

Nutrition and Health Info-Sheet

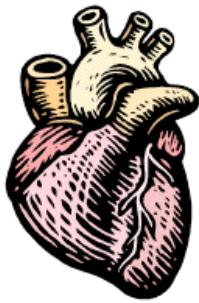
For Health Professionals

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Trans Fats and Cardiovascular Disease

What are cardiovascular disease and coronary heart disease?

Cardiovascular disease (CVD) is a category of diseases affecting the heart and circulatory system (1). It includes coronary heart disease (CHD), heart failure, stroke, pulmonary heart disease, atherosclerosis, and high blood pressure (1). It is possible for one person to have many of these conditions.



- High blood pressure and atherosclerosis are major risk factors for several types of CVD (1,2).
- Coronary heart disease is the partial or complete blockage of the arteries supplying the heart by atherosclerotic plaques.
- Heart attacks, or myocardial infarctions, are considered CHD events and are caused by a complete blockage, cutting off blood flow to a portion of the heart muscle (1).

What are the major risk factors for coronary heart disease?

There are several modifiable risk factors for CHD (1,2):

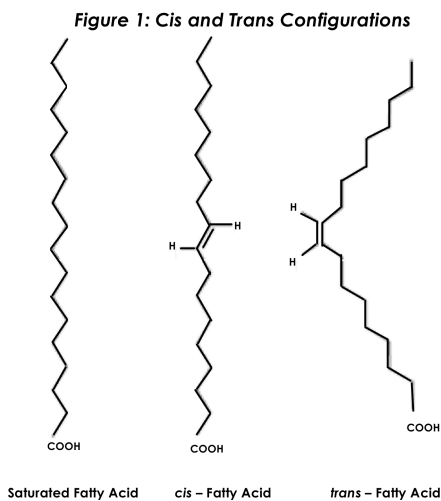
- Cigarette smoking.
- Elevated low-density lipoprotein (LDL) levels.
- High blood pressure
- Diabetes mellitus
- Low level of physical activity
- Overweight and obesity
- Low high-density lipoprotein (HDL) levels
- Poor diet



How have the rates of cardiovascular disease changed in the last 30 years?

Mortality from CHD or stroke declined by 60 percent between 1970 and 2000 (4). This decline is likely due to a number of factors, including advances in the control of hypertension, and declines in cigarette smoking and consumption of saturated fat, and improved primary and secondary prevention (3,4).

What are *trans* fatty acids (TFA)?



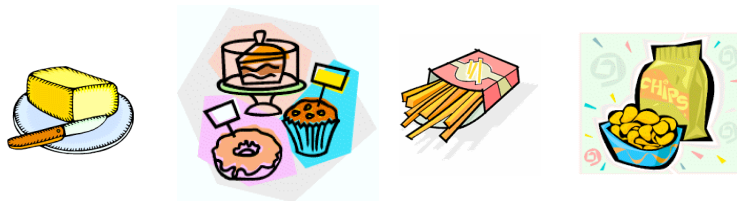
Trans fatty acids (TFA) are unsaturated fatty acids with at least one double bond in the *trans* (hydrogen on opposite sides) position (Figure 1).

- Most TFA acids found in foods are produced commercially via hydrogenation (5-8).
- Complete reduction of double bonds results in a fully hydrogenated, saturated fat, while a reduction of only some of the double bonds creates partially hydrogenated fats and oils.
- During this process, *cis* (hydrogen on the same side) bonds can reform into *trans* bonds resulting in TFA.
- Hydrogenation, and partial hydrogenation results in a semi-solid or solid product with a higher melting point, increased stability, resistance to oxidation, and shelf life (4-8).

What foods contain TFA?

The major source of TFA in the diet are commercially-produced hydrogenated oils found in many processed foods (4,7). The most common foods are:

- Margarine
- Bakery products
- Cookies and crackers
- Fried potatoes
- Chips and snacks
- Household shortening



Trans fatty acids are produced naturally by bacteria in ruminant stomachs, and as a result very small amounts can be found in products originating from these animals, such as cow's milk (4-8).

What are the current estimated intakes of TFA?

The average consumption of TFA is estimated to be 2 to 3 percent of total calories consumed, which corresponds to an average of 5.3 to 5.8 g of *trans* fatty acids per day. (3,6). Estimates of the proportion from industrially-produced TFA range from 79 to 90 percent of calories from TFA (4-7,10).

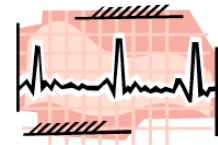
What are the current estimated intakes of saturated and unsaturated fat?

The average daily intake of fat is 79 grams (32.7 percent of calories), with 27 grams coming from saturated fat (11.2 percent of calories), 30 grams of monounsaturated fat and 16 grams of polyunsaturated fat (11,12).

What are health concerns related to TFA?

The main concern is the effect of TFA on heart health. *Trans* fatty acids have been shown to negatively impact several factors that increase risk for cardiovascular disease. Consumption of TFA:

- Lowers high-density lipoprotein (HDL) concentrations, while raising low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL) concentrations, resulting in higher total cholesterol to HDL ratios (5,7,9,13-15).
- Elevates concentrations of lipoprotein(a), a risk factor for CVD (5,7,9,14-16).
- Increases markers of inflammation, contributors to atherosclerosis, including tumor necrosis factors, C-reactive protein, and interleukin-6 (5,7,13)
- Is associated with markers of endothelial (cells lining blood vessels) dysfunction, which contributes to atherosclerosis and high blood pressure (5,7,13,14,17).
- May influence fatty acid metabolism in adipocytes, resulting in reduced uptake of triglycerides, reduced cholesterol production, increased production of free fatty acids (5).
- Increases blood levels of triglycerides (5,14,15).
- Is associated with increased oxidative stress (8).
- May also increase insulin resistance and risk of developing type 2 diabetes, although evidence is inconsistent (5,7,13-15).



How do the effects on health of TFA compare to that of unsaturated and saturated fats?

- Consumption of both saturated fatty acids and TFA raises LDL cholesterol (6,14,15); however, saturated fat also raises HDL, thereby having little impact on total to HDL ratio (14,15).
- While consumption of both saturated and TFA is associated with increased CVD risk, the proportional increase is greater with consumption of TFA.
- Consumption of *cis* unsaturated fatty acids, particularly polyunsaturated (found in corn, safflower, cottonseed and soybean oils, and fish), tends to lower overall cholesterol by lowering LDL, while HDL remains relatively unchanged (12,13).
- Consumption of unsaturated fatty acids is associated with a decreased risk of CVD (7,14,15).
 - Sources of monounsaturated oils include: olives, oil olive, nuts and seeds, nut and seed oils and butters (such as peanut butter and canola oil), and avocados.
 - Sources of polyunsaturated oils include fish, safflower, soy, corn and sunflower oils, nuts and seeds.



What options do food manufacturers have to reduce the TFA content of foods?

- Improved hydrogenation process
 - Several different modifications to the hydrogenation process have resulted in low-TFA partially-hydrogenated oils containing 6 to 11 percent TFA versus 25 to 60 percent in standard hydrogenated oils (7).
 - Modifications may result in higher saturated fat content (7).
- Interesterification of mixed fats
 - Interesterification uses two fats of different fatty acid compositions (such as saturated fat, and unsaturated oil). The ester bonds between the fatty acids and glycerol are cleaved and then reformed with the mixed free fatty acids and glycerol, resulting in triglycerides that are an even mixture of fatty acids from the two starting fats (6,7). This creates a TFA-free fat that is higher in saturated fat to produce the desired chemical properties and a variety of melting points for different purposes (6,7).
- Selective breeding and genetic engineering of oil seed plants with modified fatty acid profiles
 - This has been used to create varieties of sunflower seeds, soybeans, and canola seeds high in oleic acid, an unsaturated fatty acid that is more stable against oxidation, thereby increasing shelf-life (6,7)
- Tropical oils
 - Palm, palm kernel, and coconut oils are higher in saturated fat, resulting in higher melting points, making them a likely candidate to replace hydrogenated oils (7).
 - Fractionation of these oils has been used to create fats with specific properties (saturated fatty acid content, melting point), tailoring them for a variety of applications (7).



What are the concerns associated with reducing TFA in food and TFA consumption?

- The main concerns are that a decrease in TFA content in foods would result in a rise in saturated fat consumption as well as a rise in cost and decrease in palatability and availability of foods (5,7).
 - However, Denmark banned the use of oils containing more than 2 percent TFA in 2004, and has not experienced these problems (5).
 - Comparisons of food before and after the ban have found that hydrogenated oils were largely replaced with unsaturated oils, and less often with fully hydrogenated oils (5).
 - Overall, saturated fat consumption in Denmark has not increased, and cost, quality, and availability has not noticeably changed (5).
- Another concern is that by focusing on eliminating TFA, individuals may ignore other lifestyle changes that could have a greater impact on reducing risk for CVD, such as exercising regularly or smoking cessation. (18).
 - Effective prevention should include emphasis on healthy diet and lifestyle choices, and not focus solely on one risk factor (18).



References:

1. Rosamond W, et al. Heart Disease and Stroke Statistics – 2007 Update: A Report From the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation*; 2007; 115: 69-171.
2. Pasternak RC, et al. Spectrum of Risk Factors for Coronary Heart Disease. *J Am Coll Cardiol*; 1996; 27: 964-1047.
3. Ergin A, et al. Secular Trends in Cardiovascular Disease Mortality, Incidence, and Case Fatality Rates in Adults in the United States. *Am J Med*; 2004; 117: 219-27.
4. Rodriguez T, et al. Trends in mortality from coronary heart and cerebrovascular diseases in the Americas: 1970-2000. *Heart*; 2006; 92: 453-60.
5. Mozaffarian D, et al. Trans Fatty Acids and Cardiovascular Disease. *N Engl J Med*; 2006; 354: 1601-13.
6. ASCN/AIN Task Force on *Trans* Fatty Acids. Position paper on *trans* fatty acids. *Am J Clin Nutr*; 1996; 63: 663-70.
7. Tarrago-Trani MT, et al. New and Existing Oils and Fats Used in Products with Reduced *Trans*-Fatty Acid Content. *J Am Diet Assoc*; 2006; 106: 867-80.
8. Kuhnt K, et al. Dietary supplementation with 11*trans*- and 12*trans*-18:1 and oxidative stress in humans. *Am J Clin Nutr*; 2006; 84: 981-8.
9. Lichtenstein AH, et al. Effect of different forms of dietary hydrogenated fats on serum lipoprotein cholesterol levels. *N Engl J Med*; 1999; 340: 1933-40.
10. Allison DB, et al. Estimated intakes of *trans* fatty and other fatty acids in the US population. *J Am Diet Assoc*; 1999; 99: 166-174.
11. Wright JD, et al. Dietary intake of ten key nutrients for public health, United States: 1999-2000. *Advance Data From Vital and Health Statistics*; No. 334. Hyattsville, Maryland: National Center for Health Statistics. 2003.
12. Ervin RB, et al. Dietary intake of fats and fatty acids for the United States population: 1999-2000. *Advance Data From Vital and Health Statistics*; No. 348. Hyattsville, Maryland: National Center for Health Statistics. 2003.
13. Lopez-Garcia E, et al. Consumption of *Trans* Fatty Acids is Related to Plasma Biomarkers of Inflammation and Endothelial Dysfunction. *J Nutr*; 2005; 135: 562-6.
14. Hu FB, and Willett WC. Optimal Diets for Prevention of Coronary Heart Disease. *JAMA*; 2002; 288: 2569-78.
15. Hu FB, et al. Types of Dietary Fat and Risk of Coronary Heart Disease: A Critical Review. *J Am C Nutr*; 2001; 20: 5-19.
16. Mensink RP, et al. Effect of dietary *cis* and *trans* fatty acids on serum lipoprotein[a] levels in humans. *J Lipid Res*; 1992; 33: 1493-1501.
17. Endemann DH, and Schiffrin EL. Endothelial dysfunction. *J Am Soc Nephrol*; 2004; 15:1983-92.
18. Lomangino K. A Contrarian Take on *Trans* Fats. *Nutrition and the MD*; 2007; 33(3): 3-5.

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