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Industrial *trans* fat in popular foods is still a health issue in Europe: a market basket investigation

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Abstract

Objective: To minimise the intake of industrial *trans* fat (I-TF), nearly all European countries rely on food producers to voluntarily reduce the I-TF content in food. The objective of this study was to investigate the efficiency of this strategy in 2012-2013 in 20 European countries.

Design: The I-TF content in pre-packaged biscuits/cakes/wafers was assessed in a market basket investigation. Three large supermarkets were visited in each capital, and in some countries, three additional ethnic shops were included.

Results: A total of 598 samples of biscuits/cakes/wafers with "partially hydrogenated vegetable fat" or a similar term high on the list of ingredients were analysed, 312 products had more than 2 % of fat as I-TF, exceeding the legislatively determined I-TF limit in Austria and Denmark; the average was 19 %. In seven countries, no I-TF was found, whereas nine predominantly Eastern European countries had products with very high I-TF content. The products in the remaining four countries had intermediate levels. Of the five countries that were examined using the same procedure in 2006, three had unchanged I-TF levels in 2013, and two had lower levels. The 18 small ethnic shops examined in six Western European countries sold 83 products that contained an average of 23 % of the fat as I-TF, all imported from countries in South-eastern Europe. In Sweden, this type of imported food was also available in large supermarkets.

Conclusion: The findings suggest that subgroups of the population in many countries in Europe still consume I-TF in amounts that increase their risk of coronary heart disease. Under current EU legislation, the sale of products containing I-TF is legal but conflicts with the WHO recommendation to minimise the intake of I-TF. A EU-legislative limit on I-TF in foods is an effective strategy to achieve this goal.

Article summary

Strengths and limitations of this study

- A strength is the measurement of TF in many popular foods obtained in 3 large supermarkets in 20 different EU countries in 2012-13, and in popular foods obtained in 3 ethnic shops in Berlin, Paris, London, Malmö and Copenhagen
- In South-eastern Europe foods with high amounts of I-TF are present in large supermarkets and the same brands of foods with high amounts of I-TF are present also in ethnic shops in Western Europe
- Foods with high amounts of I-TF produced in some countries in Europe are legally exported to many other European countries
- A limitation is that the average daily intake of I-TF was not measured in subgroups of the population, but instead inferred from the presence of popular foods with high amounts of I-TF in large super markets and in small ethnic shops.

Introduction

Trans fat (TF) in food originates from the industrial hydrogenation of oils and from ruminant sources. Compared to non-hydrogenated oils, fats containing industrial *trans* fat (I-TF) are solid at room temperature, have some technical advantages for food processing, and prolong the shelf life of products. I-TF can constitute up to 60% of the fat in certain foods, whereas ruminant fat contains 6% TF at most.[1] A meta-analysis of four large prospective studies found that an average intake of

approximately five grams per day of TF, corresponding to 2% of the total energy intake, was associated with a 23% increase in the risk of coronary heart disease.[2] More recently, TF intake has also been associated with all-cause mortality in a large US-based study.[3] A 2013 review concluded that "the detrimental effects of industrial *trans* fatty acids on heart health are beyond dispute".[4] Furthermore, inverse associations have been observed between TF and essential long-chain polyunsaturated fatty acids in the blood lipids of pregnant women and their offspring at birth as well as in human milk. Because the latter fatty acids are important for neurodevelopment in infancy, the potential untoward effect of TF exposure caused by fatty acid competition in the brain has received increased attention.[5]

Based on the relationship between the intake of I-TF and heart disease, for years several public health organisations have recommended that I-TF intake be lowered as much as possible.[6–8]

In 2003, Canada introduced mandatory labelling of the I-TF content in pre-packaged foods. In the same year, Denmark introduced a legislative limit of 2% I-TF in the fat content of foods. The European Commission initially opposed this legislation but dropped its infringement proceedings in March 2007 because of increasing scientific evidence about the dangers of *trans* fat.[9] The US introduced mandatory labelling of TF on pre-packaged foods in 2006, followed by legislative limits on I-TF in the food served in restaurants in New York City in 2008 and in the state of California in 2010-11, and FDA has now proposed a legislative ban on industrial trans fat in 2014.[10] In Europe in 2009, Austria and Switzerland introduced a legislative ban similar to the Danish ban, followed by Iceland in 2011 and probably by Sweden, Hungary, and Norway in 2014.[11–13] However, in 2014, only a minority of the population in the EU (i.e., less than 50 million of the 500 million people in the EU) is protected by legislation against foods with high amounts of I-TF.

The present study, examined the I-TF content in pre-packaged biscuits/cakes/wafers in 20 European countries. The inclusion criteria for the food samples were precisely defined based on the list of

ingredients printed on the packing. The same procedure was used in similar studies in 2006 and 2009.[14,15] We further investigated whether products with high I-TF produced in some European countries were disseminated to other European countries. The findings may be relevant to the future regulation of the I-TF content in foods in the EU. "By 13 December 2014, the 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 aim of the report shall be to assess the impact of appropriate means that could enable consumers to make healthier food and overall dietary choices or that could promote the provision of healthier food options to consumers including, among others, the provision of information on trans fat to consumers or restrictions on their use. The Commission shall accompany this report with a legislative proposal, if appropriate".[16]

Methods

Purchases in supermarkets

The 20 countries visited encompass the countries in Ex-Jugoslavia, its neighbouring countries, three Scandinavian, and three large countries in northern Europe: Germany, France, and UK.

The main tourist office in the capital of each country was asked to identify three large supermarkets, preferably chain supermarkets with many large shops across the country. In several capitals, the same stores visited in 2006 and in 2009 were visited in this study.[14,15] As in the previous studies, packages of biscuits/cakes/wafers were obtained by systematically examining the labels of the products placed on the appropriate shelves in the supermarkets. Packages were purchased only if "partially hydrogenated fat" or a similar term was listed high on the list of ingredients and if the label indicated that the fat content was equal to or exceeded 15 grams of fat per 100 grams of product. In a few cases, the label also indicated the amount of TF per serving. If the same product

appeared in packages of different sizes, only the smallest size was bought. If exactly the same package was found in two different supermarkets in the same capital, only the one with the most recent "best before date" was included in the study. The packages from the three supermarkets in each capital were labelled and photographed, the package was opened, and two identical 50- to 100-gram samples of the food were placed in appropriately labelled plastic bags. All of the empty packages were stored, as were the receipts from the purchases. The name of the product, producer, country of origin, "best before" date, and the languages used in the list of ingredients were recorded.

Between May 2012 and September 2013, 454 packages were purchased in 60 supermarkets in the capitals of Albania, Austria, Bosnia-Herzegovina, Bulgaria, Croatia, Denmark, France, Germany, Hungary, The Former Yugoslav republic of Macedonia, Montenegro, Poland, Norway, Romania, Serbia, Slovakia, Sweden, the Czech Republic, and the United Kingdom. In addition, 30 packages were bought in three large supermarkets in Malmö, the third largest city in Sweden.

Purchases in ethnic shops

Because our analysis of the biscuits/cakes/wafers from supermarkets in the Balkan capitals yielded a relatively high number of foods with high amounts of I-TF, we decided to search for these types of Balkan foods in other countries using Google to identify ethnic shops selling Balkan foods. Three different shops were visited in each of the capitals Berlin, Copenhagen, London, Oslo, and Paris and in addition in Malmö. A total of 114 pre-packaged biscuits/cakes/wafers were purchased in these shops using the same inclusion criteria that were used for the purchases in supermarkets. The products were treated in the same manner as the samples from the supermarkets.

Analysis of TF

The foods were homogenised, and the fatty acid content was analysed using gas chromatography on a 60-metre highly polar capillary column using a modification of the AOAC 006·06 method. The

analytical work was conducted by Microbac Laboratories, Warrendale, Pennsylvania, US, an ISO-17025-certified laboratory.

Results

Figure 1 depicts the I-TF content in the 312 products bought in the three supermarkets in each country, ranked according to I-TF level expressed in grams per 100 grams of the product. Each bar in each panel represents a product. Only products with more than 2% of the fat content as TF are shown. The first number given in the panel is the number of products with more than 2% of the fat content as TF. The number in parentheses is the number of products that fulfilled the inclusion criteria. The difference between the two numbers reflects the number of samples that did not contain appreciable amounts of TF despite the information on the label. The panels are ranked according to the sum of I-TF concentrations in the different products. Bosnia Herzegovina appears to have the greatest sum, followed by Serbia. Of the 312 products made by 51 factories in 15 European countries, 40% of the products had more than 20% of the fat as I-TF. In the supermarkets in the capitals of Austria, Denmark, France, Germany, Norway, Sweden, and the UK, no samples were found that fulfilled the inclusion criteria (figure 1, lower right panel). The panel for three supermarkets in Malmö, Sweden was similar to the panels for Podoricia, Montenegro and Skopje, The Former Yugoslav republic of Macedonia and was very different from the zero values found in the supermarkets in Copenhagen, Oslo, and Stockholm.

A total of 83 packages of biscuits/cakes/wafers with high amounts of TF were bought in the ethnic shops in five capitals and in Malmö; this number varied between nine and 20 for each shop (figure 2). Furthermore, 60% of the products had more than 20% of the fat as I-TF. Many of the products were the same in the six countries. These foods were also found in Copenhagen, which is surprising

because their sale is illegal in Denmark, in contrast to the other countries in which the foods were found.

Discussion

Products with industrial *trans* fat in supermarkets

In each of 20 European capitals, three large supermarkets were visited in 2012-13, and in five of the capitals and in Malmö, Sweden, an additional three ethnic shops were visited. A total of 598 packages containing biscuits/cakes/wafers were bought and analysed for TF content, and 396 of these products contained high amounts of I-TF (more than 2 grams per 100 grams of fat). In several products, the I-TF content was higher than 40 grams per 100 grams of fat. Similarly high values of I-TF in foods bought in Poland and in Serbia have also been reported in Polish and Serbian studies.[16,17] The findings clearly demonstrate that I-TF is still present in 2013 in high concentrations in popular foods in many countries in Europe (figures 1 and 2).

Some foods with partially hydrogenated fat or a similar term in the list of ingredients did not contain significant amounts of TF. A mixture of cis fat and fully hydrogenated fat without TF is understood by some food producers to be partially hydrogenated fat.

In all 20 countries except for Denmark and Austria, it is legal to use as much I-TF in foods as technically possible without providing the quantity on the list of ingredients. Governments and consumer associations strive to follow the recommendations of the WHO. The voluntary reduction in the amount of I-TF in foods by food producers appears to work well in some countries, but not in others. Food producers in a given country or in neighbouring countries may remove I-TF from their products, but importing products with high I-TF content from more distant countries may counteract the initiatives, as demonstrated in the supermarkets in southern Sweden (figure 1, panel 4). Based on previous measurements, the I-TF content in biscuits/cakes/wafers from supermarkets

in Germany, France, and the UK was nearly eliminated between 2005 and 2009,[15] and no products with significant amounts of TF were found in 2013 (figure 1). This result contrasts with the situation in Poland, Bulgaria, and Romania, where there were no obvious changes in the presence of I-TF in foods between 2006 and 2013 (figure 3). The products in these countries were primarily from local food producers. Hungary and, especially, the Czech Republic showed a decline in high-I-TF foods during the same period.

Products with industrial *trans* fat in ethnic shops

Although the number of consumers who regularly buy food in ethnic shops is lower than the number of consumers who purchase food in large supermarkets, the harmful effect of I-TF is still present if the average intake at the personal level exceeds the recommended level. In many of the countries in Western Europe, mortality due to heart disease among immigrants far exceeds the mortality rate in the indigenous population. Using the same Internet procedure that was used to identify shops with Balkan foods in other countries, three ethnic shops where pre-packaged biscuits/cakes/wafers with high amounts I-TF were available were found in Copenhagen. These sales are illegal and can be stopped immediately by the food authorities, if they desire.[19]

In Southern Sweden, biscuits/cakes/wafers with high amounts of I-TF are present not only in small ethnic shops (figure 2) but also in large supermarkets (figure 1). This type of product has spread from the small ethnic shops to large supermarkets, suggesting considerable sales of these products, which remain legal in Sweden. The Swedish parliament decided in 2011 that Sweden should adopt the same I-TF legislation as Denmark, but the Swedish government decided to postpone the implementation on the advice of the Swedish food authorities because they found that all of the large food suppliers in Sweden, Norway, and Denmark had removed I-TF from products sold in Sweden.[11] They did not take into account the free flow of goods across borders in Europe. Many

products with high amounts of I-TF have ingredient lists in more than 10 different languages, suggesting that they are potentially exported to many different countries.Retailers distributing these foods are present in Sweden and in other European countries, and the majority of products with high amounts of I-TF can be bought on the Internet. Although foods with high amounts of I-TF were not found in large supermarkets in other Western countries, the Swedish story may repeat elsewhere.

The strength of this study is that it provides up to date data about the availability of popular foods containing high amounts of I-TF in 20 European countries. One weakness of the study is that the average daily intake of I-TF was not measured in subgroups of the population in the various countries but instead was inferred from the presence of biscuits/cakes/wafers with high amounts of I-TF in large supermarkets. The following assumptions led to the conclusion that these products have harmful effects: 1) the analysed brands of biscuits/cakes/wafers were stocked at the supermarkets because they are sold in considerable amounts; 2) the majority of these foods are regularly bought and consumed by the same subgroups of consumers; and 3) the findings in the supermarkets in each capital are representative of the country. In addition, the presence of I-TF in these products may be a marker of I-TF in other products, including products that are not sold in pre-packaged form. Another weakness of the study is that the foods were only bought in large supermarkets or in small ethnic shops with foods from the Balkans. The I-TF content in other foods sold by small, privately owned shops or street vendors was not examined. High amounts of I-TF prolong the shelf life of foods, and it is reasonable to assume that this factor is even more important for small shops than it is for larger supermarkets. The selective pattern of purchasing in the present study may thus have led to an underestimation of the amounts of I-TF consumed by subgroups of the population, such as truck and taxi drivers, manual labourers, and members of minority ethnic

groups, who already have an increased risk of coronary heart disease partly because of lifestyle factors such as smoking, poor diet, and metabolic syndrome.[20]

A legislative limit of industrial trans fat in foods or a voluntary reduction

In 2013, EU countries, with the exceptions of Austria and Denmark, legally allow foods with a maximum amount of I-TF as a percentage of the total fat content (up to 60%) to be sold without notice as long as the food is unpackaged, as it is in restaurants and fast food outlets. If the food is pre-packaged, the law requires the presence of I-TF to be noted only by the term "partially hydrogenated fat" on the list of ingredients. Most consumers do not recognise the hazard concealed therein and will not attempt to decipher the often illegible text in the list of ingredients.[21–23] Societal pressure on food producers has undoubtedly resulted in a reduction in the population-level mean intake of I-TF from 2005 to 2013, especially in Western EU countries,[15] but high intake of I-TF is still possible in Eastern Europe and South-eastern European countries, with no obvious downward trend in the availability of these foods from 2006 to 2013 in three of the countries (figure 3). High intake of I-TF in subgroups will continue as long as popular foods with a high concentration of I-TF are available. Although labelling foods with I-TF content may further reduce the mean intake of I-TF, such labelling still allows for the intake of high amounts because fast food in restaurants is not labelled and because consumers might not pay attention to or understand the labels.[23] An important advantage of a legislative limit on the I-TF content of food is that it does not require that the population learn about the health risks of I-TF or pay attention to the labels of food products. Furthermore, it is much simpler and less expensive to monitor the presence of I-TF in foods than to monitor the actual intake of I-TF in at-risk subgroups of the population.

Because many of the biscuits/cakes/wafers in the supermarkets that were visited did not contain I-TF, a legislative I-TF limit would not affect the supply of these foods and would most likely

moderately affect the production of most food producers. It has been shown that I-TF in cakes, cookies and micro wave popcorn can be replaced by a mixture of saturated, monounsaturated, and polyunsaturated fat, which is a healthier fat composition than a one-to-one substitution of I-TF with saturated fat.[24] A reduction in I-TF content without a commensurate increase in saturated fats was found in fast food purchases in New York City's restaurants after legislative restriction of I-TF in restaurants. [25] The regulations in Austria, Denmark, Switzerland, and Iceland have shown that the health risks of high intake of I-TF can be eliminated for the entire population without any noticeable side effects for consumers. The extent to which the difference in the presence of I-TF in popular foods in Eastern and Western Europe contributes to the much higher mortality from coronary heart disease in Eastern Europe than in Western Europe remains to be determined.[26] The same does the extent to which the more than 70% reduction from 1980 to 2009 in coronary mortality among Danish males and females (the highest reduction in the European Union) is due to a minimal intake of I-TF in all subgroups in Denmark during the latter part of this period .[26]

The effectiveness of policies for reducing dietary TF was recently assessed based on studies published between 2005 and 2012.[27] It was found that "bans were most effective in eliminating TF from the food supply, whereas mandatory TF labelling and voluntary TF limits had a varying degree of success". This statement is strongly supported by the findings in the present study concerning the current availability of popular foods with high amounts of I-TF in Europe.

Contributorship statement:

SS and JD were both responsible for the concept design of the study, for collection of food items, registration and labelling. SS and JD produced the first draft of the study and SS, JD and AA were responsible for critical revision of the manuscript. SS is the manuscripts guarantor.

Competing interest:

No competing interests

"All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work."

Ethics committee:

The study does not require an approval from the Ethics committee

Acknowledgements:

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Role of the funding source:

The sponsor of the study had no role in the study design, data collection, analysis, and interpretation, the writing of the report, or the decision to submit the article for publication. The corresponding author had full access to all of the data for the study and had final responsibility for the decision to submit the manuscript for publication.

Transparency declaration:

Steen Stender (the manuscript's guarantor) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained

Data sharing statements:

The data used to construct figure 1-3 can be shared by emailing Steen Stender

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Legends

Figure 1

Amounts of industrial *trans* fat in 100 grams of pre-packaged biscuits/cakes/wafers bought in three supermarkets in each of 20 European capitals and in Malmö, Sweden in 2012-2013. Each bar in a panel represents a product. The products are ranked according to the content of industrial *trans* fat. Products are only shown if their TF content constitutes more than 2% of the total fat content, and the numbers of these products are shown in each panel. Products were bought if "partially hydrogenated fat" or a similar term was listed high in the list of ingredients and if the food label indicated that the total fat content was equal to or exceeded 15 grams of fat per 100 grams of product. The number in parentheses is the number of foods that fulfilled the inclusion criteria. It was not possible to find products that fulfilled the inclusion criteria in large supermarkets in London, Paris, Berlin, Vienna, Copenhagen, Oslo, and Stockholm. FYROM (The Former Yugoslav republic of Macedonia)

Figure 2

Amounts of industrial *trans* fat in 100 grams of pre-packaged biscuits/cakes/wafers bought in three ethnic shops in five European capitals in 2012-2013 and in Southern Sweden. Each bar in a panel represents a product. The products bought in each city are ranked according to the content of industrial *trans* fat in the product. Products are only shown if their TF content constitutes more than 2% of the total fat content, and the numbers of these products are shown in each panel. Products were bought if "partially hydrogenated fat" or a similar term was listed high in the list of ingredients and if the food label indicated that the total fat content was equal to or exceeded 15 grams of fat per 100 grams of product. The number in parentheses is the number of foods that fulfilled the inclusion criteria.

Figure 3

Amounts of industrial *trans* fat in 100 grams of pre-packaged biscuits/cakes/wafers bought in three supermarkets in each of five capitals in Eastern Europe in 2013. The values from figure 1 are given together with values obtained using the same procedure in 2006.

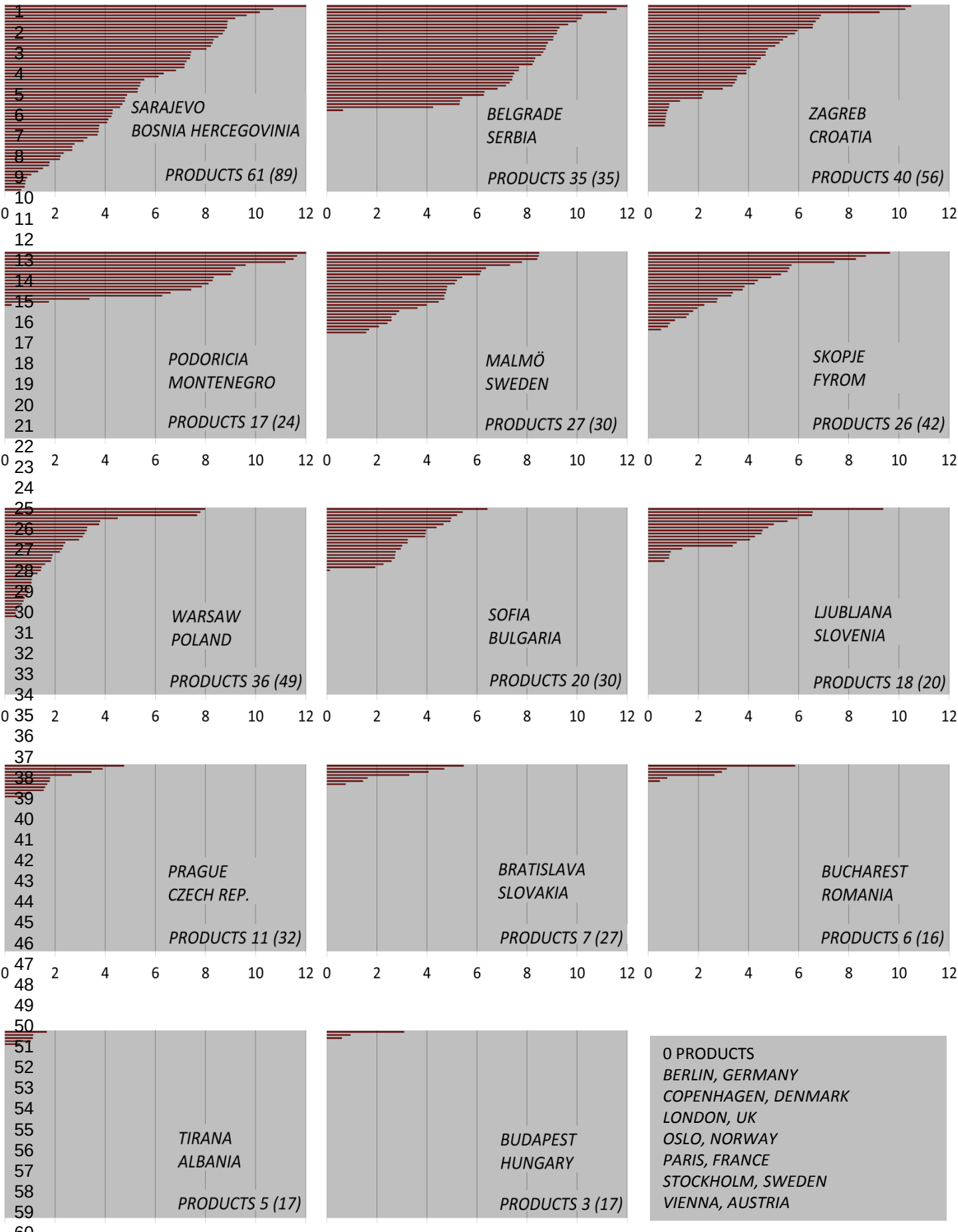
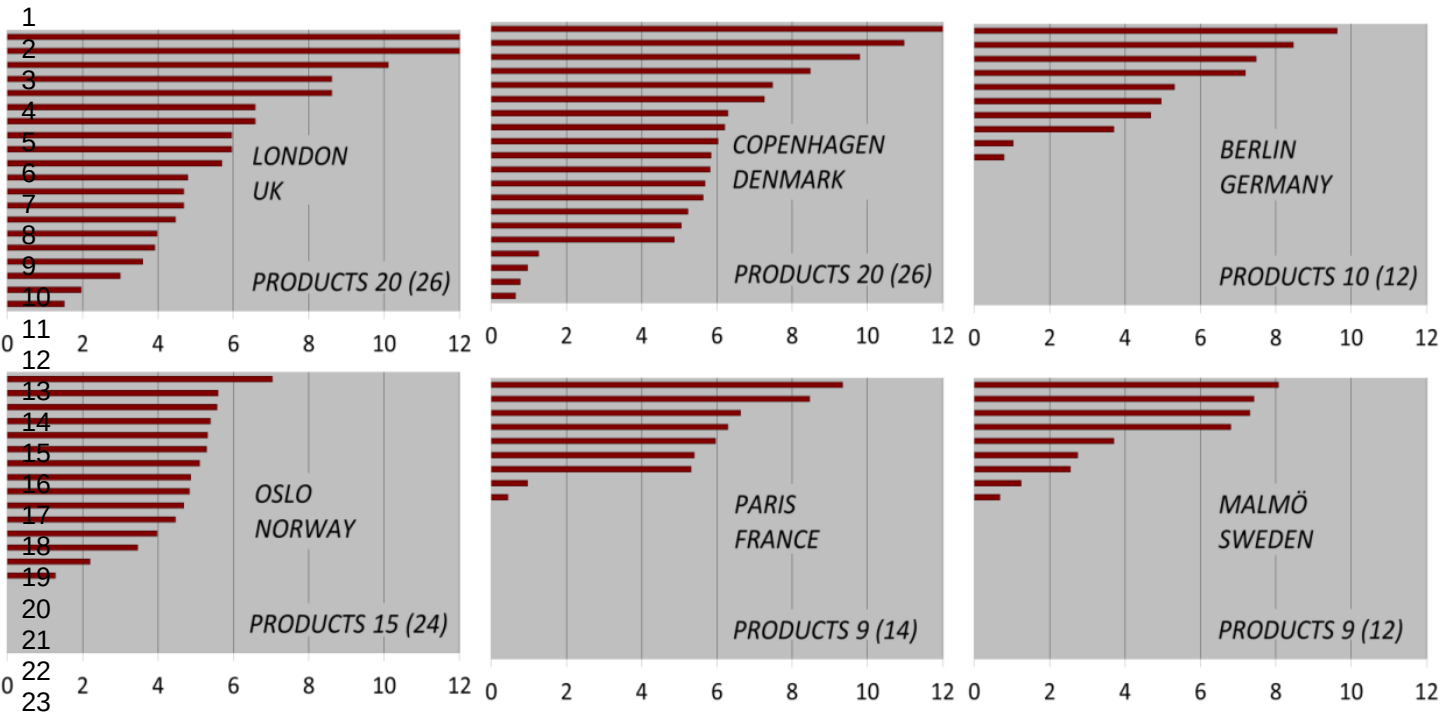
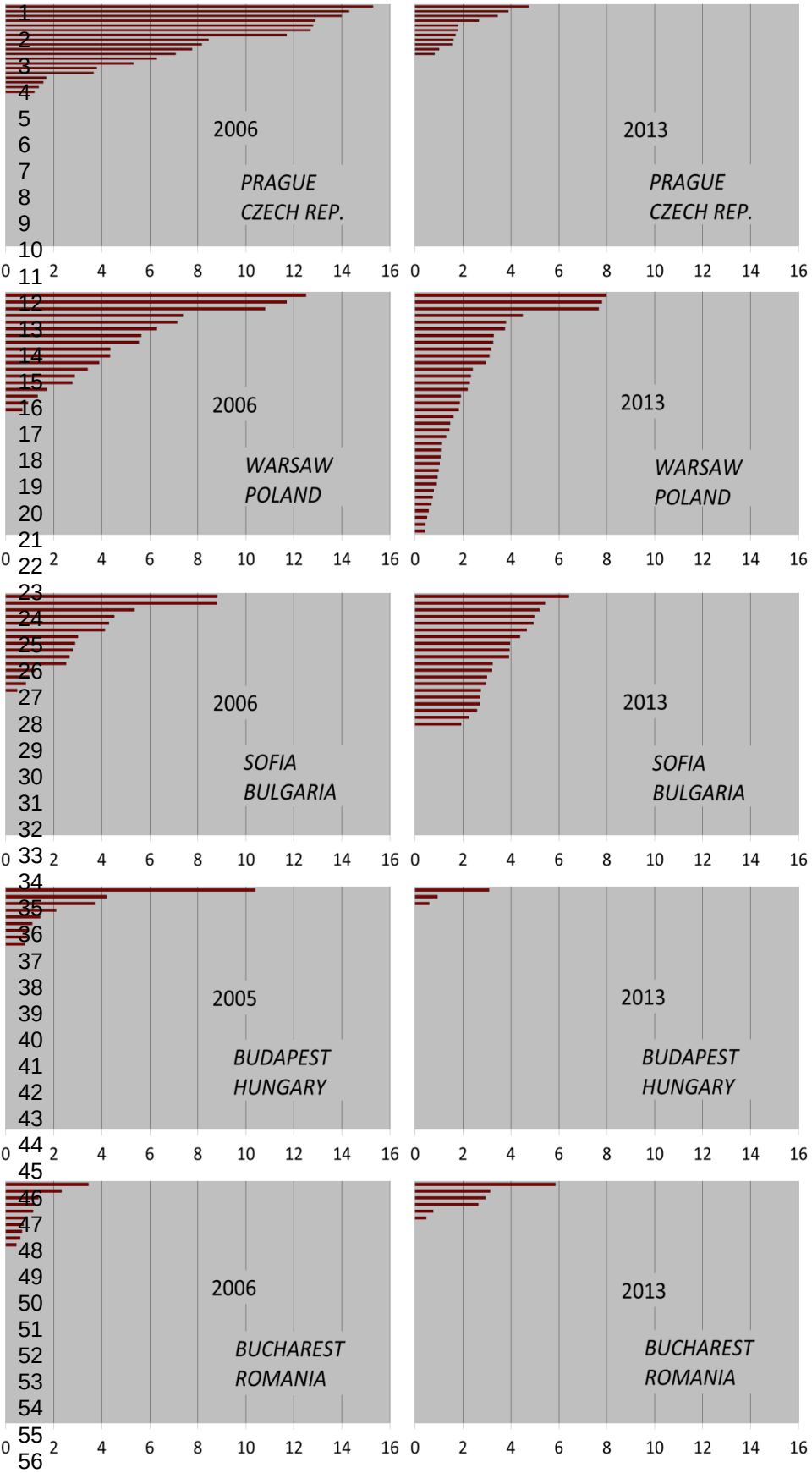


Figure 2


LONDON
UK
PRODUCTS 20 (26)
COPENHAGEN
DENMARK
PRODUCTS 20 (26)
BERLIN
GERMANY
PRODUCTS 10 (12)
OSLO
NORWAY
PRODUCTS 15 (24)
PARIS
FRANCE
PRODUCTS 9 (14)
MALMÖ
SWEDEN
PRODUCTS 9 (12)
0 2 4 6 8 10 12
Gram trans fat per 100 gram product


2006
PRAGUE
CZECH REP.
2013
PRAGUE
CZECH REP.
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WARSAW
POLAND
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BULGARIA
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BUDAPEST
HUNGARY
2013
BUDAPEST
HUNGARY
2006
BUCHAREST
ROMANIA
2013
BUCHAREST
ROMANIA
0 2 4 6 8 10 12 14 16
Gram trans fat per 100 gram product

Industrial *trans* fat in popular foods is still a health issue in Europe: a market basket investigation

This paper is a rather special epidemiologic observational study: a market basket investigation. We have gone through the various 22 points in the STROBE checklist and have made sure that relevant points for this study are fulfilled. FOR EACH ITEM NO WE HAVE ADDED THE PAGE NUMBER IN CAPITALS FOR THE PAGES WITH THE APPROPRIATE SENTENCES

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract PAGE 1"market basket investigation"
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found PAGE 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported PAGE 3
Objectives	3	State specific objectives, including any prespecified hypotheses PAGE 4
Methods		
Study design	4	Present key elements of study design early in the paper PAGE 4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection. PAGE 5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants HERE IT IS FOOD PRODUCTS DESCRIBED AT PAGE 5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable NOT APPLICABLE
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group AMOUNTS OF TRANS FAT PAGE 6
Bias	9	Describe any efforts to address potential sources of bias ANALYTICAL BIAS IN TRANS FAT RESULTS WERE ADDRESSED BY CHOOSING AN ISO_CERTIFIED LABORATORY PAGE 6
Study size	10	Explain how the study size was arrived at PAGE 4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why FIG1-3; PAGE 6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding NOT RELEVANT IN THIS PAPER
		(*b*) Describe any methods used to examine subgroups and interactions NOT RELEVANT IN THIS PAPER
		(*c*) Explain how missing data were addressed NOT RELEVANT IN THIS PAPER
		(*d*) If applicable, describe analytical methods taking account of sampling strategy NOT RELEVANT IN THIS PAPER

		(*e*) Describe any sensitivity analyses NOT RELEVANT IN THIS PAPER
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed FIGURE 1 AND 2
		(b) Give reasons for non-participation at each stage NOT RELEVANT IN THIS PAPER
		(c) Consider use of a flow diagram NOT RELEVANT IN THIS PAPER
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders PRE-PACKAGED BISCUITS/CAKES/WAFERS PAGE 5
		(b) Indicate number of participants with missing data for each variable of interest NOT RELEVANT IN THIS PAPER
Outcome data	15*	Report numbers of outcome events or summary measures FIGURE 1-3 AND " Of the 312 products made by 51 factories in 15 European countries, 40% of the products had more than 20% of the fat as I-TF" PAGE 6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included NOT RELEVANT IN THIS PAPER
		(*b*) Report category boundaries when continuous variables were categorized NOT RELEVANT IN THIS PAPER
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period NOT RELEVANT IN THIS PAPER
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses NOT RELEVANT IN THIS PAPER
Discussion		
Key results	18	Summarise key results with reference to study objectives PAGE 7
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias PAGE 9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence PAGE 11
Generalisability	21	Discuss the generalisability (external validity) of the study results PAGE 9
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based PAGE 13

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Tracing artificial trans fat in popular foods in Europe: a market basket investigation

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Tracing artificial trans fat in popular foods in Europe: a market basket investigation

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Abstract

Objective: To minimise the intake of industrial artificial *trans* fat (I-TF), nearly all European countries rely on food producers to voluntarily reduce the I-TF content in food. The objective of this study was to investigate the effect of this strategy on I-TF content in pre-packaged biscuits/cakes/wafers in 2012-2013 in 20 European countries.

Design: The I-TF content was assessed in a market basket investigation. Three large supermarkets were visited in each capital, and in some countries, three additional ethnic shops were included.

Results: A total of 598 samples of biscuits/cakes/wafers with "partially hydrogenated vegetable fat" or a similar term high on the list of ingredients were analysed, 312 products had more than 2 % of fat as I-TF, exceeding the legislatively determined I-TF limit in Austria and Denmark; the mean (SD) was 19(7)%. In seven countries, no I-TF was found, whereas nine predominantly Eastern European countries had products with very high I-TF content, and the remaining four countries had intermediate levels. Of the five countries that were examined using the same procedure as in 2006, three had unchanged I-TF levels in 2013, and two had lower levels. The 18 small ethnic shops examined in six Western European countries sold 83 products. The mean(SD) was 23(12)% of the fat as I-TF, all imported from countries in Balkan. In Sweden, this type of food imported from Balkan was also available in large supermarkets.

Conclusion: The findings suggest that subgroups of the population in many countries in Europe still consume I-TF in amounts that increase their risk of coronary heart disease. Under current EU legislation, the sale of products containing I-TF is legal but conflicts with the WHO recommendation to minimise the intake of I-TF. An EU-legislative limit on I-TF content in foods is expected to be an effective strategy to achieve this goal.

Strengths and limitations of this study

- A strength is the measurement of TF in many popular foods obtained in large supermarkets in 20 different EU countries in 2012-13, and in popular foods obtained in ethnic shops in Berlin, Paris, London, Malmö and Copenhagen.

- In South-eastern Europe foods with high amounts of I-TF are present in large supermarkets and the same brands of foods with high amounts of I-TF are present in ethnic shops in Western Europe.
- Foods with high amounts of I-TF produced in some countries in Europe are legally exported to many other European countries.
- A limitation is that the average daily intake of I-TF was not measured, but instead inferred from the presence of popular foods with high amounts of I-TF in large super markets and in small ethnic shops.

Introduction

Trans fat (TF) in food originates from the industrial hydrogenation of oils and from ruminant sources. Compared to non-hydrogenated oils, fats containing industrially produced artificial *trans* fat are solid at room temperature, have some technical advantages for food processing, and prolong the shelf life of products. I-TF can constitute up to 60% of the fat in certain foods, whereas ruminant fat contains 6% TF at most.[1] A meta-analysis of four large prospective studies found that an average intake of approximately five grams per day of TF, corresponding to 2% of the total energy intake, was associated with a 23% increase in the risk of coronary heart disease.[2] More recently, TF intake has also been associated with all-cause mortality in a large US-based study.[3] A 2013 review concluded that "the detrimental effects of industrial *trans* fatty acids on heart health are beyond dispute".[4] Furthermore, inverse associations have been observed between TF and essential long-chain polyunsaturated fatty acids in the blood lipids of pregnant women and their offspring at birth as well as in human milk. Because the latter fatty acids are important for neurodevelopment in

infancy, the potential untoward effect of TF exposure caused by fatty acid competition in the brain has received increased attention.[5-7]

Based on the relationship between the intake of I-TF and heart disease, for years several public health organisations have recommended that I-TF intake be lowered as much as possible.[8-10]

In 2003, Denmark introduced a legislative sales ban aimed at the final consumer, limiting the I-TF content in the fat of foods to a maximum of 2%. The legislation applies to locally produced as well as imported foods. The European Commission initially opposed this legislation but dropped its infringement proceedings in March 2007 because of increasing scientific evidence about the dangers of *trans* fat.[11] In 2005, Canada introduced mandatory labelling of the I-TF content in pre-packaged foods. The US introduced mandatory labelling of TF on pre-packaged foods in 2006, (US foods could be labelled "zero TFA" even if they contained 0.5 g per serving) followed by legislative limits on I-TF in the food served in restaurants in New York City in 2008, and in the state of California in 2010-11. FDA has proposed that partially hydrogenated oils, the source of I-TF, no longer be "generally recognized as safe." That means food companies would have to prove that such oils are safe to eat. [12] In Europe in 2009, Austria and Switzerland introduced a legislative ban similar to the Danish regulation, followed by Iceland in 2011 and probably by Sweden, Hungary, and Norway in 2014.[13-15] However, in 2014, only a minority of the population in the EU (i.e. less than 50 million of the 500 million people in the EU) is protected by legislation that makes it illegal to sell foods with high amounts of I-TF to the final consumer.

The purpose of the present study is to examine whether there still is a potentially negative health impact on vulnerable populations due to intake of I-TF contained in pre-packaged biscuits/cakes/wafers in 20 European countries. These food items were chosen as they are frequently consumed and easily accessible. They furthermore traditionally contain I-TF rich

partially hydrogenated vegetable oils as their major lipid ingredient.[16] Removal of I-TF in this category of food has been slower than in other food categories.[17] I-TF content in these foods may be a marker of I-TF in other products including products that are not sold in pre-packaged form.

The inclusion criteria for the food samples were defined based on the list of ingredients printed on the packing. The same procedure was used in similar studies in 2006 and 2009.[18,19] We further investigated whether products with high I-TF produced in some European countries were disseminated to other European countries, including ethnic shops. The findings may be relevant to the future regulation of the I-TF content in foods in the EU.[20] By December 2014, the Commission, taking into account scientific evidence and experience acquired in Member States, intents to submit a report on the presence of *trans* fats in foods. The aim of the report is to promote the provision of healthier food options to consumers including the provision of information on *trans* fat or restrictions on their use. The Commission shall accompany this report with a legislative proposal, if appropriate.

Methods

Purchase of biscuits/cakes/wafers in supermarkets

The 20 countries visited encompass the countries in former Yugoslavia, its neighbouring countries, three Scandinavian, and three large countries in northern Europe: Germany, France, and UK.

The main tourist office in the capital of each country was asked to identify three large supermarkets, preferably chain supermarkets with many large shops across the country. In several capitals, the same stores visited in 2006 and in 2009 were visited in this study.[18-19]

Inclusion criteria

As in the previous studies, packages of biscuits/cakes/wafers were obtained by systematically examining the labels of the products placed on the appropriate shelves in the biscuits/cakes/wafers section in the supermarket.

Packages were purchased

- If "partially hydrogenated fat" or a similar term was listed among the first 4 on the list of ingredients (ranked according to content) and:
- If total fat content was equal to or exceeded 15 grams of fat per 100 grams of product, since high fat food is generally defined as food containing more than 15-20 gram of total fat per 100 gram food. [21]
- If the label indicated the amount of *trans* fat per serving.
- If the same product appeared in packages of different sizes, only the smallest size was bought.
- If exactly the same package was found in two different supermarkets in the same capital, only the one with the latest "best before date" was included in the study.

The packages from the three supermarkets in each capital were labelled and photographed, the package was opened, and two identical 50- to 100-gram samples of the food were placed in appropriately labelled plastic bags. All the empty packages were stored, as were the receipts from the purchases. The name of the product, producer, country of origin, "best before" date, and the languages used in the list of ingredients were recorded.

Between May 2012 and September 2013, 454 packages were purchased in 60 supermarkets in the capitals of Albania, Austria, Bosnia-Herzegovina, Bulgaria, Croatia, Denmark, France, Germany, Hungary, The Former Yugoslav republic of Macedonia, Montenegro, Poland, Norway, Romania, Serbia, Slovakia, Sweden, the Czech Republic, and the United Kingdom. In addition, 30 packages were bought in three large supermarkets in Malmö, the third largest city in Sweden.

Purchase of biscuits/cakes/wafers in ethnic shops

Because our analysis of the biscuits/cakes/wafers from supermarkets in the Balkan capitals yielded a relatively high number of foods with high amounts of I-TF, we decided to search for these types of Balkan foods in other countries using Google (search term: name of capital and "Balkan foods") to identify ethnic shops selling Balkan foods. Three different shops were visited in Berlin, Copenhagen, London, Oslo, and Paris and in addition in Malmö. A total of 114 pre-packaged biscuits/cakes/wafers were purchased in these shops using the same inclusion criteria and sampling procedure as were used for the purchases in supermarkets.

Analysis of TF

The foods were homogenised, and the fatty acid content was analysed using gas chromatography on a 60-metre highly polar capillary column using a modification of the AOAC 006·06 method. The analytical work was conducted by Microbac Laboratories, Warrendale, Pennsylvania, US, an ISO-17025-certified laboratory.

Results

I-TFA content in pre-packaged biscuits / cakes / wafers

The I-TF content in the 312 products bought in the three supermarkets in each country was ranked according to I-TF level expressed in grams per 100 grams of the product (figure 1). Each bar in each panel represents a product. Only products with more than 2% of the fat content as TF are shown. The first number given in the panel is the number of products with more than 2% of the fat content as TF. The number in parentheses is the number of products that fulfilled the inclusion criteria. The difference between the two numbers reflects the number of samples that did not

contain appreciable amounts of TF despite the information on the label. The panels are ranked according to the sum of I-TF concentrations in the different products.

Dissemination across countries

The highest amount was found in Bosnia Herzegovina, followed by Serbia. Of the 312 products made by 51 food producers in 15 European countries, 40% of the products had more than 20% of the fat as I-TF with a mean(SD) of 32(7) %. We found 212 different products with more than 2 % I-TFA in the fat. Only 10 food producers provided together 110 of the products i.e. about 50%. One producer provided 30 different products. In the supermarkets in the capitals of Austria, Denmark, France, Germany, Norway, Sweden, and the UK, no samples were found that fulfilled the inclusion criteria (figure 1, lower right panel). The panel for three supermarkets in Malmö, Sweden was similar to the panels for Podgorica, Montenegro, Skopje and The Former Yugoslav republic of Macedonia, and was very different from the zero values found in the supermarkets in Copenhagen, Oslo, and Stockholm.

Ethnic shops

A total of 83 packages of biscuits/cakes/wafers with high amounts of TF were bought in the ethnic shops in five capitals and in Malmö; this number varied between nine and 20 for each shop (figure 2). Furthermore, 60% of the products had more than 20% of the fat as I-TF with a mean(SD) of 30(9) %. Many of the products were the same in the six countries. These foods were also found in Copenhagen, which is surprising because their sale is illegal in Denmark, in contrast to the other countries in which the foods were found.

Comparison between 2006 and 2013

In Poland, Bulgaria, and Romania, there were no obvious changes in the presence of many products with high I-TF between 2006 and 2013 (figure 3). The products in these countries were primarily

from local food producers. Hungary and, especially, the Czech Republic showed a decline in high-I-TF foods during the same period.

Discussion

Products with industrial *trans* fat in supermarkets

In each of 20 European capitals, three large supermarkets were visited in 2012-13, and in five of the capitals and in Malmö, Sweden, an additional three ethnic shops were visited. A total of 598 packages containing biscuits/cakes/wafers were bought and analysed for TF content, and 396 of these products contained high amounts of I-TF (more than 2 grams per 100 grams of fat). In 25 different products, the I-TF content was higher than 40 grams per 100 grams of fat. Similarly high values of I-TF in foods bought in Poland and in Serbia have also been reported in Polish and Serbian studies.[22,23] The findings clearly demonstrate that I-TF is still present in 2013 in high concentrations in popular foods in many countries in Europe (figures 1 and 2).

Some foods with partially hydrogenated fat or a similar term in the list of ingredients did not contain significant amounts of TF based on a chemical analysis. A mixture of *cis* unsaturated fat and fully hydrogenated fat without TF is understood by some food producers to be partially hydrogenated fat.

In all 20 countries except for Denmark and Austria, it is legal to use as much I-TF in foods as technically possible without providing the quantity on the list of ingredients. Governments and consumer associations strive to follow the recommendations of the WHO. The voluntary reduction in the amount of I-TF in foods by food producers appears to work well in some countries, but not in others. Food producers in a given country or in neighbouring countries may remove I-TF from their products, but importing products with high I-TF content from more distant countries may counteract the initiatives, as demonstrated in the supermarkets in southern Sweden (figure 1, panel

4). Based on previous measurements, the I-TF content in biscuits/cakes/wafers from supermarkets in Germany, France, and the UK was nearly eliminated between 2005 and 2009,[19] and no products with significant amounts of TF were found in 2013 (figure 1). This result contrasts with the situation in Poland, Bulgaria, and Romania, where there were no obvious changes in the presence of I-TF in foods between 2006 and 2013 (figure 3). The products in these countries were primarily from local food producers. Hungary and, especially, the Czech Republic showed a decline in high-I-TF foods during the same period.

Products with industrial *trans* fat in ethnic shops

Although the number of consumers who regularly buy food in ethnic shops may be lower than the number of consumers who purchase food in large supermarkets, the harmful effect of I-TF is still present. Studies from Sweden suggest that mortality due to heart disease among immigrants exceeds the mortality rate in the indigenous population [24-26]. Using the same Internet procedure that was used to identify shops with Balkan foods in other countries, three ethnic shops where pre-packaged biscuits/cakes/wafers with high amounts I-TF were available were found in Copenhagen. These sales are illegal and can be stopped immediately by the food authorities, if they desire.[27]

In Southern Sweden, biscuits/cakes/wafers with high amounts of I-TF are present not only in small ethnic shops (figure 2) but also in large supermarkets (figure 1). This type of product has spread from the small ethnic shops to large supermarkets, suggesting considerable sales of these products, which remain legal in Sweden. The Swedish parliament decided in 2011 that Sweden should adopt the same I-TF legislation as Denmark, but the Swedish government decided to postpone the implementation on the advice of the Swedish food authorities because they found that all of the large food suppliers in Sweden, Norway, and Denmark had removed I-TF from products sold in Sweden.[13] They did not take into account the free flow of goods across borders in Europe. Many

products with high amounts of I-TF have ingredient lists in more than 10 different languages, suggesting that they are potentially exported to many different countries. Retailers distributing these foods are present in Sweden and in other European countries, and the majority of products with high amounts of I-TF can be bought on the Internet, which is legal for private consumption only. Although foods with high amounts of I-TF were not found in large supermarkets in other Western countries, the Swedish story may repeat elsewhere.

The strength of this study is that it provides up-to-date data about the availability of popular foods containing high amounts of I-TF in 20 European countries. One weakness of the study is that the average daily intake of I-TF was not measured in subgroups of the population in the various countries but instead was inferred from the presence of biscuits/cakes/wafers with high amounts of I-TF in large supermarkets. The following assumptions led to the conclusion that these products have harmful effects: 1) the analysed brands of biscuits/cakes/wafers were stocked at the supermarkets because they are sold in considerable amounts; 2) the majority of these foods are regularly bought and consumed by the same subgroups of consumers; and 3) the findings in the supermarkets in each capital are representative of the country. In addition, it is likely that the presence of I-TF in biscuits/cakes/wafers is a marker of a more widespread use of I-TF in other foods, including products that are not sold in pre-packaged form suggesting a higher intake of I-TF than that from biscuits/cakes/wafers. Another weakness of the study is that the foods were only bought in large supermarkets or in small ethnic shops with foods from the Balkans. The I-TF content in other foods sold by small, privately owned shops or street vendors was not examined. High amounts of I-TF prolong the shelf life of foods, and it is reasonable to assume that this factor is even more important for small shops than it is for larger supermarkets. The selective pattern of purchasing in the present study may thus have led to an underestimation of the amounts of I-TF consumed by subgroups of the population, such as truck and taxi drivers, manual labourers, and

members of minority ethnic groups, who already have an increased risk of coronary heart disease partly because of lifestyle factors such as smoking, poor diet, and metabolic syndrome.[28]

A legislative limit of industrial *trans* fat in foods or a voluntary reduction?

EU countries, with the exceptions of Austria and Denmark, legally allow foods with a high amount of I-TF as a percentage of the total fat content (up to 60%) to be sold without notice as long as the food is unpackaged, as it is in restaurants and fast food outlets. If the food is pre-packaged, the law requires the presence of I-TF to be noted only by the term "partially hydrogenated fat" on the list of ingredients. Most consumers do not recognise the hazard concealed therein and will have difficulties in, or not attempt to decipher the often illegible text in the list of ingredients.[29-31] Societal pressure on food producers has undoubtedly resulted in a reduction in the population-level mean intake of I-TF from 2005 to 2013, especially in Western EU countries[19], but high intake of I-TF is still possible in Eastern Europe and South-eastern European countries, with no obvious downward trend in the availability of these foods from 2006 to 2013 in three of the countries (figure 3). High intake of I-TF in subgroups will continue as long as popular foods with a high concentration of I-TF are available. Although labelling foods with I-TF content may further reduce the mean intake of I-TF, such labelling still allows for the intake of high amounts because fast food in restaurants is not labelled and because consumers might not pay attention to or understand the labels.[31] An important advantage of a legislative limit on the I-TF content of food is that it does not require that the population learn about the health risks of I-TF or pay attention to the labels of food products. Furthermore, it is simpler and less expensive to monitor the presence of I-TF in foods at the sales level than to monitor the actual intake of I-TF at the individual level in at-risk subgroups of the population.

Because many of the biscuits/cakes/wafers in the supermarkets that were visited did not contain I-TF, a legislative I-TF limit would not affect the supply of these foods and would most likely moderately affect the production of most food producers. It has been shown that I-TF in cakes, cookies and micro wave popcorn can be replaced by a mixture of saturated, monounsaturated, and polyunsaturated fat, which is a healthier fat composition than a one-to-one substitution of I-TF with saturated fat.[32] A reduction in I-TF content without a commensurate increase in saturated fats was found in fast food purchases in New York City's restaurants after legislative restriction of I-TF in restaurants.[33] The regulations in Austria, Denmark, Switzerland, and Iceland have shown that the health risks of high intake of I-TF can be eliminated for the entire population without any noticeable side effects for consumers. The extent to which the difference in the presence of I-TF in popular foods in Eastern and Western Europe contributes to the much higher mortality from coronary heart disease in Eastern Europe than in Western Europe remains to be determined.[34] It also needs to be determined to which extent the approximate 70% reduction (the highest reduction in the European Union from 1980 to 2009) in coronary mortality among Danish males and females is actually due to a minimal intake of I-TF in all subgroups in Denmark during the latter part of this period .[34] The effectiveness of policies for reducing dietary TF was recently assessed based on studies published between 2005 and 2012.[17] It was found that "bans were most effective in eliminating TF from the food supply, whereas mandatory TF labelling and voluntary TF limits had a varying degree of success". This statement is strongly supported by the findings in the present study concerning the current availability of popular foods with high amounts of I-TF in Europe, thus lending support for a legislative *trans* fat restriction by the EU. This is a low hanging fruit to pick in the prevention of coronary heart disease among 500 million EU citizens.

Contributors:

SS and JD were both responsible for the concept design of the study, for collection of food items, registration and labelling. SS and JD produced the first draft of the study and SS, JD and AA were responsible for critical revision of the manuscript. SS is the manuscripts guarantor.

Competing interest:

No competing interests

"All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work."

Ethics committee:

The study does not require an approval from the Ethics committee

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Copyright statement:

Transparency declaration:

Steen Stender (the manuscript's guarantor) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been

omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained

Data sharing statements:

The data used to construct figure 1-3 can be shared by emailing Steen Stender

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Legends

Figure 1

Amounts of industrially produced artificial *trans* fat (I-TF) in 100 grams of pre-packaged biscuits/cakes/wafers with more than 2% I-TF of the total fat content, bought in three supermarkets in each of 20 European capitals and in Malmö, Sweden in 2012-2013. Each bar in a panel represents a product. N is the number of products. The number in parentheses is the number of foods that fulfilled the inclusion criteria.

$\bar{x}$ (SD) is the mean value of I-TF% of total fat in the products shown in the panel. FYROM (The Former Yugoslav Republic of Macedonia).No products fulfilled the inclusion criteria in supermarkets in London, Paris, Berlin, Vienna, Copenhagen, Oslo, and Stockholm.

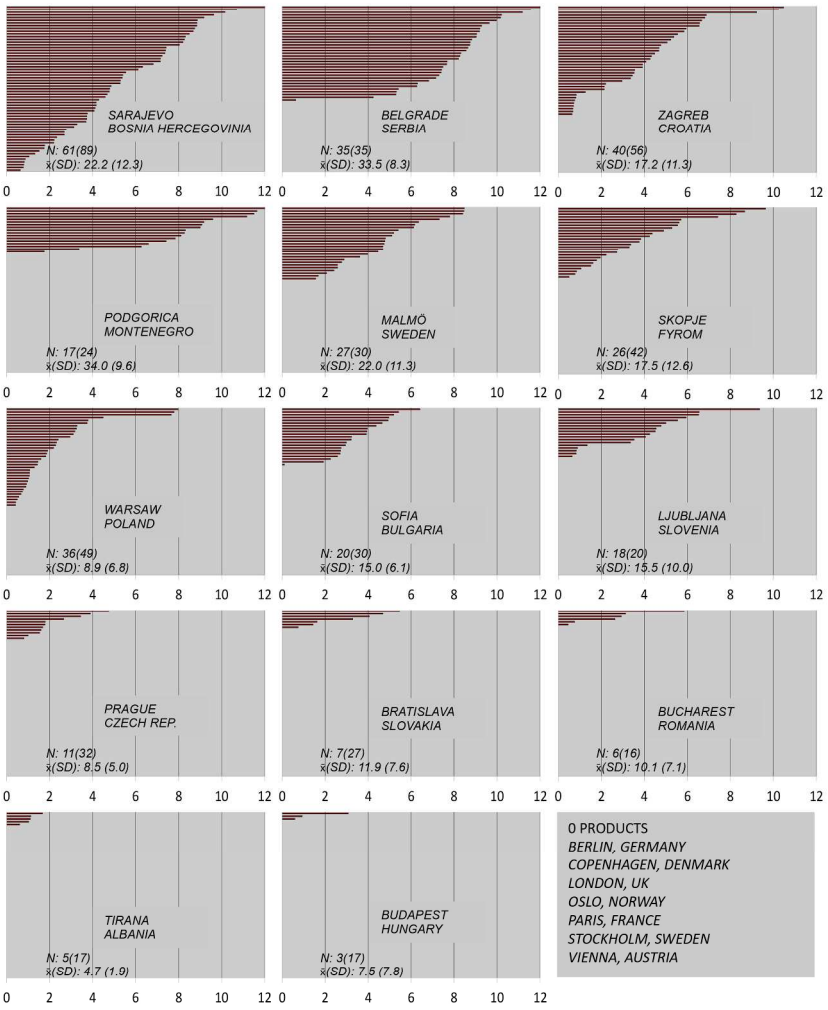
Figure 2

Amounts of industrially produced artificial *trans* fat (I-TF) in 100 grams of pre-packaged biscuits/cakes/wafers with more than 2% I-TF of the total fat content bought in three ethnic shops in five European capitals in 2012-2013 and in Southern Sweden. Each bar in a panel represents a product. N is the number of products. The number in parentheses is the number of foods that fulfilled the inclusion criteria. $\bar{x}$ (SD) is the mean value of I-TF% of total fat in the products shown in the panel.

Figure 3

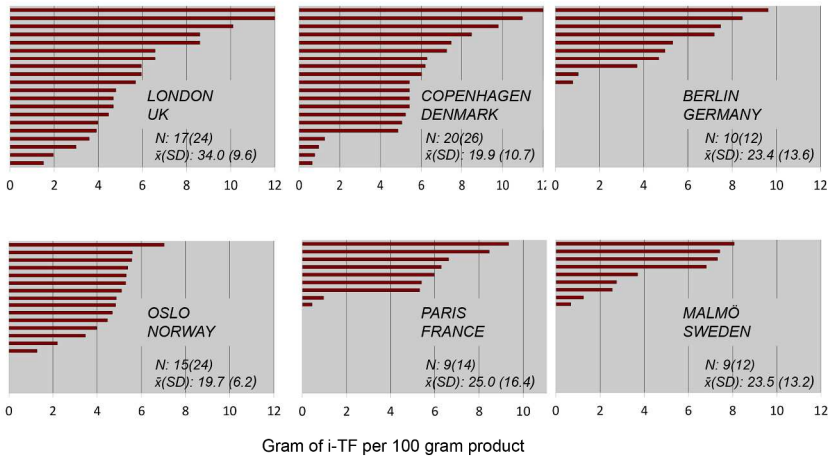
Amounts of industrially produced artificial *trans* fat (I-TF) in 100 grams of pre-packaged biscuits/cakes/wafers with more than 2% I-TF of the total fat content bought in three supermarkets in each of five capitals in Eastern Europe in 2006 and 2013. $\bar{x}$ (SD) is the mean value of I-TF% of total fat in the products shown in the panel.

Figure 1



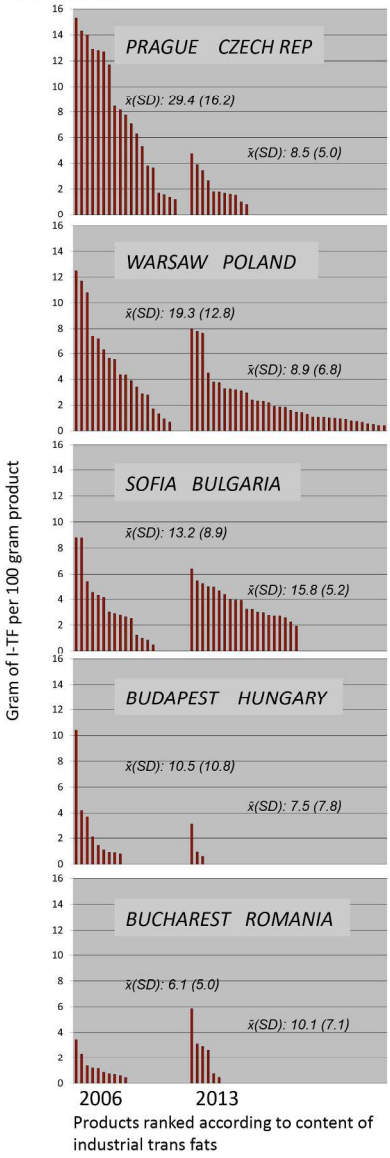
190x275mm (300 x 300 DPI)

Figure 2



190x275mm (300 x 300 DPI)

FIGURE 3



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Industrial *trans* fat in popular foods is still a health issue in Europe: a market basket investigation

This paper is a rather special epidemiologic observational study: a market basket investigation. We have gone through the various 22 points in the STROBE checklist and have made sure that relevant points for this study are fulfilled. FOR EACH ITEM NO WE HAVE ADDED THE PAGE NUMBER IN CAPITALS FOR THE PAGES WITH THE APPROPRIATE SENTENCES

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract PAGE 1"market basket investigation"
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found PAGE 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported PAGE 3
Objectives	3	State specific objectives, including any prespecified hypotheses PAGE 4
Methods		
Study design	4	Present key elements of study design early in the paper PAGE 4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection. PAGE 5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants HERE IT IS FOOD PRODUCTS DESCRIBED AT PAGE 5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable NOT APPLICABLE
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group AMOUNTS OF TRANS FAT PAGE 6
Bias	9	Describe any efforts to address potential sources of bias ANALYTICAL BIAS IN TRANS FAT RESULTS WERE ADDRESSED BY CHOOSING AN ISO_CERTIFIED LABORATORY PAGE 6
Study size	10	Explain how the study size was arrived at PAGE 4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why FIG1-3; PAGE 6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding NOT RELEVANT IN THIS PAPER
		(*b*) Describe any methods used to examine subgroups and interactions NOT RELEVANT IN THIS PAPER
		(*c*) Explain how missing data were addressed NOT RELEVANT IN THIS PAPER
		(*d*) If applicable, describe analytical methods taking account of sampling strategy NOT RELEVANT IN THIS PAPER

		(*e*) Describe any sensitivity analyses NOT RELEVANT IN THIS PAPER
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed FIGURE 1 AND 2
		(b) Give reasons for non-participation at each stage NOT RELEVANT IN THIS PAPER
		(c) Consider use of a flow diagram NOT RELEVANT IN THIS PAPER
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders PRE-PACKAGED BISCUITS/CAKES/WAFERS PAGE 5
		(b) Indicate number of participants with missing data for each variable of interest NOT RELEVANT IN THIS PAPER
Outcome data	15*	Report numbers of outcome events or summary measures FIGURE 1-3 AND " Of the 312 products made by 51 factories in 15 European countries, 40% of the products had more than 20% of the fat as I-TF" PAGE 6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included NOT RELEVANT IN THIS PAPER
		(*b*) Report category boundaries when continuous variables were categorized NOT RELEVANT IN THIS PAPER
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period NOT RELEVANT IN THIS PAPER
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses NOT RELEVANT IN THIS PAPER
Discussion		
Key results	18	Summarise key results with reference to study objectives PAGE 7
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias PAGE 9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence PAGE 11
Generalisability	21	Discuss the generalisability (external validity) of the study results PAGE 9
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based PAGE 13

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.