



fighting heart disease  
and stroke

european heart network

## Trans fatty acids and heart disease – a European Heart Network paper

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### Introduction

*The aim* of this paper is to describe trans fatty acids (TFAs) and their detrimental effect on cardiovascular health. The paper will inform the debate regarding how best to eliminate industrially produced TFAs (IPTFAs) from foodstuffs marketed in the European Union (EU).

Cardiovascular disease (CVD) – the main forms of which are coronary heart disease (CHD) and stroke – is the main cause of death in the EU, accounting for over 1.9 million deaths each year. CHD is the single most common cause of death in the EU accounting for over 680 000 deaths every year.<sup>1</sup> CHD is also a major cause of disability and a significant economic burden across the EU, estimated to cost the EU economy 60 billion euros every year; this is 31% of total costs from CVD which amount to almost 196 billion euros every year.<sup>2</sup>

Leading risk factors for CVD are tobacco use, high blood pressure, high cholesterol, overweight and obesity, physical inactivity, diabetes, unhealthy diets and harmful use of alcohol.

### *About the European Heart Network*

The European Heart Network (EHN) is a Brussels-based alliance of heart foundations and other like-minded non-governmental organisations throughout Europe. EHN has members in 25 countries in Europe. EHN plays a leading role in the prevention and reduction of cardiovascular diseases, in particular heart disease and stroke, through advocacy, networking, capacity-building and patient support, so that they are no longer a major cause of premature death and disability throughout Europe.

### Summary

Trans fatty acids are a particular type of unsaturated fat found in foods obtained from ruminants, such as dairy products and meat, and in industrially produced partially

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<sup>1</sup> Nichols M, Townsend, N, Scarborough P, Luengo-Fernandez R, Real J, Gray A, Rayner M (2012); *European Cardiovascular Disease Statistics 2012*. European Heart Network, Brussels, European Society of Cardiology, Sophia Antipolis - <http://www.ehnheart.org/cvd-statistics.html>

<sup>2</sup> Idem

hydrogenated vegetable oils. They are widely recognised as the most harmful type of dietary fat on a per weight basis and their detrimental effect on heart disease is no longer disputed.

For every 2% energy of trans fatty acid consumption, the risk of heart attack or death from heart disease is increased by about 25% – or, in other words, every extra gram of trans fatty acids consumed per day will increase the risk of heart attack or heart disease by about 5%.

Recent data indicate that intake of industrially produced trans fatty acids in several European countries on average does not exceed 1% of total energy intake, corresponding to about 2.5g per day. But it is likely that millions of people, in particular from socially disadvantaged groups, have higher intakes, which puts them at increased risk of heart disease.

Since heart disease is the single most common cause of death in the EU, any reduction in its incidence will result in major health gains. In fact, strictly limiting prevalence of industrially produced trans fatty acids in all foods marketed in the EU could save about 50 000 lives every year. It may also save billions of euros in cardiovascular-related healthcare costs.

The virtual removal of industrially produced trans fatty acids from the food supply is one of the most straightforward public health interventions. And it can be done by replacing trans fatty acids with healthier substitutes without increasing the cost or reducing the quality of foods.

If the EU were to introduce a mandatory upper limit of industrially produced trans fatty acids, it would contribute to:

- Improving health of all EU citizens;
- Reducing deaths from heart disease;
- Contributing to tackling inequalities in health; and
- Saving healthcare costs.

Therefore, EHN recommends that the European Commission adopt a legislative proposal setting a mandatory upper limit of industrially produced trans fatty acids thereby harmonising standards across the EU and ensuring that no foods with too high levels of industrially produced trans fatty acids are placed on the market.

## **Trans fatty acids**

Trans fatty acids (TFAs) are a particular type of unsaturated fat found in foods obtained from ruminants, such as dairy products and meat, and in industrially produced partially hydrogenated vegetable oils.<sup>3</sup> In this paper the TFAs derived from this industrial process are referred to as industrially produced TFAs or IPTFAs.

IPTFAs are created when vegetable oils are partially hydrogenated to convert large numbers (typically 30-60%) of naturally occurring cis unsaturated double bonds into trans unsaturated double bonds. TFAs have physical and chemical properties that are attractive to food manufacturers. They are both relatively inexpensive and are solid or semi-solid fat at room

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<sup>3</sup> Shauna M Downs, Anne Marie Thow and Stephen R Leeder. The effectiveness of policies for reducing dietary trans fat: a systematic review of the evidence. *Bull World Health Organ* 2013;91:262–269H; doi:10.2471/BLT.12.111468

temperature. The production process also destroys labile omega-3 acids ( $\alpha$ -linoleic acid), and this reduces the propensity for fats to become rancid, increases shelf life, and optimises deep frying applications.<sup>4</sup>

IPTFAs and ruminant TFAs have similar metabolic effects, but they contain different proportions of some isomers. Ruminant TFAs are generally consumed in low amounts in most populations (about 0.5% of total energy intake) and at this level they have no apparent major adverse health effects.<sup>5</sup> High intakes of ruminant TFAs can affect CHD risk; the effect on lipids is similar to that of IPTFAs.<sup>6,7</sup>

## Cardiovascular diseases

Over the past 30 years death rates from cardiovascular diseases (CVD), in particular coronary heart disease (CHD) and stroke, have fallen by more than 50% in several European countries.<sup>8</sup> Between 50-75% of the fall has been explained by risk factor improvements.<sup>9</sup> The greatest benefits appear to have come from reductions in mean cholesterol concentrations, smoking prevalence and blood pressure levels.<sup>10</sup> The remaining 25-50% of the fall is attributed to improvements in medical and surgical treatments.

Nevertheless, CVD remain the main cause of death in the EU accounting for over 1.9 million deaths each year. CHD is the single most common cause of death in the EU accounting for over 680 000 deaths every year. These diseases are a major cause of disability. Moreover, inequalities in mortality from CVD account for almost half of the excess mortality in lower socio-economic groups in most European countries.<sup>11</sup>

Therefore, any reduction in CVD and CHD incidence will result in major health gains and reductions in health inequalities.

## Trans fatty acids and heart disease

The adverse effects of TFAs on CHD are mediated by increases in plasma concentrations of low-density lipoprotein cholesterol (LDL-C) and lipoprotein(a) (Lp(a)), and reductions in high-density lipoprotein cholesterol (HDL-C), promotion of inflammation and endothelial dysfunction, and possible effects on coagulation, insulin resistance and displacement of essential fatty acids from membranes, affecting prostanoid-related functions and possibly

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<sup>4</sup> D Mozaffarian, MJ Stampfer. *BMJ* 2010;340:c1826; doi: 10.1136/bmj.c1826

<sup>5</sup> Idem

<sup>6</sup> Brouwer IA, Wanders AJ, Katan MB (2010); Effect of Animal and Industrial Trans Fatty Acids on HDL and LDL Cholesterol Levels in Humans – A Quantitative Review. *PLoS ONE* 5(3): e9434. doi:10.1371/journal.pone.0009434

<sup>7</sup> Sarah K Gebauer, Frédéric Destaillets, Fabiola Dionisi, Ronald M Krauss, and David J Baer (2015); Vaccenic acid and trans fatty acid isomers from partially hydrogenated oil both adversely affect LDL cholesterol: a double-blind, randomized controlled trial 1–3; *Am J Clin Nutr* 2015;102:1339–46

<sup>8</sup> Nichols M, Townsend, N, Scarborough P, Luengo-Fernandez R, Real J, Gray A, Rayner M (2012); *European Cardiovascular Disease Statistics 2012*. European Heart Network, Brussels, European Society of Cardiology, Sophia Antipolis - <http://www.ehnheart.org/cvd-statistics.html>

<sup>9</sup> EuroHeart II; Work Package 6: CHD mortality projections to 2020, comparing different policy scenarios - <http://www.ehnheart.org/euroheart-ii/euroheart-ii-publications/publication/787-chd-mortality-projections-to-2020-comparing-different-policy-scenarios.html>

<sup>10</sup> <http://www.euro.who.int/en/health-topics/noncommunicable-diseases/cardiovascular-diseases/data-and-statistics>

<sup>11</sup> Prof. Dr Johan P. Mackenbach, 'Health Inequalities: Europe in Profile' 2006 [http://ec.europa.eu/health/ph\\_determinants/socio\\_economics/documents/ev\\_060302\\_rd06\\_en.pdf](http://ec.europa.eu/health/ph_determinants/socio_economics/documents/ev_060302_rd06_en.pdf)

other key membrane-related functions. Intake of TFAs thus has adverse effects on multiple cardiovascular risk factors and increases CHD-related events.<sup>12</sup>

Put more simply, a major reason for TFAs' adverse effect on CHD is that they increase the 'bad' cholesterol, LDL, and reduce the 'good' cholesterol, HDL.

A pooled meta-analysis of prospective studies has indicated 24%, 20%, 27% and 32% higher risk of myocardial infarction or CHD death respectively for every 2% energy of TFAs consumption, isocalorically replacing carbohydrate, SFA, cis monounsaturated fatty acids and cis polyunsaturated fatty acids, respectively.<sup>13</sup> In other words, every extra gram of TFAs consumed per day will increase the risk of heart attack or heart disease by about 5%.<sup>14</sup>

### The scale of the problem

Compared to the situation in European countries some ten to 15 years ago, today's food products generally do not contain high levels of IPTFAs. Data presented at a workshop organised by the EU Joint Research Centre (JRC) in April 2013<sup>15</sup> found that a majority of food products analysed contained no IPTFAs or less than 2g IPTFAs per 100g of total fat. However, some of the data presented at the workshop showed that there are food products marketed in the EU that contain much higher levels. For example a food product in Poland (a shortening) contained 54% IPTFAs. A paper *Tracing artificial trans fat in popular foods in Europe: a market basket investigation*<sup>16</sup> found that high intake of IPTFAs is still possible in Eastern Europe and South-Eastern European countries. Foods investigated included biscuits/cakes/wafers, which were pre-packaged, and French fries, and popcorn. These food items were chosen as they are frequently consumed, easily accessible and traditionally contain IPTFA-rich partially hydrogenated vegetable oils as their major lipid ingredient. IPTFAs content in these foods may be a marker of IPTFAs in other products including products that are not sold in pre-packaged form. Tests carried out by consumer organisations in Europe, published by BEUC (the European Consumer Organisation) in February 2014<sup>17</sup>, also found that several products still contain harmful levels of IPTFAs.

Data presented at the workshop also showed that average population intake did not exceed 1% of total energy intake in eight European countries<sup>18</sup> where data was collected – this corresponds to about 2.5 g per day. The workshop report noted that this level is in line with the target recommended in the 2002 *Joint WHO/FAO Expert Consultation on diet, nutrition and the prevention of chronic diseases: process, product and policy implications* (WHO/FAO).<sup>19</sup>

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<sup>12</sup> R Uauy A Aro R Clarke, R Ghafoorunissa, M L'Abbe', D Mozaffarian, M Skeaff, S Stender and M Tavella. WHO Scientific Update on trans fatty acids: summary and conclusions. *Eur J Clin Nutr* (2009) 63, S68–S75

<sup>13</sup> D Mozaffarian, A Aro and WC Willett. Health effects of trans-fatty acids: experimental and observational evidence. *Eur J Clin Nutr* (2009) 63, S5–S21

<sup>14</sup> One gram of fat = 9 calories; daily intake about 2 000 calories for women and 2 500 calories for men; thus one percent energy intake is about 20 calories, or a little more than 2 grams for women; about 25 calories, or 2.7 g for men

<sup>15</sup> [https://ec.europa.eu/jrc/sites/default/files/tfa\\_report\\_jrc\\_nutrition\\_group\\_final\\_online.pdf](https://ec.europa.eu/jrc/sites/default/files/tfa_report_jrc_nutrition_group_final_online.pdf)

<sup>16</sup> Stender S, Astrup A, Dyerberg J. Tracing artificial trans fat in popular foods in Europe: a market basket investigation. *BMJ Open* 2014;4:e005218. doi:10.1136/bmjopen-2014-005218

<sup>17</sup> [http://www.beuc.org/publications/beuc-x-2014-](http://www.beuc.org/publications/beuc-x-2014-010_the_consumer_case_for_eu_legal_restrictions_on_the_use_of_artificial_trans.pdf)

[010 the consumer case for eu legal restrictions on the use of artificial trans.pdf](http://www.beuc.org/publications/beuc-x-2014-010_the_consumer_case_for_eu_legal_restrictions_on_the_use_of_artificial_trans.pdf)

<sup>18</sup> Croatia, Denmark, Finland, Germany, Netherlands, Spain, Sweden and UK

<sup>19</sup> [http://www.who.int/nutrition/publications/public\\_health\\_nut9.pdf](http://www.who.int/nutrition/publications/public_health_nut9.pdf)

Whilst the WHO/FAO recommendation on TFAs from 2002 was for a population intake of less than 1% of total energy intake, the 2009 WHO Scientific Update on trans fatty acids concluded that there is a need to significantly reduce or virtually eliminate IPTFAs from the food supply in agreement with the implementation of the 2004 WHO Global Strategy on Diet, Physical Activity and Health.<sup>20</sup>

Moreover, EFSA recommended in 2010 that TFAs intakes should be as low as possible.<sup>21</sup> On this basis and on the basis that every gram counts, EHN in its 2011 paper *Diet, Physical Activity and Cardiovascular Disease Prevention in Europe*<sup>22</sup> recommended an ambitious longer-term goal of less than 0.5% of total energy intake.

If we consider that the average population intake of IPTFAs does not exceed 1% of total energy intake (at least in the eight European countries surveyed), we still *do not know* how many people in the EU – or indeed in wider Europe – consume levels higher than 1%. There is a concern that people from socially disadvantaged groups consume products that have high amounts of IPTFAs. These people will be at much higher risk of CHD.<sup>23</sup>

What we *do know* is that, even if the average population intake in Denmark was estimated at 1g per day, the Danish government decided, in 2003, to introduce a regulatory limit on IPTFAs because an estimated 1% of its population (roughly 50 000 people) had high intake – more than 5g per day.<sup>24</sup> Drawing a parallel to the EU, more than 5 million people may consume more than 5 g of IPTFA per day.

## Impact of reducing intake of IPTFAs

Since the introduction of its regulation, Denmark has seen several benefits. Intake has decreased and is now one tenth of the level that it was at the time when the regulation was adopted; this drop in trans fat consumption partly accounts for the significant decrease in mortality from cardiovascular diseases recently experienced in Denmark.<sup>25</sup> Indeed, Denmark had the highest annual decline in coronary heart disease death among EU-countries in the past decade<sup>26</sup>, placing Denmark amongst the countries, such as France, Portugal, the Netherlands, and Spain, with the lowest rates of CHD mortality in Europe.<sup>27</sup>

In England alone it is predicted that if consumption of IPTFAs were reduced by even 1% of total energy intake, it would prevent 11 000 heart attacks and 7 000 deaths.<sup>28</sup> And it might

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<sup>20</sup> R Uauy A Aro R Clarke, R Ghafoorunissa, M L'Abbe', D Mozaffarian M Skeaff, S Stender and M Tavella. WHO Scientific Update on trans fatty acids: summary and conclusions. *Eur J Clin Nutr* 2009 63, S68–S75

<sup>21</sup> <http://www.efsa.europa.eu/en/search/doc/1461.pdf>

<sup>22</sup> <http://www.ehnheart.org/publications/publications/publication/521-diet-physical-activity-and-cardiovascular-disease-prevention.html>

<sup>23</sup> [file:///Z:/Nutrition/trans%20fats/NICE\\_public%20health%20guidance%2025\\_CVD%20prevention\\_June2010.pdf](file:///Z:/Nutrition/trans%20fats/NICE_public%20health%20guidance%2025_CVD%20prevention_June2010.pdf)

<sup>24</sup> Steen Stender, Jørn Dyerberg, and Arne Astrup. Consumer protection through a legislative ban on industrially produced trans fatty acids in foods in Denmark. *Scandinavian Journal of Food and Nutrition* 2006; 50 (4): 155-160

<sup>25</sup> Brandon J. Restrepo, PhD, Matthias Rieger, PhD. Denmark's Policy on Artificial Trans Fat and Cardiovascular Disease. *Am J Prev Med* 2016 Jan;50(1):69-76; doi: 10.1016/j.amepre.2015.06.018

<sup>26</sup> Melanie Nichols, Nick Townsend1, Peter Scarborough, and Mike Rayner. Trends in age-specific coronary heart disease mortality in the European Union over three decades: 1980–2009. *European Heart Journal* (2013) 34, 3017-3027; doi:10.1093/eurheartj/eh1159

<sup>27</sup> Melanie Nichols, Nick Townsend, Peter Scarborough, and Mike Rayner. Cardiovascular disease in Europe 2014: epidemiological update. *European Heart Journal* (2014) 35, 2950–2959; doi:10.1093/eurheartj/ehu299

<sup>28</sup> D Mozaffarian, MJ Stampfer. *BMJ* 2010;340:c1826; doi: 10.1136/bmj.c1826

save annually some £2 billion in cardiovascular-related healthcare cost (around 2.28 billion euros).<sup>29</sup>

Therefore, strictly limiting IPTFAs in all EU Member States could potentially save about 50 000 lives every year<sup>30</sup> and billions of euros in cardiovascular-related healthcare cost.<sup>31</sup>

It is, therefore, not surprising that such regulation was recommended in a study by the European Parliament's policy department on economic and scientific policy published in 2008.<sup>32</sup> Nor is it surprising that six European countries have already set mandatory upper limits of IPTFAs. Three are EU Member States: Austria, Denmark and Hungary; the other three are Iceland, Norway and Switzerland. In the US, several cities, including New York and Boston, have implemented such legislation. It is frankly more surprising that not more countries have followed suit. Especially since experience has shown that IPTFAs can be replaced with healthier substitutes without increasing the cost or reducing the quality of foods. Analyses of foods before and after implementation of legislative restrictions on the content of IPTFAs in foods have demonstrated widespread compliance with little evidence of adverse effects on food availability, price or quality.<sup>33,34</sup>

## Conclusions and Recommendations

In conclusion, the virtual removal of IPTFAs from the food supply is one of the most straightforward public health interventions.<sup>35</sup>

If the EU were to introduce a mandatory upper limit of industrially produced trans fatty acids, it would contribute to:

- Improving health of all EU citizens;
- Reducing deaths from heart disease;
- Contributing to tackling inequalities in health; and
- Saving healthcare costs.

Acknowledging that significant reductions in IPTFAs have been achieved in several European countries, EHN remains very concerned about the high risk of heart disease that a large number of people in the EU is exposed to because they consume a disproportionate amount of foods with high levels of IPTFAs. It is also clear that when the levels of IPTFAs are not regulated, foods from countries that have been less successful in reducing IPTFAs can cross borders and be freely available for all.

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<sup>29</sup> [file:///Z:/Nutrition/trans%20fats/NICE\\_public%20health%20guidance%2025\\_CVD%20prevention\\_June2010.pdf](file:///Z:/Nutrition/trans%20fats/NICE_public%20health%20guidance%2025_CVD%20prevention_June2010.pdf)

<sup>30</sup> [http://www.europarl.europa.eu/RegData/etudes/workshop/join/2014/518744/IPOL-ENVI\\_AT%282014%29518744\\_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/workshop/join/2014/518744/IPOL-ENVI_AT%282014%29518744_EN.pdf)

<sup>31</sup> [file:///Z:/Nutrition/trans%20fats/NICE\\_public%20health%20guidance%2025\\_CVD%20prevention\\_June2010.pdf](file:///Z:/Nutrition/trans%20fats/NICE_public%20health%20guidance%2025_CVD%20prevention_June2010.pdf)

<sup>32</sup> [http://www.europarl.europa.eu/RegData/etudes/etudes/join/2008/408584/IPOL-JOIN\\_ET%282008%29408584\\_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/etudes/join/2008/408584/IPOL-JOIN_ET%282008%29408584_EN.pdf)

<sup>33</sup> Stender S, Dyerberg J, Bysted A, Leth T, Astrup A. A trans world journey. *Atheroscler Suppl* 2006;7:47–52. doi:10.1016/j.atherosclerosissup.2006.04.011 PMID:16713385

<sup>34</sup> Angell SY, Silver LD, Goldstein GP, Johnson CM, Deitcher DR, Frieden TR et al. Cholesterol control beyond the clinic: New York City's trans fat restriction. *Ann Intern Med* 2009;151:129–34. PMID:19620165

<sup>35</sup> D Mozaffarian, MJ Stampfer. *BMJ* 2010;340:c1826; doi: 10.1136/bmj.c1826

Therefore, EHN recommends that the European Commission adopt a legislative proposal setting a mandatory upper limit of IPTFAs thereby harmonising standards across the EU and ensuring that no foods with too high levels of IPTFAs are placed on the market.