

WHO Scientific Update on health consequences of trans fatty acids. Eur J Clin Nutr 2009;63(Supplement):S1-S75.

Health effects of trans-fatty acids: experimental and observational evidence. Mozaffarian et al.

Background/Objectives: Growing evidence indicates that trans-fatty acids (TFA) adversely affect cardiovascular health. As part of the World Health Organization (WHO) Scientific Update on TFA, we reviewed the evidence for effects of TFA consumption on coronary heart disease (CHD). **Subjects/Methods:** We searched Medline publications examining TFA consumption and CHD risk factors or outcomes, emphasizing results of studies in humans. We evaluated and synthesized evidence from both controlled feeding trials evaluating risk factors and long-term observational studies evaluating risk factors or clinical outcomes, each of which have complementary strengths and limitations, to enable the most robust and reliable inferences of effects. **Results:** The effects of TFA consumption on risk factors most consistently seen in both controlled trials and observational studies included adverse lipid effects (for example ↑low-density lipoprotein cholesterol, ↓high-density lipoprotein cholesterol (HDL-C), ↑total/HDL-C ratio), proinflammatory effects (for example ↑tumor necrosis factor- α activity, ↑interleukin-6, ↑C-reactive protein) and endothelial dysfunction. These effects were most prominent in comparison with cis unsaturated fats; adverse effects on total/HDL-C and endothelial function were also seen in comparison with saturated fatty acids (SFA). TFA may also worsen insulin sensitivity, particularly among individuals predisposed to insulin resistance; possible effects on weight gain and diabetes incidence require further confirmation. Five retrospective case-control studies and four prospective cohort studies demonstrated positive associations between TFA consumption and CHD events. A meta-analysis of prospective studies indicated 24, 20, 27 and 32% higher risk of myocardial infarction (MI) or CHD death for every 2% energy of TFA consumption isocalorically replacing carbohydrate, SFA, cis monounsaturated fatty acids and cis polyunsaturated fatty acids, respectively. The differential effects of specific TFA isomers may be important but are less well established. The available evidence indicates that trans-18:1 and particularly trans-18:2 isomers have stronger CHD effects than trans-16:1 isomers. The limited data suggest that the experimental effects of ruminant and industrial TFA are similar when consumed in similar quantities, but very few persons consume such high levels of ruminant TFA, and observational studies do not support adverse CHD effects of ruminant TFA in amounts actually consumed. **Conclusions:** Controlled trials and observational studies provide concordant evidence that consumption of TFA from partially hydrogenated oils adversely affects multiple cardiovascular risk factors and contributes significantly to increased risk of CHD events. The public health implications of ruminant TFA consumption appear much more limited. The effects of specific TFA isomers require further investigation. **Keywords:** trans-fatty acids, coronary heart disease, randomized controlled trials, epidemiology, review.

Quantitative effects on cardiovascular risk factors and coronary heart disease risk of replacing partially hydrogenated vegetable oils with other fats and oils. D Mozaffarian and R Clarke.

Background/Objectives: Reduced consumption of trans-fatty acids (TFA) is desirable to lower coronary heart disease (CHD) risk. In practice, partially hydrogenated vegetable oils (PHVO) that contain both TFAs and other fatty acids are the unit of replacement and could be replaced with diverse alternative fats and oils. We performed quantitative estimates of CHD effects if a person's PHVO consumption were to be replaced with alternative fats and oils based on (1) randomized dietary trials and (2) prospective observational studies. **Subjects/Methods:** We performed meta-analyses of (1) the effects of TFAs on blood lipids and lipoproteins in controlled dietary trials and (2) associations of habitual TFA consumption with CHD outcomes in prospective cohort studies. On the basis of these results and corresponding findings for saturated fatty acids (SFA), cis-monounsaturated fatty acids (MUFA) and cis-polyunsaturated fatty acids (PUFA), we calculated the effects on CHD risk for replacing 7.5% of energy from three different PHVO formulations (containing 20, 35 or 45% TFAs) with butter, lard, palm or vegetable oils. **Results:** In controlled trials, each 1% energy replacement of TFAs with SFAs, MUFAs or PUFAs, respectively, decreased the total cholesterol (TC)/high-density lipoprotein cholesterol (HDL-C) ratio by 0.31, 0.54 and 0.67; the

apolipoprotein (Apo)-B/ApoAI ratio by 0.007, 0.010 and 0.011; and lipoprotein (Lp)(a) by 3.76, 1.39 and 1.11 mg/l ($P < 0.05$ for each). We also included possible effects on C-reactive protein (CRP) of TFAs vs other fats from one trial. On the basis of these risk factor changes in controlled trials, CHD risk would be variably decreased by different fats and oils replacing 7.5% of energy from 20% TFA PHVO (CHD risk reduction: -2.7% (butter) to -9.9% (canola)); 35% TFA PHVO (-11.9% (butter) to -16.0% (canola)); or 45% TFA PHVO (-17.6% (butter) to -19.8% (canola)). In prospective cohort studies, each 2% energy replacement of TFAs with SFAs, MUFAs or PUFAs would lower CHD risk by 17% (95% confidence interval (CI)=7–25%), 21% (95% CI=12–30%) or 24% (95% CI=15–33%), respectively. On the basis of these associations in observational studies, CHD risk would be variably decreased by different fats and oils replacing 7.5% of energy from 20% TFA PHVO (CHD risk reduction: +0.5% (butter) to -21.8% (soybean)); 35% TFA PHVO (-14.4% (butter) to -33.4% (soybean)); or 45% TFA PHVO (-22.4% (butter) to -39.6% (soybean)). The demonstrated effects on TC/HDL-C, ApoB/ApoAI, Lp(a), and CRP in randomized feeding trials together accounted for ~65–80% and ~50% of the estimated risk reduction for replacing PHVO with animal fats and vegetable oils, respectively, that would be calculated from prospective cohort studies. **Conclusions:** Effects on CHD risk of removing PHVO from a person's diet vary depending on the TFA content of the PHVO and the fatty acid composition of the replacement fat or oil, with direct implications for reformulation of individual food products. Accounting for the summed effects of TFAs on multiple CHD risk factors provides more accurate estimates of potential risk reduction than considering each risk factor in isolation, and approaches the estimated risk reduction derived from prospective cohort studies. **Keywords:** trans-fatty acids, coronary heart disease, meta-analysis, randomized controlled trials, epidemiology.

Feasibility of recommending certain replacement or alternative fats. C M Skeaff

Expert groups and public health authorities recommend that trans-fatty acid (TFA) intakes from industrially produced partially hydrogenated vegetable oils (PHVOs) should be less than 1% of total energy intake. The starting point for any regulatory or nonregulatory response to this recommendation is to assess the extent of the problem by determining where in the food supply TFAs are found and the amounts consumed in the population. Unfortunately, this is a particularly difficult task using traditional methods of dietary assessment inasmuch as food composition databases with TFA data are either nonexistent or incomplete in most countries. Current evidence on estimates of intake suggests there is high variability in TFA intakes and their food sources between countries. The ubiquitous presence of PHVOs in the global food supply in bakery products, deep-fried foods, snack foods, confectionery products and table spreads attests to their commercial value and convenience. However, their common use is more the result of historical convenience from an industry infrastructure developed over 50 years based on efficient, cost-effective hydrogenation of vegetable oils rather than any inherent sensory or physical superiority of the hydrogenated fats over purpose-made zero-trans fats and oils. Current global supply of appropriate zero-trans replacement fats high in cis-unsaturated fatty acids is insufficient to meet the demand if all PHVOs in the food supply were replaced. Regulatory action needs to be coordinated with supply to maximize the opportunity for health gains by replacing partially hydrogenated fats with purpose-ready zero-trans vegetable oils low in saturates and high in cis-unsaturates rather than animal fats and tropical oils high in saturated fatty acids. **Keywords:** trans-fatty acids, diet surveys, dietary fats, nutrition assessment, food supply.

Approaches to removing trans fats from the food supply in industrialized and developing countries. M R L'Abbé et al.

A number of approaches have been initiated by governmental and public health organizations in different countries to reduce trans-fatty acid (TFA) intakes. These have included nutrition recommendations with regard to TFAs and general nutrition recommendations regarding the selection of healthy fats, programmes to raise awareness about the adverse effects of TFAs through nutrition and health claims, voluntary or mandatory labelling of the trans content of foods, voluntary or legislated programmes to encourage or force industry to reformulate food products to remove TFAs, the promotion of health and agricultural policies that encourage the production of healthy alternatives to trans fat and finally, mandatory regulation of food standards to remove or reduce the TFA content. This paper reviews a number of initiatives to

reduce the intake of TFAs underway in selected industrialized and developing countries, which serves to illustrate the merits and limitations of the available options and how the approaches that have been taken reflect local conditions.

Keywords: trans fat, labelling, Denmark, Canada, New York City, Argentina, India.