LDL-cholesterol, reduce the levels of HDL-cholesterol and worsen the Castelli I rate; when compared to other fats, trans fats also raise triglyceride levels, lipoprotein(a) levels and reduce the size of the LDL-cholesterol particles[3]. There seems to be also an association between a kind of trans-fatty acid and sudden cardiac death, as recently reported by Lemaitre et al[23]. As the relationship between consumption of trans-fatty acids and the risk of coronary artery disease, diabetes and sudden death is greater than expected due to their effects on lipoproteins, it is suggested that the proinflammatory and endothelial function effects may contribute to increase the risk[24-28].

A recent study conducted with 35,924 Iranian individuals showed that the replacement of trans-fatty acids with unsaturated fats would reduce coronary events by 9%, and by 8% if trans-fatty acids were replaced with saturated fats, when only the effects on the total/HDL cholesterol ratio are taken in consideration, or by around 22% and 17%, respectively, if prospective studies were included[29].

### Recommendations for cardiologists

Although there are no clinical trials that yield solid outcomes about the effects of a reduced ingestion of trans fats, currently available literature evidences show that an increased consumption of trans fats changes the lipid and inflammatory profile, and is associated with a greater incidence of coronary artery diseases. Actually, as randomized clinical assays show that a reduced consumption of these fats can improve the lipid profile, some authors believe that it would not be ethical to conduct a large randomized trial with solid outcomes[3]. The cardiologist, therefore, should recommend the reduction or even the total elimination of consumption of the foods listed on Table 1 as primary and secondary prevention measures.

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No potential conflict of interest relevant to this article was reported.

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## References

1. World Health Organization. Manual on monitoring cardiovascular diseases. Washington (DC); 2001.
2. Instituto Brasileiro de Geografia e Estatística. Pesquisa de orçamentos familiares 2002-2003. Aquisição alimentar familiar domiciliar per capita Brasil e grandes regiões. Rio de Janeiro; 2004.
3. Monzaffarian D, Katan MB, Ascherio A, Stampfer MJ, Willett WC. Trans fatty acids and cardiovascular disease. N Engl J Med. 2006; 354: 1601-13.
4. 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: 1146-55.
5. Ascherio A, Katan MB, Zock PL, Stampfer MJ, Willett WC. Trans fatty acids and coronary heart disease. N Engl J Med. 1999; 340: 1994-8.
6. Mauger JF, Lichtenstein AH, Ausman LM, Jalbert SM, Jauhiainen M, Ehnholm C, et al. Effect of different forms of dietary hydrogenated fats on LDL particle size. Am J Clin Nutr. 2003; 78: 370-5.
7. Jakobsen MU, Bysted A, Andersen NL, Heitmann BL, Hartkopp HB, Leth T, et al. Intake of ruminant trans fatty acids and risk of coronary heart disease – an overview. Atheroscler Suppl. 2006; 7: 9-11.
8. Stachowska E, Luterek K, Gutowska I, Zyluk P, Bober J, Chlubek D. Atherogenic trans isomers of fatty acids in some food products. Ann Acad Med Stetin. 2006; 52: 13-6.
9. Stender S, Dyerberg J, Bysted A, Leth T, Astrup A. A trans world journey. Atheroscler Suppl. 2006; 7: 47-52.
10. Chiara VL, Sichieri R, Carvalho TSF. Teores de ácidos graxos trans de alguns alimentos consumidos no Rio de Janeiro. Rev Nutr. 2003; 16: 227-33.
11. Allison DB, Egan SK, Barraj LM, Caughman C, Infante M, Heimbach JT. Estimated intakes of trans fatty and other fatty acids in the US population. J Am Diet Assoc. 1999; 99: 166-74.
12. Dietary Guidelines Advisory Committee. Nutrition and your health. Dietary guidelines for Americans. 2005 Dietary Guidelines Advisory Committee Report. Washington (DC): Department of Agriculture; 2005.
13. Scherr C. Soluções nutricionais para diminuir o risco cardiovascular [Tese]. Porto Alegre: Universidade Federal do Rio Grande do Sul; 2006.
14. Oomen CM, Ocke MC, Feskens EJ, van Erp-Baart MA, Kok FJ, Kromhout D. Association between trans fatty acid intake and 10-year risk of coronary heart disease in the Zutphen Elderly Study: a prospective population-based study. Lancet. 2001; 357: 746-51.
15. Lopez-Garcia E, Schulze MB, Meigs JB, Manson JE, Rifai N, Stampfer MJ, et al. Consumption of trans fatty acids is related to plasma biomarkers of inflammation and endothelial dysfunction. J Nutr. 2005; 135: 562-6.
16. de Roos NM, Bots ML, Siebelink E, Schouten E, Katan MB. Flow-mediated vasodilation is not impaired when HDL-cholesterol is lowered by substituting carbohydrates for monounsatured fat. Br J Nutr. 2001; 86: 181-8.
17. de Roos NM, Schouten EG, Katan MB. Trans fatty acids, HDL-cholesterol, and cardiovascular disease: effects of dietary changes on vascular reactivity. Eur J Med Res. 2003; 8: 355-7.
18. de Roos NM, Bots ML, Katan MB. Replacement of dietary saturated fatty acids by trans fatty acids lowers serum HDL cholesterol and impairs endothelial function in healthy men and women. Arterioscler Thromb Vasc Biol. 2001; 21: 1233-7.
19. Pietinen P, Ascherio A, Korhonen P, Hartman AM, Willett WC, Albanes D, et al. Intake of fatty acids and risk of coronary heart disease in a cohort of Finnish men: the Alpha-Tocopherol, Beta-Carotene Cancer Prevention Study. Am J Epidemiol. 1997; 145: 876-87.
20. Ascherio A, Rimm EB, Giovannucci EL, Spiegelman D, Stampfer M, Willett WC. Dietary fat and risk of coronary heart disease in men: cohort follow up study in the United States. Br Med J. 1996; 313: 84-90.
21. Hu FB, Manson JE, Stampfer MJ, Colditz G, Liu S, Solomon CG, et al. Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. N Engl J Med. 2001; 345: 790-7.
22. Oh K, Hu FB, Manson JE, Stampfer MJ, Willett WC. Dietary fat intake and risk of coronary heart disease in women: 20 years of follow-up of the Nurses' Health Study. Am J Epidemiol. 2005; 161: 672-9.
23. Lemaitre RN, King IB, Mozaffarian D, Sotoodehnia N, Siscovick DS. Trans-fatty acids and sudden cardiac death. Atheroscler Suppl. 2006; 7: 13-5.
24. Mozaffarian D. Trans fatty acids: effects on systemic inflammation and endothelial function. Atheroscler Suppl. 2006; 7: 29-32.
25. Lemaitre RN, King IB, Mozaffarian D, Sotoodehnia N, Rea TD, Kuller LH, et al. Plasma phospholipid trans fatty acids, fatal ischemic heart disease, and sudden cardiac death in older adults: the Cardiovascular Health Study. Circulation. 2006; 114: 209-15.
26. Aro A, Kardinaal AF, Salminen I, Kark JD, Riemersma RA, Delgado-Rodriguez M, et al. Adipose tissue isomeric trans fatty acids and risk of myocardial infarction in nine countries: the EURAMIC study. Lancet. 1995; 345: 273-8.
27. Baylin A, Kabagambe EK, Ascherio A, Spiegelman D, Campos H. High 18:2 trans-fatty acids in adipose tissue are associated with increased risk of nonfatal acute myocardial infarction in Costa Rican adults. J Nutr. 2003; 133: 1186-91.
28. Clifton PM, Keogh JB, Noakes M. Trans fatty acids in adipose tissue and the food supply are associated with myocardial infarction. J Nutr. 2004; 134: 874-9.
29. Mozaffarian D, Abdollahi M, Campos H, Houshiarrad A, Willet WC. Consumption of trans fats and estimated effects on coronary heart disease in Iran. Eur J Clin Nutr. 2007; 61 (8): 1004-10.