

# Consumer protection through a legislative ban on industrially produced *trans* fatty acids in foods in Denmark

Steen Stender<sup>1</sup>, Jørn Dyerberg<sup>1</sup> and Arne Astrup<sup>2</sup>

<sup>1</sup>Department of Clinical Biochemistry, Gentofte University Hospital, Copenhagen, Denmark; <sup>2</sup>Department of Human Nutrition, Centre of Advanced Food Research, The Royal Veterinary and Agricultural University Copenhagen, Denmark

## Abstract

Legislation has, within a few years, virtually eliminated the intake of industrially produced *trans* fatty acids (IP-TFA) in Denmark, by banning any food with an IP-TFA content greater than 2% of total fat. This accomplishment has been obtained without noticeable effects on the availability, price or quality of foods previously containing high amounts of IP-TFA. Various public health organizations, including the World Health Organization, have recommended reducing the consumption of IP-TFA, and efforts have been made in several countries to comply, through the mandatory TFA labelling of prepackaged food, societal pressure and industrial initiatives to lower the content of IP-TFA in foods. Yet still, high concentrations of IP-TFA are found in popular foods in several countries including Norway and Sweden. This indicates that millions of people currently have intakes of IP-TFA that increase their risk of coronary heart disease. The Danish experience demonstrates that this risk can be eliminated.

Keywords: *fast food; labelling; legislation; recommendations; regulation; snack; trans fatty acids*

## Introduction and background

The *trans* fatty acid (TFA) story in Denmark began when Willett and co-workers published an article in the *Lancet* in 1993 demonstrating a positive association between the intake of TFA and the risk of coronary heart disease (CHD) (1). The Danish Nutrition Council (DNC), established in 1992, called an emergency meeting to discuss the implications of this publication. This meeting was reported by the media, with headlines such as “Emergency meeting on margarine hazard”. At the meeting, the council decided that the health effects of TFA deserved a thorough review, and a working group was formed to fulfil that goal.\*

The margarine industry reacted initially by announcing that it would be too expensive to produce margarines free of industrially produced *trans* fatty acids (IP-TFA). An expert group within the Swedish Nutrition Foundation stated in October 1993: “The metabolism of *trans* fatty acids has been studied in

detail in animals and man during the last 20 years”, “*Trans* fat and saturated fat exert similar effects from a health perspective” and “Recent epidemiological studies from the USA are difficult to interpret, and it cannot be judged from these studies if the intake of *trans* fatty acids in a normal mixed Scandinavian diet may contribute to coronary heart disease”. Upon reviewing this and other evidence, the Danish Food Agency concluded that there were no grounds for new guidelines and advised the public to follow the existing dietary recommendations because “Currently there is not sufficient evidence to recommend a specific reduction in the intake of *trans* fatty acids.” At this point in time, the DNC clearly had little or no support for its initiative.

The first report by the DNC on the health aspects of TFA was released in 1994. It found that although there was some evidence to support the existence of a causal link between the intake of IP-TFA and CHD, the studies were observational and therefore did not provide final proof of this link. The report further stated that, although IP-TFA did not thus far appear to be significantly more harmful than

\*AA was chairman of DNC 1992–2003, SS was chairman of the *trans* fat group 1993–2005, and JD member of DNC, and SS and JD were authors of the councils *trans* fat reports.

saturated fatty acids, there was no evidence of any health benefits from a high intake of IP-TFA. The report concluded that TFA may facilitate the development of CHD and, to a lesser extent, other diseases in adults, fetuses and infants. It suggested that protection of the public health should be the primary consideration in the light of the prevailing uncertainty, and that there was no reason to continue to allow this potential health hazard. The report found that, in 1991, hard margarines used as spreads and industrially for baking were responsible for approximately 2.5 of the 3.5 g of IP-TFA consumed daily, on average, per capita in Denmark. Some margarines had up to 20% TFA. DNC recommended that IP-TFA should be reduced to less than 5% in all margarines within a few years. "This would ensure that Danes – including pregnant and nursing women – with a high intake of margarine would consume, on average, less than 2 gram IP-TFA per day."

Remarkably, the margarine industry responded by accepting the reduction of IP-TFA fat in their products, and within a year, competition among producers led to the launch of several zero-*trans*-fat margarines. It was obvious that many other stakeholders in nutrition, whether scientific, consumer orientated or industrial, did not agree with the conclusion of the DNC. However, the dairy industry was quite content. The sale of butter increased by about 10%, compared with previous years.

As recommended by the DNC, the Danish government in 1994 asked the European Union (EU) to implement initiatives that would decrease the intake of IP-TFA. This suggestion was rejected by the EU in 1998, after a scientific panel had concluded that there was insufficient scientific evidence on any harmful health effects of IP-TFA. In 2001, the Danish government asked the DNC for an update of its first report, so that the government could decide whether to proceed with TFA regulation in the EU context.

The second and third reports on TFA by the DNC were released in 2001 and 2003 (2). They found that the evidence on the harmful effects of IP-TFA, especially with regard to CHD, had been strengthened since 1994. In particular, a meta-analysis showed that an intake of approximately 5 g per day of (TFA) was associated with a 25% increased risk of CHD (3). This finding indicated a four- to five-fold higher risk of CHD per gram of TFA intake than per gram of saturated fat. The risk

was found to be related mainly to IP-TFA rather than to ruminant TFA. Several national and international public health organizations have consequently recommended that the intake of TFA should be lowered as much as possible (4–7).

Although in Denmark, the mean intake was approximately 1 g IP-TFA per day in 2001, it was still possible to consume 20–30 g of IP-TFA in a high-*trans*-fat menu, by eating two or three popular food products such as biscuits, microwave popcorn, chicken nuggets and French fries. It was estimated that 1% of the Danish population, i.e. 50 000 people, might consume more than 5 g IP-TFA per day through intake of foods with a high concentration of IP-TFA. Based on a concern for this subgroup, the DNC recommended "that addition of IP-TFA to foodstuffs ceases as soon as possible" (2).

The Danish ministers of food and agriculture were convinced by the conclusions of the DNC's reports, and consequently took whatever steps possible to obtain EU endorsement for a Danish legislation. The EU initially accepted that Denmark had a right to its own legislation, which was fully enforced from 1 January 2004, restricting the IP-TFA content of all food products and ready meals to a maximum 2% of the total fat content.

The European Food and Safety Authority (EFSA), however, concluded in 2004 that the average intake of TFA in the EU is much smaller than the intake of saturated fat. The authority therefore found it more prudent to reduce the intake of saturated fat than that of TFA (8). In the EU, the food industry later objected to the Danish legislation, stating that it created trade barriers and, in December 2005, the EU commission asked Denmark to give up its regulation of IP-TFA in food. The answer of the Danish government was: No and if necessary the case would be brought to the EF-court.

Within the past few years several investigations have added to the suspicion that the intake of IP-TFA is harmful to human health, including the promotion of type 2 diabetes and perhaps also obesity. The health effects of *trans* fatty acids were reviewed in April 2006 (9).

#### **Investigation on trans fatty acid content in foods and possible intakes**

About a year after the Danish regulation came into force, we began to investigate the availability of a

“high-trans-fat menu” in Denmark and other countries, to examine the differing effects of legislation, in comparison to mandatory labelling, recommendations, societal pressure and industrial initiatives, on the availability of IP-TFA in certain popular foods (10, 11).

### Methods

Three categories of food were bought between November 2004 and July 2006. In total, 63 fast food items (chicken nuggets and French fries) were bought from McDonald's and/or Kentucky Fried Chicken (KFC) outlets in 30 different countries; 110 bags of microwave popcorn were bought in 29 countries; and 476 biscuits/cakes/wafers were bought in 28 countries in large supermarkets if “partially hydrogenated fat” or similar terms were listed among the three first ingredients on the food label, and if the fat content was higher than 15%. In 21 different countries, foods were obtained from all three categories.

The fatty acid content in each of these 714 food samples was analysed by gas chromatography on a 100 m highly polar capillary column. For comparison, the amounts of IP-TFA in the French fries and chicken nuggets were expressed per serving equivalent to a large serving from McDonald's in the USA, consisting of 171 g French fries and 160 g chicken nuggets. A high-trans-fat menu in each country was defined as a large serving of French fries and chicken nuggets, a bag (100 g) of microwave popcorn and a 100 g serving of biscuits/cakes/wafers, each with the highest identified amount of IP-TFA in that country. The methodology has been described in detail elsewhere (11).

### Results

#### Fast food

The IP-TFA content of the McDonald's servings varied from less than 1 g in Denmark, and China to 10 g in the USA. For KFC servings even larger differences were found, from less than 1 g in Germany and India, to 24 g in Hungary (Fig. 1). Fifteen per cent of the 63 fast food servings contained more than 10 g TFA per serving, and 50% contained more than 5 g. In Sweden, Norway and Finland, values around 5 g in McDonald's servings were found. KFC products were not available in these countries.

The IP-TFA content of the frying oil differed substantially within the same chain in different countries (Fig. 1, given in brackets). In McDonald's outlets in the USA, South Africa and Peru, the oils contained 23–28% IP-TFA, and in Oman as much as 33%. In many countries in Europe, the oils contained about 10% IP-TFA, in contrast to 1% in Denmark. In frying oils at KFC, values of up to 42% (Poland) were found.

#### Biscuits, cakes, wafers and popcorn

Of the 476 samples of biscuits, cakes and wafers, 3% contained more than 10 g IP-TFA, and 12% more than 5 g  $100\text{ g}^{-1}$ . The high IP-TFA content was due to fats with 35–43% IP-TFA, found particularly in Eastern Europe and the USA.

The highest contents (around 14 g) per 100 g servings of microwave popcorn were found in Portugal, the USA, France and Spain. In most of the countries, fats used for popcorn contained 40–50% IP-TFA; in Sweden and Norway they contained 48 and 49%, respectively. Thirty-one per cent of the 110 samples contained more than 10 g IP-TFA, 50% more than 5 g, and 25% less than 1 g per 100 g serving. By contrast, the IP-TFA content in six samples from Denmark was below  $0.5\text{ g }100\text{ g}^{-1}$ .

#### High-trans-fat menu

The exposure to IP-TFA by a high-trans-fat menu was 30 g in Denmark in 2001, but in 2005 this amount was reduced to less than 1 g (Fig. 2). By contrast, the intake from a high-trans-fat menu exceeded 20 g TFA in 18 of the 21 other countries in 2004–2006, with Hungary, Czech Republic, Poland, Bulgaria, the USA, Canada and Peru ranking highest, with 42–36 g (Fig. 2).

Eighty-three per cent of the fast foods (French fries or chicken nuggets), 50% of the popcorns and 43% of the biscuits/cakes/wafers purchased outside Denmark contained fat with more than 2% IP-TFA, which would be illegal to sell in Denmark. However, similar products, i.e. 13% of fast food servings from McDonald's and 17% of the servings from KFC, about 50% of the popcorns and 60% of the biscuits/cakes/wafers in the present study contained less than 2% of the fat as IP-TFA.

### Discussion

In the light of the present debate over whether the intake of IP-TFA is just as effectively reduced by

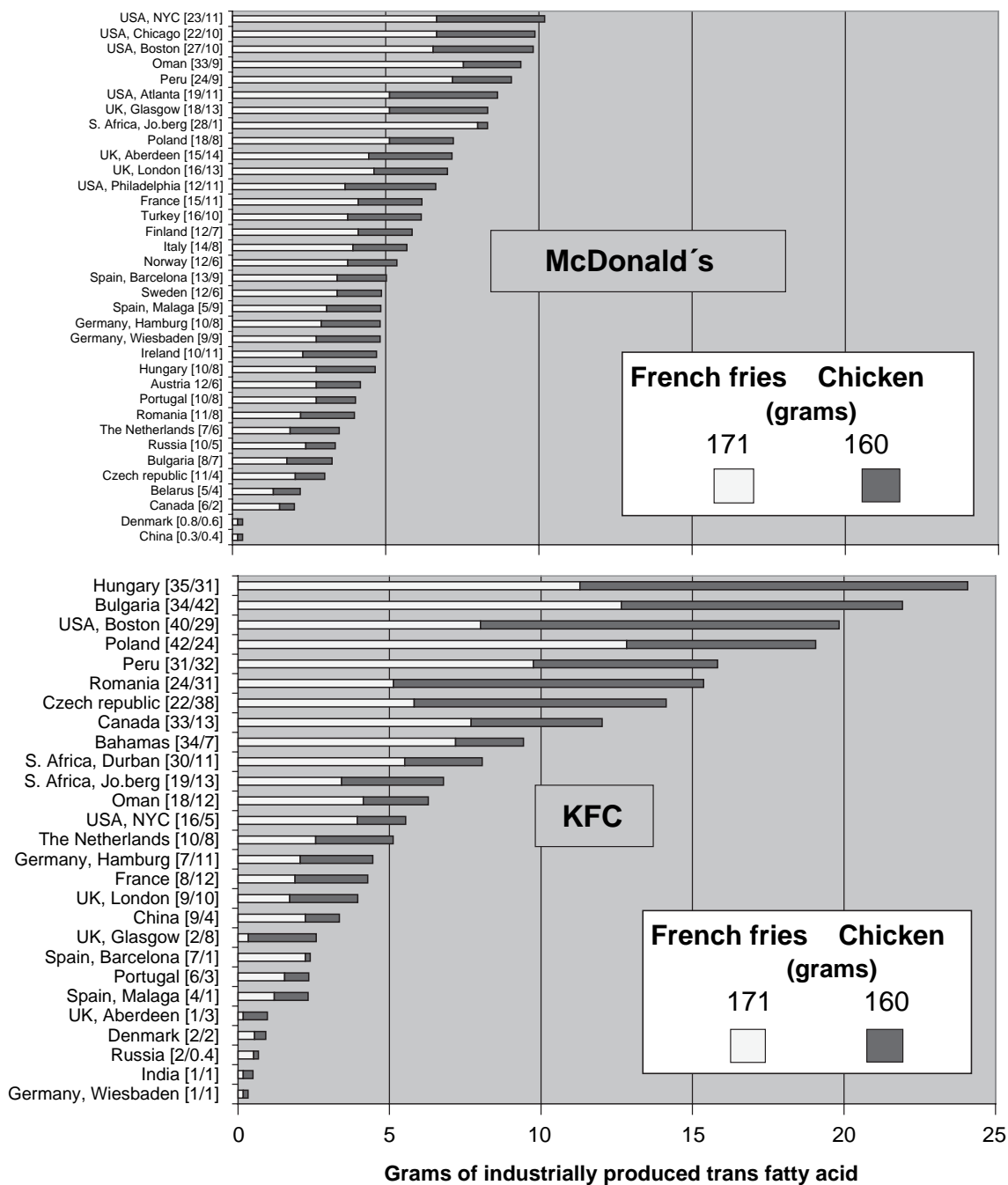


Fig. 1. Amounts of industrially produced *trans* fatty acids in a large serving from McDonald's and KFC outlets in various countries. Values in brackets are % *trans* fatty acids of total fat in French fries and chicken, respectively.

societal pressure and industrial initiatives as by legislative limitations, this study has several important findings. Since 1994, the margarine industry in Denmark has, based on societal pressure, voluntarily reduced the IP-TFA content in its products, resulting in a reduction in the average daily IP-TFA intake from 3.5 g to less than 1 g IP-TFA per person per day in 2001. In spite of this, it was still possible in 2001 to obtain 20–30 g IP-TFA in a high-*trans*-

fat menu in Denmark. Following the legislation in Denmark, the IP-TFA content in the same menu was reduced to less than 1 g (Fig. 2). This is consistent with a public surveillance programme in 2005 that found that it was impossible to ingest more than 1 g IP-TFA on a daily basis in Denmark. The results demonstrate that the Danish legislation was an effective intervention to ensure protection of the entire population. The legislation

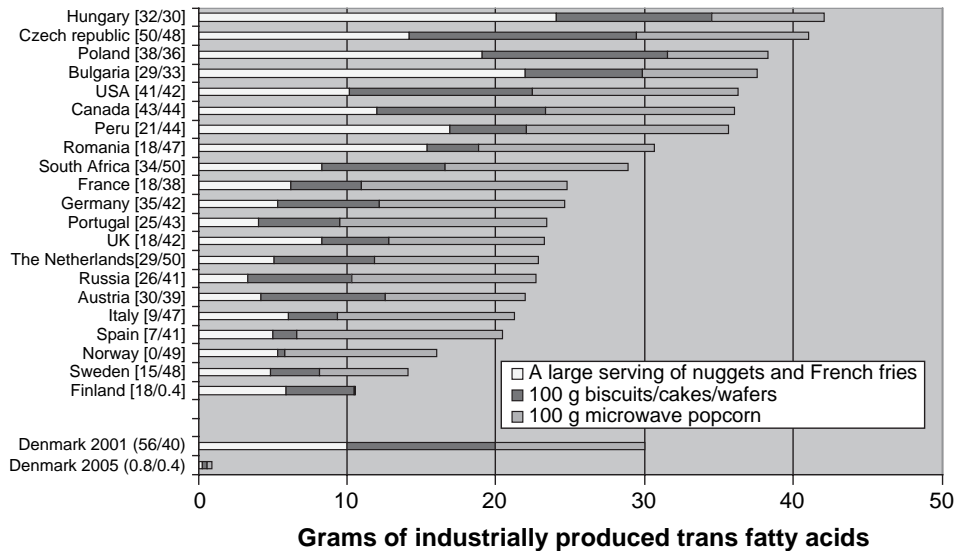


Fig. 2. Amounts of industrially produced *trans* fatty acids in a “high *trans* menu” consisting of fast food, biscuits/cakes/wafers and microwave popcorn. In each country the products with the highest concentration in each category are shown. Values in brackets are % *trans* fatty acids of total fat in biscuits/cakes/wafers and microwave popcorn, respectively.

had no noticeable effect on the availability, price or quality of food items previously containing high amounts of TFA.

Another important finding is that, in most countries where a high societal pressure has resulted in a reduction in the daily average intake of IP-TFA, such as in Sweden, Norway and the Netherlands, it was still possible in 2005 and 2006 to compose a menu of popular foods containing high amounts of IP-TFA. The average daily intake of IP-TFA in Norway has recently been estimated at 0.5 g, and it was concluded that the “intake of *trans* fatty acids no longer represents a public health concern in Norway” (12). The situation in Sweden is probably similar. However, food bought in major super-

markets in Norway and Sweden can provide a meal containing about 15 g of IP-TFA (Fig. 2).

Even if the consumers of such a menu in the various countries represent only a small proportion of the population, these people still represent millions of Europeans with an average daily intake of IP-TFA exceeding 5 g. Thus, owing to a wide distribution of intakes, a low average intake on a population basis does not preclude a very high intake among subgroups,

In EU countries, with the exception of Denmark, foods with up to 60% of the total fat as IP-TFA, which is the maximally obtainable concentration, can be legally sold without any notice, as long as the food is not packaged, at restaurants and fast food outlets, for example. If the food is prepackaged, the use of high amounts of IP-TFA is only mentioned on the package by the words “partially hydrogenated fat” or something similar in the list of ingredients. This information is often exceedingly difficult to decipher from the package imprint, as illustrated in Fig. 3, indicating that only educated and devoted consumers may be able to adjust their purchase accordingly.

Recently, the term “partially hydrogenated fat” has also been used to characterize a mixture of fully hydrogenated fat (saturated fat) and non-hydrogenated unsaturated fat. Consequently, the term is also used on packaged food that does not contain TFA, which further confuses the consumer. Mandatory labelling of foods with their TFA content in an easily



Fig. 3. Biscuits/cakes bought in the Czech Republic in February 2006. This sample had a fat content of 31.8 g 100 g<sup>-1</sup> product. The *trans* fat content was 8.45 g 100 g<sup>-1</sup>, which was 27% of the fat. The highly magnified (note the match) “partially hydrogenated vegetable oil” in English among 16 different languages is an example of legal labelling and legal content of *trans* fatty acids in the EU.

readable form undoubtedly results in a reduction in the mean daily intake of TFA because of the pressure it imposes on the producer. Labelling nevertheless still allows for a high intake of these fatty acids, as exemplified by the purchase of a high-*trans*-fat menu with 37 g of IP-TFA in Canada in November 2005 (Fig. 2). Canada has had mandatory labelling of TFA in packaged food since January 2003.

The present study further demonstrates that foods with similar taste and quality can be produced with and without IP-TFA. This is especially obvious in the fast food category. The same meal bought in the same fast food chain at different locations may contain either 22 g or less than 1 g IP-TFA.

*In summary*, intake of 5 g TFA daily, corresponding to about 2% of energy intake, is associated with a health risk that could be eliminated more easily than many other dietary health risks. This is a matter of concern, particularly for low-income groups who, owing to other lifestyle factors, already have an increased risk of CHD and may also more commonly eat foods with a high TFA content.

Denmark has, through legislative limits, shown how the intake of industrially produced TFA can be eliminated at the individual level within a few years without any noticeable side-effects for consumers. It therefore makes sense that a Canadian task force has recommended that its government implement the Danish model (13), that the Health Board of New York City is considering a ban on *trans* fats in the city's 40 000 restaurants (14) and, finally, that in September 2006 the World Health Organization recommended that governments around the world phase out partially hydrogenated oils if *trans*-fat labelling alone does not spur significant reductions (15).

### Acknowledgements

We thank Jenny Vissing's Foundation, University of Copenhagen, and colleagues, family and friends who bought the fast food meals all over the world.

### References

1. Willett WC, Stampfer MJ, Manson JE, Colditz GA, Speizer FE, Rosner BA, et al. Intake of *trans* fatty acids and risk of coronary heart disease among women. *Lancet* 1993; 341: 581–5.
2. Stender S, Dyerberg J. The influence of *trans* fatty acids on health. 4th edn. A report from the Danish Nutrition Council, Copenhagen, 2003. ([http://www.meraadet.dk/gfx/uploads/rapporter\\_pdf/Trans%20fatty%20acids\\_4.th%20ed.\\_UK\\_.www.pdf](http://www.meraadet.dk/gfx/uploads/rapporter_pdf/Trans%20fatty%20acids_4.th%20ed._UK_.www.pdf)).
3. 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.
4. Letter. Report on dietary reference intakes for *trans* fatty acids. Washington, DC: National Academy Press; 2002. ([www.iom.edu/file.asp?id=13083](http://www.iom.edu/file.asp?id=13083). Accessed 15 September 2005).
5. World Health Organization. Population nutrient intake goals for preventing diet-related chronic diseases. WHO; 2003 ([www.who.int/nutrition/topics/5\\_population\\_nutrient/en/index12.html](http://www.who.int/nutrition/topics/5_population_nutrient/en/index12.html). Accessed 9 October 2006).
6. Nordic Council of Ministers, Copenhagen, 2004. Nutrition Recommendations 2004. 4th edn. Integrating nutrition and physical activity. Nord 2004;3. ([www.norden.org/order](http://www.norden.org/order). Accessed 15 September 2005).
7. Dietary Guidelines for Americans 2005. ([www.health.gov/dietaryguidelines](http://www.health.gov/dietaryguidelines). Accessed 15 September 2005).
8. Opinion of the Scientific Panel on Dietetic Products, Nutrition and Allergies on a request from the Commission related to the presence of *trans* fatty acids in foods and the effect on human health of the consumption of *trans* fatty acids. *EFSA Journal* 2004;81:1–49.
9. Mozaffarian D, Katan MB, Ascherio A, Stampfer MJ, Willet W. *Trans* fatty acids and cardiovascular disease. *N Engl J Med* 2006; 354: 1601–13.
10. Stender S, Dyerberg J, Astrup A. High levels of industrially produced *trans* fat in popular fast foods. *N Engl J Med* 2006; 354: 1650–2.
11. Stender S, Dyerberg J, Bysted A, Leth T, Astrup A. A *trans* world journey. *Atherosclerosis Suppl* 2006; 7: 47–52.
12. Johansson L, Borgejordet A, Pedersen JI. *Trans* fatty acids in the Norwegian diet. *Tidsskr Nor Laegeforen* 2006; 126: 760–3.
13. TRANSforming the food supply ([http://www.hc-sc.gc.ca/fn-an/alt\\_formats/hpfb-dgpsa/pdf/nutrition/tf-gt\\_rep-rap\\_e.pdf](http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/nutrition/tf-gt_rep-rap_e.pdf). Accessed 6 October 2006).
14. Health Department asks restaurateurs and food suppliers to voluntarily make an oil change and eliminate artificial *trans* fat (<http://www.nyc.gov/html/doh/html/pr/pr083-05.shtml>. Accessed 6 October 2006).
15. Fletcher A. WHO recommends global phasing out of *trans* fats. (<http://www.foodproductiondaily.com/news/ng.asp?id=70926>. Accessed 6 October 2006).

### Steen Stender, MD

Department of Clinical Biochemistry  
Gentofte University Hospital  
Niels Andersens Vej 65  
DK-2900 Hellerup  
Denmark  
E-mail: [stst@gentoftehosp.kbhamt.dk](mailto:stst@gentoftehosp.kbhamt.dk)