Adverse effects of industrially produced trans fats on the cardiovascular system and the presence of these fats in popular foods in Europe. Time to protect the population?

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Department of Nutrition, Exersize and Sports
University of Copenhagen, Denmark

Conference
Trans fats in food: Consumer protection
and challenges for food industry
18 -9-2017, Vilnius, Lithuania

I have no conflicts of interest
Edible oil → Max. 50% trans fat → Margarine

Grass → Cow → Butter → Max. 5% trans fat
In 1940 Denmark with 3.8 million inhabitants had about 120 different factories producing margarine
ERNÄHRUNGSPROBLEME
IN MANGELZEITEN

Die schweizerische Kriegernährung 1939–1946

Von Prof. Dr. med. ALFRED FLEISCH
Ordinarius für Physiologie und Direktor des Physiologischen Institutes
an der Universität Lausanne

Präsident der Eidgenössischen Kommission
für Kriegernährung

BENNO SCHWABE & CO · VERLAG · BASEL
1947
"However, the fat industry has so far failed to study the biological and medical side of hydrogenation.

If new chemical substances or chemically modified nutrients are marketed for human beings over a long period, and consumed in large amounts and already are consumed, large and long-term trials are necessary to at least prove the harmlessness of prolonged use.

It is desirable that the fat industry acknowledge this challenge and carefully study the conditions in the organism regarding hydrogenated fat, which has been launched on such a large scale."
Fatty acids in the diet and LDL- and HDL-cholesterol in the blood

**Saturated fatty acids**

- LDL (Lousy): Up
- HDL (Healthy): Up

**Unsaturated fatty acids**

- LDL (Lousy): Down
- HDL (Healthy): Down
Fatty acids and cholesterol in the blood

- Saturated fatty acids
- Unsaturated fatty acids
- Trans fatty acids

LDL (Lousy)
HDL (Healthy)
Isocaloric substitution of 2E% carbohydrates with trans fatty acids ~ 5 gram/day

<table>
<thead>
<tr>
<th>Type and Year of Study</th>
<th>No. of Subjects</th>
<th>No. of Events</th>
<th>Better</th>
<th>Worse</th>
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<tbody>
<tr>
<td>Prospective cohort studies</td>
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<td>Nurses’ Health Study, 2005</td>
<td>78,778</td>
<td>1766</td>
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<td>Health Professionals Follow-up Study, 2005</td>
<td>38,461</td>
<td>1702</td>
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<td>Alpha-Tocopherol Beta-Carotene Cancer Prevention Study, 1997</td>
<td>21,930</td>
<td>1399</td>
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<td>Zutphen Elderly Study, 2001</td>
<td>667</td>
<td>98</td>
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<tr>
<td>Pooled prospective studies</td>
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</tr>
</tbody>
</table>

Multivariable Relative Risk of CHD with Higher Trans Fatty Acid Intake

Mozaffarian et al. NEJM 2006;354(15):1601-13
WHO recommends global phasing out of trans fats

By Anthony Fletcher

29/09/2006 - The World Health Organization (WHO) has recommended that governments around the world phase out partially hydrogenated oils if trans-fat labeling alone doesn't spur significant reductions.

http://www.foodproductiondaily.com/news
**Trans-FAT Intake and All-Cause Mortality**

Quintiles of trans fat intake:

- Quintile 1: ~ 4.0 g/d
- Quintile 2: ~ 5.8 g/d
- Quintile 3: ~ 7.1 g/d
- Quintile 4: ~ 8.6 g/d
- Quintile 5: ~ 11.7 g/d

18,513 participants recruited from all across the US from 2003 to 2007
"In conclusion, the detrimental effects of industrial \textit{trans} fatty acids on heart health are beyond dispute."
Atherosclerotic Plaque Development

0 10 20 30 40 50 60 70 80 90

Years of life

Plaque instability

Rupture
Calcification
Thrombosis
Occlusion

Stroke
TIA

Myocardial infarction
Angina

Peripheral arterial disease
“There does not appear to be a threshold under which the association between concentration of trans fatty acid in plasma and plasma lipoprotein profiles might become undetectable”

Yang Q et al J Nutr 2017 (April); 147: 896-907
The impact of serum trans fatty acids concentration on plaque vulnerability in patients with coronary artery disease: Assessment via optical coherence tomography

161 consecutive patients with Coronary artery disease underwent the investigations at Kobe University Hospital in Japan

Nagasawa Y et al,
Plaque rupture

Thin fibrous cap

Thrombus

Thin-cap fibroatheroma

Ruptured plaque

Elaidic acid level in serum was identified as the independent risk factor of TCFA: Thin Cap FibroAtheroma, and may affect plaque vulnerability in patients with heart disease.

*Nagasawa Y et al. Atherosclerosis June 2017*

Hirata Y et al. J Biol Chem 2017 May 19 292(20)
Trans fatty acids promote extracellular ATP-induced apoptosis (cellular suicide) in a murine macrophage-like cell line.

Hirata Y et al. J Biol Chem 2017 May 19 292(20)
The Danish trans fat story
An intake of 5 grams per day is associated with 23% increase in risk of heart disease.

There is no beneficial effect of trans fatty acids on health.

In light of the Danish Nutrition Council’s reports on trans fatty acids from 1994, 2001, 2003, and the present update, the Danish Nutrition Council recommends the following:

That industrially produced trans fatty acids should not be used in food.
“A high trans fat menu”

Danmark 2001
Grams of industrially produced trans fatty acids
A large serving of nuggets and French fries
100 g biscuits/cakes/wafers
100 g microwave popcorn

- A large serving of nuggets and French fries
- 100 grams biscuits/cakes/wafers
- 100 grams popcorn
Member of the Danish parliament from 1971
EU Environment Commissioner 1995-1999
Minister of food from 2000-2001

Member of the Danish parliament from 1990. Minister of food from 2001-2004
EU Agriculture Commissioner 2004-2009
Chapter 1
Scope

Section 1. This Order applies to oils and fats, including emulsions with fat as the continuous phase which, either alone or as part of processed foodstuffs, are intended, or are likely, to be consumed by humans.

Subsection 2. The Order does not apply to the naturally occurring content of trans fatty acids in animal fats or products governed under other legislation.

Subsection 3. The Order only applies to products sold to the final consumer.

Section 2. It is prohibited to sell the oils and fats covered by the Order to consumers if they contain a higher level of the trans fatty acids defined in the Annex than that stated in Section 3.

Subsection 2. From 1 June 2003 until 31 December 2003 the oils and fats covered by this Order and included in processed foodstuffs which also contain ingredients other than oils and fats and which are produced by the foodstuffs industry, in retail outlets, catering establishments, restaurants, institutions, bakeries etc. may, however, contain up to 5 grams of trans fatty acids per 100 grams of oil or fat.

Section 3. As from 1 June 2003, the content of trans fatty acids in the oils and fats covered by this Order must not exceed 2 grams per 100 grams of oil or fat, cf. however subsection 2.

Subsection 2. From 1 June 2003 until 31 December 2003 the oils and fats covered by this Order and included in processed foodstuffs which also contain ingredients other than oils and fats and which are produced by the foodstuffs industry, in retail outlets, catering establishments, restaurants, institutions, bakeries etc. may, however, contain up to 5 grams of trans fatty acids per 100 grams of oil or fat.

Section 4. In products which are claimed to be “free from trans fatty acids”, the content of trans fatty acids in the finished product shall be less than 1 gram per 100 grams of the individual oil or fat.

Chapter 2
Penalty provisions etc.

Section 5. A fine shall be imposed on anyone who contravenes Section 2 or Section 4 of this Order.

Subsection 2. The penalty may increase to imprisonment for up to two years if the contravention was committed willfully or through gross negligence, and the contravention

1) caused damage to health or led to the risk thereof, or
2) resulted in, or was intended to result in, financial gain for the perpetrator themselves or for others, including as a result of savings made.

Subsection 3. Criminal liability may be incurred by companies etc. (legal entities) in accordance with the rules of Chapter 5 of the Penal Code.

Section 6. This Order shall enter into force on 31 March 2003.

Subsection 2. Products manufactured before this Order has entered into force, as well as products manufactured within the periods stated in Section 3(2), may be sold until expiry of the best before date. Annex 1

Definition of trans fatty acids

For the purposes of this Order, trans fatty acids are defined as the sum of all fatty acid isomers with 14, 16, 18, 20 or 22 carbon atoms and one or more trans double bonds, i.e. C14:1, C16:1, C18:1, C18:2, C18:3, C20:1, C20:2, C22:1, C22:2 fatty acid trans isomers, but only polyunsaturated fatty acids with methylene interrupted double bonds.

11 March 2003
"A high trans fat menu"

A large fast food serving

French fries and fried chicken meat from McDonalds and from KFC

Biscuits/cakes/wafers and microwave popcorn

More than 15% fat in the product

Partially hydrogenated fat or similar term high on the list of ingredients

3 large supermarkets in the capital chosen by the local Turist Information Office were visited
Places where “a potentially high trans fat menu” was bought during 2005-2006
Trans fatty acids in "a high trans fat menu" 2005-2006

Grams of industrially produced trans fatty acids

A large serving of nuggets and French fries
100 g biscuits/cakes/wafers
100 g microwave popcorn

USA
Czech Rep.
Poland
Hungary
Bulgaria
Canada
Iceland
Peru
Romania
South Africa
France
Lithuania
Germany
Portugal
Spain
UK
The Netherlands
Russia
Austria
Italy
Sweden
Norway
China
Finland
Switzerland

Denmark 2001
Denmark 2005

0 10 20 30 40 50

A large serving of nuggets and French fries
100 g biscuits/cakes/wafers
100 g microwave popcorn

Grams of trans fatty acids
Amounts of industrially produced trans fatty acids in a large serving 2005-2006

*Values in brackets are % trans fatty acids of total fat in French fries and chicken respectively.

Stender et al NEJM, April 12; 2006
A decrease of $1.5 billion
McDonald’s® Europe takes action to reduce Trans Fatty Acids in cooking oil

London, United Kingdom (November 7 2006)

McDonald’s Europe today made public its 2-year plan to achieve a substantial reduction in trans fatty acids in its cooking oil.

By mid 2008 (depending on supply availabilities), McDonald’s plans to have more than 6,300 restaurants across Europe using the new oil that will contain no more than 2% trans fatty acids.

Press release fra McDonald’s Europe
Trans fatty acid in "a high trans fat menu" in 2006 and 2009

A large serving of nuggets and French fries
100 g biscuits/cakes/wafers
100 g microwave popcorn

Hungary
Czech Rep.
Poland
France
Germany
UK
Denmark

2006
2009

Stender S et al. BMJ Open 2012;2
Premature mortality from diseases of the circulatory system in Latvia and EU countries, 1970–2008

**Good news**: the large increase in the early 1990s among both men and women was temporary.

**Bad news**: the rates for men and women are the highest in the EU, with no overall improvement in the trends and, for men, even an overall rise starting in 1980 but with a welcome drop in 2008.

Foods bought in Riga, Latvia in March 2011
Amounts of trans fat in biscuits/cakes/wafers with more than 2% of the fat as trans fat

Bought March 2011 in 3 large supermarkets in the capital of Latvia

Gram trans fat per 100 gram product

10 products
Kā klājas
Jāņītim no beibīboksa

Vafeļu skandāla profesors dushman

Stēns Stenders izgrieza rekas pat McDonald's Tikāmies Dānijā aci pret aci

Rīdošana
«Dati var būt iespējams arī specifiski interpretēti, kas saistīti ar dāvanu ieguvumiem.»

Nacibol Līndermans
Ari gatavojas

Jauna slota Centrāltirgu

Mūsu bāsiša čempioni

Top filma

Vārds: Sestdiena

Izbaudiet politisko diskusiju uz tvaiku

Vasaras skandāla profesors dushmani

Stēns Stenders izgrieza rekas pat McDonald's Tikāmies Dānijā acīm pret acīm.
Latvian counter-attack

”Expell him from the country”
”We will sue him for 1 mill Euro”
”We will report it to EU-authorities”
Draft Cabinet of Ministers regulation on the maximum permissible content of trans fatty acids in foodstuffs

Notification Number: 2015/510/LV (Latvia)
Date received: 02/09/2015

“The main reason for the need to limit trans fatty acids in foodstuffs in Latvia, i.e. by setting the maximum permissible limits, is the high incidence of morbidity and mortality related to cardiovascular diseases”
Regulation in various countries concerning industrial trans fatty acids (TFA) in food

<table>
<thead>
<tr>
<th>Countries</th>
<th>Legislative limits for TFA</th>
<th>No limits for TFA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No labelling</td>
<td>Labelling by naming TFA</td>
</tr>
<tr>
<td></td>
<td>Denmark, Switzerland, Austria, Iceland</td>
<td>EU</td>
</tr>
<tr>
<td></td>
<td>Hungary, Norway, Latvia, NY-City, California</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Georgia, Lithuania, US, Canada</td>
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<tr>
<td></td>
<td>2017 2018</td>
<td>Partial hydrogenation of fat illegal from 18th of June 2018</td>
</tr>
</tbody>
</table>

Example

No need for information

Partially hydrogenated fat

"Trans 3 grams per serving"

“By 13 December 2014, the EU-Commission, taking into account scientific evidence and experience acquired in Member States, shall submit a report on the presence of trans fats in foods and in the overall diet of the Union population.

The Commission shall accompany this report with a legislative proposal, if appropriate”. 
Amounts of trans fat in biscuits/cakes/wafers with more than 2% of the fat as trans fat. Bought 2012/2013 in 3 large supermarkets in the capital of 20 European countries.
Options Considered

- **Commission Staff Working Document**  September 2014
- 4 Policy options:
  - Option 1: EU introduces **mandatory TFA content declaration**
  - Option 2: EU introduces a **legal limit on the TFA content of food**
  - Option 3: **Voluntary agreements** towards reducing TFA in foods and diets are made at EU level
  - Option 4: **No further action** towards reducing TFA in foods and diets is taken at EU level
Amounts of trans fat in biscuits/cakes/wafers with more than 2% of the fat as trans fat. Bought in 3 large supermarkets in 2012 and in the same supermarkets in 2014.

**2012**

- **BELGRADE SERBIA**
  - N: 35 (35)
  - X(SD): 33.5 (8.3): % trans fat in fat

- **LIJUBLJANA SLOVENIA**
  - N: 18 (20)
  - X(SD): 15.5 (10.0): % trans fat in fat

- **ZAGREB CROATIA**
  - N: 40 (56)
  - X(SD): 17.2 (11.3): % trans fat in fat

**2014**

- **BELGRADE SERBIA**
  - N: 82 (110)
  - X(SD): 20.0 (8.4): % trans fat in fat

- **LIJUBLJANA SLOVENIA**
  - N: 53 (72)
  - X(SD): 17.9 (11.2): % trans fat in fat

- **ZAGREB CROATIA**
  - N: 53 (86)
  - X(SD): 19.5 (10.5): trans fat in fat

*BMJ Open; Feb 2016*
REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL

regarding trans fats in foods and in the overall diet of the Union population

“All of the above clearly indicates the need to continue and expedite work in this area by collecting more information .... in particular the option of legal limits for industrial TFA.”
Aged-standardized death rates from coronary heart disease in (WHO)-Europe

Belarus (2009)
Ukraine (2012)
Turkmenistan (1998)
Kyrgyzstan (2010)
Rep. of Moldova (2012)
Russian Federation (2010)
Uzbekistan (2005)
Lithuania (2010)
Latvia (2012)
Armenia (2012)
Slovakia (2010)
Tajikistan (2004)
Hungary (2012)
Kazakhstan (2010)
Estonia (2012)
Romania (2010)
Czech Republic (2012)
Croatia (2012)
Malta (2011)
Finland (2011)
Albania (2004)
Azerbaijan (2007)
Bulgaria (2011)
Ireland (2009)
Poland (2011)
Austria (2011)
Serbia (2012)
Iceland (2009)
TFYR Macedonia (2010)
Sweden (2010)
UK (2010)
Cyprus (2011)
Germany (2012)
Slovenia (2010)
Bosnia and Herzegovinia (2011)
Greece (2011)
Switzerland (2010)
Georgia (2010)
Norway (2012)
Italy (2010)
Belgium (2010)
Israel (2011)
Denmark (2011)
Luxembourg (2011)
Spain (2011)
Netherlands (2011)
Portugal (2011)
France (2010)
San Marino (2005)

Number of deaths per 100,000

M Nichols et al. Eur Heart J 2014; 35, 2950-9
The former Soviet Union
Population in the 15 republics before 1991

Population all together ~300 millions
Does legislative restriction on trans fat reduce heart disease?
Denmark’s Policy on Artificial Trans Fat and Cardiovascular Disease

Mortality of coronary artery disease

"In the 3 years after the policy was implemented, mortality attributable to CVD decreased on average by about 14.2 deaths per 100,000 people per year in Denmark relative to the synthetic control group”.

It corresponds to an additional reduction of 4.3% in CVD deaths
Conclusion
“The results indicate that the policy caused a 4.5% reduction in CVD mortality rates”
Original Investigation

June 2017

Hospital Admissions for Myocardial Infarction and Stroke Before and After the Trans-Fatty Acid Restrictions in New York

Eric J. Brandt, MD1; Rebecca Myerson, MPH, PhD2; Marcelo Coca Perraillon, PhD3; et al Tamar S. Polonsky, MD, MSCI4

CONCLUSION AND RELEVANCE “The NYS population with TFA restrictions experienced fewer cardiovascular events, beyond temporal trends compared with those without restrictions.”

A 6.2% additional decline in hospital admissions of myocardial infarction and strokes after 3 years
SUMMARY

Industrial trans fat is a metabolic poison that is present in popular foods in many of WHO-Europe’s 52 different countries.

Voluntary reduction of industrial trans fat by food producers does not effectively remove trans fat from foods.

Mandatory labelling is not understood by many people and does not include un-packed food.

A legislative limit restricts intake of industrial trans fat in all subgroups of the population and reduces heart disease.

It is a low hanging fruit to pick in the prevention of heart disease.
Blocked blood supply

Occluded coronary artery

Damaged heart muscle

http://forte.fh-hagenberg.at/cardiac/
DISEASED ARTERY

Heavy plaque buildup narrows the opening and restricts blood flow.
11. april 2006: 200 hits
14. april 2006: 23,000 hits
Tagebuch Eintrag Wilhelm Normann

"Erfindung der Fetthärtung"

27. Februar 1901

Umwandlung von Ölsäure in Stearinsäure

6. März 1901

(1870-1939)
Indbyggertallet i de 15 Sovjetrepublikker før unionens opløsning 1991:

1. Rusland: 147,0 mio.
2. Estland: 1,6 mio.
3. Letland: 2,6 mio.
4. Litauen: 3,7 mio.
5. Hviderusland: 10,0 mio.
6. Ukraine: 51,0 mio.
10. Aserbajdsjan: 7,0 mio.
11. Turkmenistan: 3,5 mio.
12. Usbekistan: 20,0 mio.
13. Tadsjikistan: 5,1 mio.
15. Kasakhstan: 16,0 mio.

I alt ca. 300 millioner
December 2011

Dear Mr. Stender!

We are united in care about consumers.

We wish you a warmth and love inspired Christmas time and the whole year 2012 ahead!

Your Laima