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Intake of fatty acids in Western Europe with emphasis on *trans* fatty acids: The TRANSFAIR study

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Objective: To assess the intake of *trans* fatty acids (TFA) and other fatty acids in 14 Western European countries.
Design and subjects: A maximum of 100 foods per country were sampled and centrally analysed. Each country calculated the intake of individual *trans* and other fatty acids, clusters of fatty acids and total fat in adults and/or the total population using the best available national food consumption data set.
Results: A wide variation was observed in the intake of total fat and (clusters) of fatty acids in absolute amounts. The variation in proportion of energy derived from total fat and from clusters of fatty acids was less. Only in Finland, Italy, Norway and Portugal total fat did provide on average less than 35% of energy intake. Saturated fatty acids (SFA) provided on average between 10% and 19% of total energy intake, with the lowest contribution in most Mediterranean countries. TFA intake ranged from 0.5% (Greece, Italy) to 2.1% (Iceland) of energy intake among men and from 0.8% (Greece) to 1.9% among women (Iceland) (1.2–6.7 g/d and 1.7–4.1 g/d, respectively). The TFA intake was lowest in Mediterranean countries (0.5–0.8 en%) but was also below 1% of energy in Finland and Germany. Moderate intakes were seen in Belgium, The Netherlands, Norway and UK and highest intake in Iceland. *Trans* isomers of $C_{18:1}$ were the most TFA in the diet. Monounsaturated fatty acids contributed 9–12% of mean daily energy intake (except for Greece, nearly 18%) and polyunsaturated fatty acids 3–7%.
Conclusion: The current intake of TFA in most Western European countries does not appear to be a reason for major concern. In several countries a considerable proportion of energy was derived from SFA. It would therefore be prudent to reduce intake of all cholesterol-raising fatty acids, TFA included.
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Descriptors: diet; total fat; *trans* and other fatty acids; Western European countries

Introduction

The relation between dietary intake of fatty acids, blood cholesterol levels and risk for cardiovascular disease has been an important research topic during recent decades. At the moment, there is a consensus that consumption of foods rich in saturated fatty acids and cholesterol promotes the risk of ischaemic heart disease and expert committees worldwide have recommended that the intake of such fats be reduced (Katan, 1997). However, there is no universal agreement as to which foods should replace them (Connor & Connor, 1997; Katan, 1997; Katan *et al*, 1997). Recent scientific data suggest a more complicated relationship between fatty acids and cardiovascular health. Among the saturated fatty acids (SFA), $C_{12:0}$ to $C_{16:0}$ may be particularly cholesterol-raising, whereas $C_{18:0}$ may be neutral in its effect on serum cholesterol (Katan *et al*, 1994). Among the unsaturated fatty acids (UFA), distinction between *cis* (CIS UFA) and *trans* isomers (TFA) and the health implications thereof has recently caused much scientific and public turmoil (Mensink & Katan, 1990; Willet *et al*, 1993; Willet and Ascherio, 1994). TFA are found in products originating from ruminant animals and in partially hydrogenated fats that are the result of the hardening process of vegetable oils in, for example, margarines, shortenings, frying fats. The *trans* configuration of unsaturated fatty acids resembles the straight chain of saturated fatty acids and human feeding studies have shown them to have cholesterol-raising effects (Zock and Katan, 1992; Ascherio *et al*, 1994; Judd *et al*, 1994). Epidemiological studies from the United States caused worldwide concern, since in these studies intake of TFA was associated with considerably increased cardiovascular risk (Willet *et al*, 1993). However, subsequent studies, including European ones, yielded conflicting results (Mensink & Katan, 1990; Aro *et al*, 1995; Van de Vijver *et al*, 1996).

For a comprehensive evaluation of the public health impact of TFA, more precise information on *trans* fatty acid intake is necessary. Given the physiological effects of other fatty acids for which TFAs might be a substitute, this evaluation should include the relation of TFA intake with intake of other fatty acids, particularly that of the saturated fatty acids. Estimates of TFA intake vary between 8.1 and 12.8 g/day in the United States, and between 2.4 and 17.4 g/day in Europe (Boatella *et al*, 1993; Precht & Molkentin, 1995; Becker 1996). Differences in estimates

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can be attributed partly to differences in food consumption data used and lack of information on actual TFA content of foods. Most of the estimations are based on limited food consumption data together with older databases of TFA levels in foods. Moreover, insight into the distribution of *trans* fatty acid intake within groups of the population is lacking, more so in different European countries with varying dietary patterns. The European TRANSFAIR study aims to provide reliable and comparable data on TFA content of foods and to estimate intake of TFA and other fatty acids in European countries in a uniform way by linking these data with available food consumption data for the participating countries. Previous papers have described results of fatty acid analyses in 1299 European foods (Aro *et al*, 1988a, b, c; Van Erp-Baart *et al*, 1988; Van Poppel *et al*, 1998). This paper describes the intake estimate of TFA and other fatty acids in 14 European countries, as well as the most important sources of TFA and other fatty acids in the diet of various populations.

Material and methods

Fatty acids in foods

To obtain data on TFA and other fatty acids in foods, a market basket study was performed in 14 European countries. The participating countries were Belgium (BEL), Denmark (DEN), Finland (FIN), France (FRA), Germany (GER), Greece (GRE), Iceland (ICE), Italy (ITA), The Netherlands (NET), Norway (NOR), Portugal (POR), Spain (SPA), Sweden (SWE) and United Kingdom (UKI). In each country, a maximum of 100 food samples representative of the fat intake, e.g. contributing to 95% of total fat intake, were collected and centrally analysed. The selection of foods, sample handling and the analytical methods are described in detail elsewhere (van Poppel *et al*, 1998). Briefly, sampling was performed following a stepwise approach. Samples were purchased in retail outlets, except for some products for industrial use. For practical reasons, the number of foods in each country was reduced to 100 or fewer by selection among foods with similar fat composition and by the production of aggregates of different brands of similar foods (data provided by national industries on a confidential basis). All sampling took place between June 1995 and April 1996. Samples were homogenised, frozen and stored at $-20^{\circ}C$ and transported to central laboratory facilities. The fats were extracted, the total fat content was determined, and the fatty acid methyl esters were separated by capillary gas chromatography. The fatty acids were identified by comparisons with standards. A total of 44 fatty acid or groups of fatty acids with 8 to 26 carbon atoms were identified including 7 *trans* isomers or *trans* isomer groups. The $C_{18:1}$ TFA, the $C_{18:2}$ *trans* isomers and the $C_{18:3}$ *trans* + $C_{20:1}$ TFA were calculated as groups because of incomplete separation between individual fatty acid isomers (Van Poppel *et al*, 1998). Conjugated linoleic acids were not included in the calculated TFA. Results were reported as mg fatty acid methyl esters per 100 g food. A database was compiled, comprising the analytical data for each country separately. Main results are published elsewhere (Aro *et al*, 1998a, b, c; Van Erp-Baart *et al*, 1998). Table 1 gives an overview of individual fatty acid isomers and the composition of the clusters of fatty acids used in the calculations of reported intake figures in this paper.

At most 100 foods representative of fat intake were analysed and the number of foods in the national food consumption surveys varied between 180 to over 1000 for each country. It was therefore necessary for each country to complete the national operational database (ODB) with estimates of levels of individual *trans* and other fatty acids and clusters of fatty acids in all foods (in absolute amounts and as percentage of energy intake). The starting point of the ODB was the analytical database, which includes all TRANSFAIR analyses. In addition, information had to be 'borrowed' from other sources, e.g. TRANSFAIR analyses from other countries or from comparable foods, information from national food composition tables and from literature. Owing to analytical procedures, $C_{2:0}-C_{6:0}$ fatty acids were not identified in the TRANSFAIR analyses. These fatty acids are mainly present in dairy products and are estimated to be $\sim 6\%$ of total fatty acid content (NPR 6305, 1987). To avoid underestimation of SFA, each country made its own corrections for products containing milk fat. To facilitate intake figures expressed as percentage of energy intake (en%), energy values of foods used in the food consumption surveys (if necessary corrected for total fat according to new TRANSFAIR analyses) were added. Based on calculations in a pilot study, it was decided to include energy from alcohol (differences between intake figures expressed as percentages of energy including and excluding energy from alcohol were small).

Food consumption data

To estimate dietary intake, three main sources of data can be used: food supply data, household consumption surveys and dietary surveys of individuals. Each source of data corresponds to a different stage in the food distribution chain and is obtained by different methods. Food Balance Sheets or food supply data refer to food availability, which gives only a crude impression of potential consumption without information about the distribution of food among population groups or districts (Kelley *et al*, 1991). In household consumption surveys, the quantity of food and drinks brought into each household are recorded. For the most part, only expenditures on meals outside the home are noted. Sometimes, the consumption data are converted to

Table 1 Composition of fatty acid clusters

		Cis unsaturated	
Saturated	*Trans unsaturated*	*Monounsaturated*	*Polyunsaturated*
$C_{2:0}-_{6:0}$[a]			
$C_{8:0}$	$C_{14:1t9}$	$C_{16:1c9}$	
$C_{10:0}$	$C_{16:1t9}$	$C_{18:1c9}$	
$C_{12:0}$	$C_{18:1t9}$	$C_{18:1c11}$	
$C_{14:0}$	$C_{18:2t9}$	$C_{18:1c}$ others	
$C_{15:0}$ or $C_{14:1c9}$	$C_{18:3t}+C_{20:1t}$		$C_{18:2c9,12}$
C_{15} iso	$C_{20:2t11,14}$		$C_{18:3c9,12,15}$
C_{15} anteiso	$C_{22:1t}$	$C_{20:1c11}$	
$C_{16:0}$			$C_{20:2c11,14}$
$C_{17:0}$			$C_{20:3c8,11,14}$
$C_{17:0}$iso			$C_{20:3c11,14,17}$
$C_{17:0}$anteiso			$C_{20:4c5,8,11,14}$
$C_{18:0}$			$C_{20:5c5,8,11,14,17}$
$C_{20:0}$		$C_{22:1c}$	
$C_{22:0}$			$C_{22:2c13,16}$
$C_{24:0}$			$C_{22:3c13,16,19}$
$C_{25:0}$			$C_{22:4c7,10,13,16}$
$C_{26:0}$			$C_{22:6c4,7,10,13,16,19}$
		$C_{24:1c15}$	

[a]Estimated values.

individual intake levels (Cameron & Van Staveren, 1988). Data from individual surveys provide more detailed information on average food and nutrient intake and their distribution over various well-defined groups of individuals.

To get insight into the available food consumption studies, an inventory among all TRANSFAIR participants was carried out. Briefly, the inventory led to the conclusion that most countries could provide intake figures of the total population and/or adults aged 19–64 years (or the nearest age), separately for men and women. The year of data collection in the different countries ranged from 1980/84 to 1996. For 10 countries the data came from a nationwide representative sample. Sampling units varied from household data to individual data. Several methods were used to estimate dietary intake: dietary records (1–7 d), 24 h recalls, dietary histories, semiquantitative food frequency questionnaires and household consumption method (7-d household record). Although data from individual surveys are preferred, it was decided to include also household food consumption data for sake of completeness, to avoid exclusion of TRANSFAIR participants. Table 2 gives an overview of the intake data that were used in the different countries.

Statistics

For the surveys, individually based intake of all fatty acids, clusters of fatty acids and total fat means, standard deviations (s.d.) and centiles (P10, P50, P90) were calculated. For the household food consumption surveys, only mean intake data were calculated. Each country used its own calculation system to compute the intake figures.

To determine the most important sources of (*trans*) fatty acids in foods the percentage contribution of food groups to fatty acids was calculated. The Eurocode 2 food grouping system was used as a starting point (Poortvliet *et al*, 1992). Some food groups were split up into subgroups to allow a more detailed information on the specific sources for TFA in the different European food patterns. For instance, cheese was separated from the group of milk and milk products. Butter was reported separately from the fat and oil group, which included spreading fats (margarines), cooking fats, etc. Results from major food groups are tabulated, but sometimes in the text more of detail is given.

Results

The intake of total fat and clusters of fatty acids in the participating European countries are presented in Tables 3 and 4 in the absolute amounts and as proportion of energy intake in Tables 5 and 6. Tables 7 and 8 give the intake of individual fatty acid isomers in absolute amounts. Tables 9–13 give the contribution of food groups to the intake of the different clusters of fatty acids. Since differences in sources according to gender were mostly small, these figures are presented for total population groups.

Total fat

Mean total fat intake ranged from 30.7 en% ($\sim$82 g/d in POR and 85 g/d in FIN) to 43.1 en% (141 g/d in ICE) in men and from 30.5 en% (63 g/d in FIN) to 43.9 en% (96 g/d in GER) in women). In Denmark, Greece and Iceland, in 10% of the (male) subjects fat contributed more than 50% of total energy intake, whereas in Denmark, France, Germany and Greece, 10% of the female subjects had a total fat intake of at least 49.5 en% (Tables 3–6).

Main sources of total fat: Most important sources of total fat (Table 9) were milk and milk products and cheese (13% of total fat intake in Germany to 27% in Sweden); meat and meat products (11% in Greece to 29% in Germany); oils and fats (8% in Sweden to 46% in Italy) and butter ($<1\%$ in Greece to 27% in Germany); and biscuits and cakes (4% in Finland to 10% in Sweden).

Trans fatty acids

Mean total *trans* fatty acid (TFA) intake ranged from 1.2 g/day (GRE) to 6.7 g/day (ICE) in men and 1.7 g/day (GRE) to 4.1 g/day (ICE) in women. Median intake in all countries was slightly lower (Tables 3 and 4). TFA represented 0.5% (GRE and ITA (total population)) to 2.1% (ICE) and 0.8% to 1.9% of total dietary energy intake among men and women, respectively (Tables 5 and 6). Some men (top 10% of intake distribution) consumed 10.8 g or more TFA/day (ICE) and others (lowest 10% distribution) less than 0.5 g/d (GRE), i.e. 2.8% and 0.1% of total energy intake, respectively (Tables 3–6).

In all countries, *trans* isomers of the monounsaturated octadecenoic acid ($C_{18:1}$) were the most common TFA in the diet. They accounted for 54% (FRA, women) to 82% (NET, women) of total TFA in the diet of the participating

Table 2 Details of dietary intake studies used for the assessment of fatty acids in the TRANSFAIR study

Country	*Year of survey*	*Sampling unit*	*Method*	*n*	*Age range*	*Reference*
Belgium (BEL)	1991–1992	Individual	3-d record	492	18–65	Den Hond *et al* (1994)
Denmark (DEN)	1995	Individual	7-d record	3 000	1–80	Andersen *et al* (1996)
Finland (FIN)	1992	Individual	3-d record	1 861	25–64	Kleemola *et al* (1994)
France (FRA)	1993–1994	Individual	7-d record	1 500	15–65+	Rigaud *et al* (1997)
Germany (GER)	1991	Individual	Dietary history	1 897	18–80	Hess *et al* (1992)
Greece (GRE)	1995	Individual	24 h recall	248	23–64	Kafatos *et al* (1998)
Iceland (ICE)	1990	Individual	Dietary history	1 240	15–80	Steingrimsdottir (1993)
Italy (ITA)	1980–1984	Household	7-d hh consumption	10 000	1–80	Turrini *et al* (1991)
The Netherlands (NET)	1992	Individual	2-d record	6 218	1–92	Anonymous (1993)
Norway (NOR)	1993–1994	Individual	Quantitative food freq	3 144	16–79	Johansson *et al* (1997)
Portugal (POR)	1988–1989	Individual	24 h recall	78	38	Amorim Cruz *et al*, to be published
Spain (SPA)	1991	Household	7-d hh consumption	21 555	0–70+	Varela *et al* (1995)
Sweden (SWE)	1989	Individual	7-d record	3 000	1–74	Becker (1994)
United Kingdom (UKI)	1996	Household	7-d hh consumption	7 921	0–75+	MAFF (1997)

d, day; h, hour; hh, household.

Table 3 Daily intake of total fat and clusters of (*trans*) fatty acids (g methylesters/day) among men in different countries

Country:	*BEL*	*DEN*	*FIN*	*FRA*	*GER*	*GRE*	*ICE*	*ITA*	*NET*	*NOR*	*POR*	*SPA*	*SWE*	*UKI*
Survey year:	*1991/92*	*1995*	*1992*	*1993/94*	*1991*	*1995*	*1990*	*1980/84*	*1992*	*1993/94*	*1988/89*	*1991*	*1989*	*1996*
Type of survey:[a]	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*HH*	*Ind*	*Ind*	*Ind*	*HH*	*Ind*	*HH*
Number of subject:	*323*	*650*	*870*	*300*	*794*	*141*	*483*	*10 000*	*1 822*	*1 257*	*78*	*21 155*	*646*	*7 921*
Age group (years):	*18–65*	*19–64*	*25–64*	*19–64*	*19–64*	*23–64*	*19–64*	*1–80*	*19–64*	*19–64*	*38*	*0–70+*	*19–64*	*0–75+*
Sex:[b]	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m+f*	*m*	*m*	*m*	*m+f*	*m*	*m+f*
Total fat														
Mean	119.2	113.6	84.7	91.3	121.2	84.7	141.2	96.4	109.5	99.3	81.7	124.5	94.6	77.0
s.d.	35.2	38.6	33.6	30.4	37.8	46.6	61.9		27.7	44.3	33.2		33.3	
P50	117.8	110.7	80.0	87.0	113.2	79.7	128.6		106.5	91.5	76.9		90.6	
P10	79.4	70.4	47.3	59.9	82.5	31.8	72.2		77.0	53.9	48.8		56.1	
P90	159.3	158.0	126.2	126.3	166.4	140.8	226.0		146.8	154.0	123.0		139.4	
Total *trans* UFA														
Mean	4.4	2.9	2.3	2.7	2.4	1.2	6.7	1.6	4.8	4.8	1.6	2.1	3.0	2.8
s.d.	2.0	1.3	1.1	1.2	0.9	1.2	3.5		2.3	2.9	0.8		1.4	
P50	4.1	2.8	2.1	2.5	2.3	1.0	6.3		4.2	4.1	1.4		2.8	
P10	2.2	1.6	1.1	1.4	1.4	0.1	3.1		2.8	2.1	0.7		1.4	
P90	6.8	4.4	3.7	4.1	3.6	2.3	10.8		7.4	8.3	2.7		4.7	
Total SFA														
Mean	47.3	48.2	34.6	36.0	51.6	23.8	59.7	32.5	42.1	39.2	29.6	35.2	39.7	28.5
s.d.	15.8	17.5	14.6	13.8	18.3	17.0	29.1		11.7	18.1	13.1		15.6	
P50	47.0	47.5	32.9	34.3	48.8	19.9	52.5		41.0	35.5	26.7		37.0	
P10	27.6	28.0	18.7	21.8	31.9	7.5	26.9		28.7	20.8	16.2		22.2	
P90	65.8	68.9	52.6	52.8	72.8	45.4	98.2		56.9	61.8	47.0		59.4	
$C_{12}+C_{14}+C_{16}$ SAT														
Mean	29.6	33.7	23.4	23.7	37.0	14.7	37.2	21.9	27.9	25.3	19.9	23.0	26.0	19.4
s.d.	9.9	12.8	9.9	9.0	12.6	9.9	18.0		7.9	11.5	8.8		10.2	
P50	29.5	32.9	22.1	22.4	34.9	12.6	33.2		27.1	22.9	17.7		24.4	
P10	17.6	19.7	12.5	14.6	23.6	5.0	16.9		19.0	13.6	8.8		14.8	
P90	41.7	49.4	35.9	34.1	51.9	27.4	61.8		37.7	39.5	31.4		38.7	
Total *cis* MUFA														
Mean	36.1	32.4	28.7	26.6	26.3	39.2	39.2	40.6	31.1	27.9	28.9	49.0	30.6	24.5
s.d.	11.6	11.1	11.5	9.5	8.4	23.5	17.6		8.7	12.2	13.0		11.0	
P50	34.8	31.5	26.8	25.0	25.1	36.1	36.4		29.8	25.9	25.6		29.6	
P10	22.6	20.2	15.9	16.6	17.1	13.8	18.7		21.2	15.3	17.6		17.9	
P90	51.3	46.3	43.4	38.3	37.5	68.2	63.1		42.9	43.5	43.0		45.8	
Total *cis* PUFA														
Mean	19.2	14.5	10.6	9.3	10.8	10.1	14.7	15.5	21.1	17.2	13.8	22.9	8.6	13.4
s.d.	7.2	5.9	4.8	5.1	4.1	8.6	6.8		7.6	10.5	9.8		3.7	
P50	18.9	13.9	9.9	8.2	10.1	7.7	13.4		19.9	14.8	10.7		8.0	
P10	10.9	8.3	5.3	4.6	6.6	2.7	6.9		12.5	7.6	5.6		4.6	
P90	28.2	21.6	17.1	14.2	16.1	20.4	23.6		30.7	29.9	22.4		13.7	

[a]Ind = individual survey; HH = household survey (only mean intake available).
[b]m = male; f = female.

countries (Tables 7 and 8). Relatively high intakes of $C_{22:1t}$ were observed in France, Iceland and Norway and high intakes of $C_{18:3t}+C_{20:1t}$ were observed in Belgium, Iceland and Norway.

Main sources of trans fatty acids. In Finland, Iceland, The Netherlands, Norway and the United Kingdom, the main sources of TFA were partially hydrogenated oils and fats. Of these, margarines, spreads, frying and cooking fats and oils contributed at least 31% TFA in the diet. In the other countries, the contribution of these products was only $<1-18\%$. Chips and french fries were important contributors of TFA (12–14%) in the Belgian, Dutch and Swedish diet (Table 10). Bakery products provided about 7% (FIN) to 21% (SWE) of TFA intake. About 28% (NOR) to 79% (GER) of the TFA intake was derived from natural animal sources (milk and ruminant fat). In Germany and France, the contribution of butter to TFA intake was high. Ruminant meat fats contributed about 5% (FIN, GER) to 21% (SPA, SWE) TFA. Within the meat group, meat products were the most important contributors in FIN, GER, NET, SWE and UKI, beef and veal in BEL, FRA, GRE, ITA and POR, and mutton and lamb in FRA and ICE. Butter provided 3% (NET, NOR) to $\sim$50% (GER) TFA, and milk fats and dairy products (cheese included) approximately 14% (NET) to 50% (ITA).

Intake of saturated fatty acids

Saturated fatty acids (SFA) represented a major fatty acid group in the diet in most countries. SFA provided about 10–19% of the total energy, with the lowest contribution in most Mediterranean countries (Tables 5 and 6). The average estimated intake ranged from about 10 en% (24 g/day in GRE) to nearly 18 en% ($\sim$60 g/d) among men (ICE) and from about 12 en% (27 g/d, NOR) to 19 en% (41 g/day) among women (GER). Highest 90th centile values among men were observed in Iceland and Denmark ($\sim$23 en%) and among women in Germany and Denmark ($\sim$22.5 en%) (Tables 3–6).

Table 4 Daily intake of total fat and clusters of (*trans*) fatty acids (g methylesters/day) among women in different countries

Country:	*BEL*	*DEN*	*FIN*	*FRA*	*GER*	*GRE*	*ICE*	*NET*	*NOR*	*SWE*
Survey year:	*1991/92*	*1995*	*1992*	*1993/94*	*1991*	*1995*	*1990*	*1992*	*1993/94*	*1989*
Type of survey:[a]	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*
Number of subject:	*169*	*702*	*991*	*463*	*881*	*107*	*510*	*2 203*	*1 330*	*697*
Age group (years):	*18–65*	*19–64*	*25–64*	*19–64*	*19–64*	*23–64*	*19–64*	*19–64*	*19–64*	*19–64*
Sex:[b]	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*
Total fat										
Mean	94.2	83.9	63.1	71.0	96.2	82.1	88.0	82.4	67.9	70.6
s.d.	30.3	27.5	23.1	20.7	29.9	40.4	36.8	23.1	29.2	23.2
P50	91.3	83.5	60.1	67.4	92.2	75.4	82.1	81.0	63.2	68.9
P10	59.3	50.3	36.3	47.3	64.4	40.3	48.2	53.9	36.9	43.6
P90	130.5	117.4	92.5	99.8	131.1	129.6	136.7	111.5	102.4	99.7
Total *trans* UFA										
Mean	3.6	2.3	1.9	2.1	1.9	1.7	4.1	3.8	3.2	2.3
s.d.	1.8	1.2	0.9	0.8	0.7	1.3	2.2	2.0	1.9	1.0
P50	3.2	2.2	1.7	1.9	1.8	1.6	3.7	3.2	2.8	2.1
P10	1.7	1.2	0.9	1.1	1.2	0.2	1.9	2.1	1.5	1.1
P90	6.1	3.5	2.9	3.2	2.9	3.1	7.0	6.1	5.4	3.6
Total SFA										
Mean	37.8	35.7	26.5	27.3	41.2	25.4	37.5	32.3	27.5	29.2
s.d.	13.8	12.9	10.1	9.0	14.7	14.0	16.9	9.3	12.5	10.3
P50	37.1	35.3	25.2	25.6	39.4	23.3	34.4	31.6	25.6	28.2
P10	20.5	20.3	14.8	16.9	25.4	10.8	18.6	21.3	14.5	17.3
P90	53.7	51.6	39.9	40.0	59.0	40.7	59.7	43.8	41.8	42.4
$C_{12}+C_{14}+C_{16}$ SAT										
Mean	23.8	25.1	17.9	18.0	29.4	15.8	23.6	21.4	17.8	19.1
s.d.	8.8	10.2	6.8	5.9	10.1	8.6	10.7	6.2	8.0	6.8
P50	23.2	24.4	17.2	17.0	28.2	15.2	21.5	20.8	16.5	18.4
P10	13.0	13.6	10.1	11.1	18.5	6.7	12.1	13.9	9.5	11.3
P90	34.2	37.6	27.2	26.7	41.7	24.7	37.5	28.9	26.7	27.7
Total *cis* MUFA										
Mean	28.1	23.4	20.9	21.0	20.4	35.0	23.6	23.2	19.1	22.4
s.d.	9.5	8.0	7.9	7.2	6.3	19.7	10.3	7.3	8.0	7.8
P50	27.5	23.1	19.7	19.8	19.5	32.6	21.9	22.4	17.9	21.6
P10	17.1	14.0	11.9	13.2	13.8	13.6	11.9	14.8	10.3	13.0
P90	41.0	32.8	30.7	31.4	28.1	60.6	36.5	32.6	28.6	32.2
Total *cis* PUFA										
Mean	14.9	10.9	7.7	7.6	9.2	10.8	9.5	14.8	11.1	6.5
s.d.	6.0	3.8	3.3	4.2	3.8	11.6	4.7	5.6	6.4	2.6
P50	14.0	10.6	7.2	6.6	8.4	7.1	8.8	14.1	9.5	6.2
P10	7.5	6.6	3.7	3.3	5.5	2.4	4.4	8.4	4.7	3.5
P90	22.6	15.6	11.7	12.3	13.8	21.5	16.1	21.9	19.2	9.9

[a]Ind = individual survey; [b]f = female.

In all countries, the cluster $C_{12}-C_{16}$ accounted for 60–72% and $C_{18:0}$ for 18–23% of the SFA intake (Tables 7 and 8).

Main sources of saturated fatty acids. Milk and milk products, cheese, meat and meat products, butter, and fats and oils were the main sources of SFA in all countries. The contribution of butter to SFA intake varied widely. In Greece, Spain, The Netherlands and Norway butter provided less than 5%, whereas high contributions were observed in France (30%) and Germany (39%). Together the mentioned food groups accounted for about 70–87% of the mean daily intake of SFA in the diets (Table 11).

Cis unsaturated fatty acids

The contribution of *cis* isomers of the monounsaturated fatty acids (MUFA) to energy intake ranged from 8.7% (NOR, women) to 18.1% (GRE, women) (Tables 5 and 6). Oleic acid ($C_{18:1}$) was the major MUFA (18–32 g/d among males and 12–28 g/d among females; 19–37 g total population) in the diet in European countries (Tables 7 and 8).

Polyunsaturated fatty acids (PUFA) contributed about 3% (SWE) to 7% (NET, SPA, UKI) of the total energy intake in the different countries (Tables 5 and 6), or ranged from about 9 g/day (SWE, FRA) to >20 g/day (NET) in males and SPA (total population) and about 7 g/day (SWE, FIN, FRA) to 15 g/day (BEL, NET) in females (Tables 3 and 4). Linoleic acid ($C_{18:2c9,12}$) was the major PUFA consumed. Particularly in BEL and NET, a relatively high intake of this fatty acid was observed. Average linoleic acid intake ($C_{18:3c9,12,15}$) ranged from <1 to 2.5 g/day in the diet of males and from <1 to 2.1 g/day in the diet of females (Tables 7 and 8).

Sources of MUFA and PUFA The MUFA in the diet was obtained mainly from meat and meat products (11–43%) and from oils & fats (10–63%). In Greece, Italy and Spain

Table 5 Daily intake of clusters of fatty acid methyl esters (energy %) among men in different countries

Country:	*BEL*	*DEN*	*FIN*	*FRA*	*GER*	*GRE*	*ICE*	*ITA*	*NET*	*NOR*	*POR*	*SPA*	*SWE*	*UKI*
Survey year:	*1991/92*	*1995*	*1992*	*1993/94*	*1991*	*1995*	*1990*	*1980/84*	*1992*	*1993/94*	*1988/89*	*1991*	*1989*	*1996*
Type of survey:[a]	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*HH*	*Ind*	*Ind*	*Ind*	*HH*	*Ind*	*HH*
Number of subject:	*323*	*650*	*870*	*300*	*794*	*141*	*483*	*10 000*	*1 822*	*1 257*	*78*	*21 155*	*646*	*7 921*
Age group (years):	*18–65*	*19–64*	*25–64*	*19–64*	*19–64*	*23–64*	*19–64*	*1–80*	*19–64*	*19–64*	*38*	*0–70+*	*19–64*	*0–75+*
Sex:[b]	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m+f*	*m*	*m*	*m*	*m+f*	*m*	*m+f*
Total fat														
Mean	38.7	37.4	30.7	38.3	41.3	38.2	43.1	31.4	35.9	31.6	30.7	41.4	36.0	35.7
s.d.	5.4	12.7	6.5	6.6	5.2	10.7	6.8		4.5	5.7	8.1		5.7	
P50	39.2	36.4	30.7	38.9	41.2	37.5	43.1		35.9	31.6	30.4		35.8	
P10	32.6	23.2	22.4	29.9	34.7	24.8	34.7		30.4	24.1	21.4		29.2	
P90	44.8	52.0	38.9	46.7	47.7	52.3	51.0		41.5	38.7	41.3		43.2	
Total *trans* UFA														
Mean	1.4	1.0	0.8	1.1	0.8	0.5	2.1	0.5	1.5	1.5	0.6	0.7	1.1	1.3
s.d.	0.5	0.4	0.3	0.4	0.2	0.4	0.6		0.6	0.6	0.3		0.4	
P50	1.3	0.9	0.8	1.1	0.8	0.4	2.0		1.4	1.4	0.6		1.1	
P10	0.9	0.5	0.5	0.7	0.6	0.1	1.4		1.0	0.9	0.3		0.7	
P90	2.0	1.4	1.1	1.6	1.1	1.0	2.8		2.3	2.3	1.1		1.6	
Total SFA														
Mean	15.3	15.8	12.5	15.0	17.5	10.5	18.0	10.6	13.9	12.5	11.2	11.7	15.0	13.2
s.d.	2.7	5.8	2.9	3.6	3.3	4.7	3.9		2.2	2.8	3.8		3.1	
P50	15.5	15.6	12.4	15.2	17.6	9.8	17.6		13.7	12.3	11.6		14.9	
P10	12.0	9.3	8.9	10.7	13.2	5.4	13.5		11.1	9.2	6.2		11.4	
P90	18.6	22.7	16.1	19.2	21.5	16.2	23.1		16.6	15.8	16.3		19.0	
$C_{12}+C_{14}+C_{16}$ SAT														
Mean	9.6	11.1	8.5	9.9	12.6	6.5	11.3	7.1	9.2	8.1	7.5	7.6	9.9	9.0
s.d.	1.7	4.2	2.0	2.4	2.1	2.6	2.4		1.5	1.7	2.6		2.0	
P50	9.6	10.8	8.4	10.0	12.6	6.2	11.0		9.1	7.9	7.6		9.8	
P10	7.4	6.5	6.0	7.1	10.0	3.2	8.4		7.3	6.1	4.2		7.4	
P90	11.7	16.3	11.0	12.7	15.0	10.0	14.3		11.1	10.1	11.0		12.3	
Total *cis* MUFA														
Mean	11.7	10.7	10.4	11.2	9.0	17.9	12.0	13.2	10.2	8.9	10.9	16.3	11.7	11.4
s.d.	2.1	3.7	2.5	2.4	1.9	7.6	2.4		1.7	1.6	3.5		2.2	
P50	11.6	10.4	10.4	11.2	8.7	17.4	11.9		10.0	8.9	10.7		11.6	
P10	9.3	6.6	7.3	8.2	7.1	8.4	9.1		8.2	6.8	6.8		9.0	
P90	14.3	15.2	13.7	14.0	11.5	27.8	14.9		12.3	11.0	15.0		14.3	
Total *cis* PUFA														
Mean	6.3	4.8	3.9	3.9	3.7	4.4	4.7	5.1	7.0	5.4	5.1	7.6	3.3	6.2
s.d.	2.1	1.9	1.3	1.8	1.1	2.9	1.5		1.9	2.0	2.8		0.9	
P50	6.2	4.6	3.9	3.6	3.5	3.8	4.6		6.7	5.0	4.4		3.1	
P10	3.7	2.7	2.2	2.2	2.5	1.8	2.8		4.6	3.1	2.5		2.2	
P90	9.0	7.1	5.5	5.7	5.3	7.5	6.6		9.5	8.2	8.1		4.4	

[a]Ind = individual survey; HH = household survey (only mean intake available).
[b]m = male; f = female.

about 50–63% of MUFA came from oils and fats (Table 12). Fats and oils (including spreads), meat and meat products (mainly pork) and, in some countries (Norway, Iceland, Sweden and France) also soups and sauces (mainly mayonnaise) were the main sources of PUFA. Other contributors included grain products and biscuits, cakes and other bakery products (Table 13).

Discussion

In the present study, we have characterized the fatty acid intake patterns and identified the major sources of fatty acid clusters in the diets of population groups in 14 European countries. A wide variation was observed in absolute intake levels. The variation in the proportions of energy derived from total fat and clusters of fatty acids was less, owing to differences in reported daily energy intake. In general, average daily energy intake ranged from ~7.5 to 8.5 MJ (1750–2050 kcal) in women and from 9.6 to 12.3 MJ (2250–3000 kcal) in men (Turrini *et al*, 1991 ; Hess *et al*, 1992; Anonymous, 1993; Steingrimsdottir, 1993; Becker, 1994; Den Hond *et al*, 1994; Kleemola *et al*, 1994; Mamalakis *et al*, 1998; Varela *et al*, 1995; Anderson *et al*, 1996; Johansson *et al*, 1997; MAFF, 1997; Rigaud *et al*, 1997; Amorim Cruz *et al*, to be published). Therefore, it is more appropriate to use energy-related figures when comparing the results from the various countries. Only in Finland, Italy, Norway and Portugal did total fat provide on average less than 35% of energy intake. SFA contributed generally less energy in the Mediterranean countries (10–13 en%) than in most other participating countries, with exception of Norway and Finland (12–13 en%).

The results from the present study clearly indicate that the TFA intake in Western Europe (1.2–6.7 g/day, 0.5–2.1 en%) is lower than previously assumed. An overview of TFA intake rates in different Western countries was given by Precht & Molkentin (1995), covering a period from 1982 to 1992. TFA intake ranged for Finland from 1.5 to 5.6 g/day, for Germany from 3.4 to 6.4 g/day, and for

Table 6 Daily intake of total fat and clusters of (*trans*) fatty acids (energy %) among women in different countries

Country:	*BEL*	*DEN*	*FIN*	*FRA*	*GER*	*GRE*	*ICE*	*NET*	*NOR*	*SWE*
Survey year:	*1991/92*	*1995*	*1992*	*1993/94*	*1991*	*1995*	*1990*	*1992*	*1993/94*	*1988/89*
Type of survey:[a]	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*
Number of subject:	*169*	*702*	*991*	*463*	*881*	*107*	*510*	*2 203*	*1 330*	*697*
Age group (years):	*18–65*	*19–64*	*25–64*	*19–64*	*19–64*	*23–64*	*19–64*	*19–64*	*19–64*	*19–64*
Sex:[b]	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*
Total fat										
Mean	38.9	36.4	30.5	41.2	43.9	42.0	41.0	36.2	30.8	35.2
s.d.	5.9	11.9	6.2	5.9	4.7	10.6	6.5	5.1	5.8	4.9
P50	39.0	36.2	30.6	41.4	44.0	42.4	41.3	36.2	30.8	35.2
P10	31.6	21.8	22.6	33.8	38.1	28.8	32.9	29.7	23.5	29.4
P90	46.3	50.9	38.2	49.6	49.5	54.3	48.8	42.6	38.6	41.4
Total *trans* UFA										
Mean	1.5	1.0	0.9	1.2	0.9	0.8	1.9	1.6	1.4	1.1
s.d.	0.5	0.5	0.3	0.3	0.2	0.6	0.6	0.7	0.5	0.4
P50	1.4	1.0	0.8	1.2	0.9	0.8	1.8	1.4	1.3	1.1
P10	0.9	0.5	0.6	0.8	0.7	0.2	1.3	1.0	0.9	0.7
P90	2.2	1.5	1.2	1.6	1.1	1.5	2.7	2.5	2.1	1.6
Total SFA										
Mean	15.5	15.5	12.8	15.8	18.6	12.9	17.4	14.3	12.4	14.5
s.d.	3.2	5.6	2.8	3.2	3.2	4.7	3.3	2.4	2.7	2.6
P50	15.4	15.3	12.7	15.8	18.6	13.2	17.4	14.2	12.3	14.4
P10	11.2	8.8	9.3	12.0	14.5	6.9	13.4	11.2	9.2	11.3
P90	19.8	22.4	16.5	20.4	22.7	17.3	21.3	17.3	15.7	17.7
$C_{12} + C_{14} + C_{16}$ SAT										
Mean	9.8	10.9	8.6	10.4	13.3	8.1	10.9	9.4	8.0	9.5
s.d.	2.0	4.4	1.9	2.2	2.0	3.0	2.1	1.7	1.7	1.7
P50	9.8	10.6	8.5	10.4	13.3	8.1	10.9	9.3	7.9	9.4
P10	7.0	5.9	6.3	7.8	10.9	4.3	8.3	7.3	6.0	7.5
P90	12.4	16.3	11.2	13.6	15.7	11.6	13.5	11.6	10.1	11.5
Total *cis* MUFA										
Mean	11.6	10.1	10.1	12.2	9.4	18.1	11.0	10.2	8.7	11.2
s.d.	2.3	3.5	2.4	2.6	1.9	7.9	2.3	1.9	1.7	2.0
P50	11.5	10.0	10.0	11.9	9.1	17.7	11.0	10.0	8.6	11.1
P10	8.8	8.8	7.3	9.1	7.5	8.5	8.2	7.9	6.6	8.7
P90	14.5	14.2	12.9	15.6	11.6	27.7	13.6	12.4	10.9	13.7
Total *cis* PUFA										
Mean	6.2	4.7	3.7	4.4	4.3	5.1	4.5	6.5	5.0	3.3
s.d.	2.0	1.6	1.2	2.0	1.4	3.7	1.5	1.9	1.9	0.9
P50	6.1	4.6	3.6	3.7	4.0	3.9	4.3	6.3	4.6	3.1
P10	3.8	2.9	2.2	2.3	2.8	2.0	2.7	4.2	2.9	2.2
P90	8.6	6.8	5.4	7.4	6.0	8.8	6.5	9.1	7.7	4.4

[a]Ind = individual survey; [b]f = female.

The Netherlands from 10.0 to 17.4 g/day. Boatella *et al* (1993) reported a mean TFA intake of 2.4 g/day in Spain. More recent data from the Nordic countries show somewhat lower levels for Finland (1.4–1.9 g/day, 0.7 en%, Denmark (5 g/day, 1.5 en%) and Sweden (3.3 g/day, 1 en%) (Becker, 1996). Some of the earlier TFA data, however, often refer to food supply data, which provide information on the type and amount of food available for human consumption to the country as a whole. Losses prior to consumption may not be adequately accounted for and food supply data may overestimate the intake of foods and nutrients including TFA. Most of the previous data have been calculated using mean values for total *trans* fatty acids in various food groups. Moreover, TFA values were partly based on older analytical techniques. In our study, intake figures in the different countries were calculated using food consumption databases with detailed information, mostly individually based, and using an extensive collection of data on fatty acid composition of foods that are representative for total fat intake for each country. Samples were purchased between June 1995 and April 1996, and cover to some extent industrial lowering of TFA in the last decade in many products after the public turmoil on this issue.

Regarding analytical techniques, it should be realised that the GLC analysis used in this large study does not always give complete separation between all fatty acid peaks (Van Poppel *et al*, 1998). We have compared our method with a labour-intensive method using a similar column but with previous separation by argentation chromatography, and found that 25% of $C_{18:1}$ TFA are overlapped by $C_{18:1}$ *cis* (Aro *et al*, 1998d). This 25% underestimation of $C_{18:1}$ *trans* will, however, also have affected previous estimates, such as the ones reported by Precht & Molkentin (1995). Moreover, hydrogenated fish oils are still used in food products in Norway. A fraction of unidentified acids might be TFA in these products.

The lowest TFA intake was observed in the Mediterranean countries and in Finland and Germany. In Belgium, The Netherlands, Norway and United Kingdom, intakes were moderate, while the highest intake was found in

Table 7 Daily intake of individual (*trans*) fatty acids isomers (g methylesters/day) among men in different countries

Country:	*BEL*	*DEN*	*FIN*	*FRA*	*GER*	*GRE*	*ICE*	*ITA*	*NET*	*NOR*	*POR*	*SPA*	*SWE*	*UKI*
Survey year:	*1991/92*	*1995*	*1992*	*1993/94*	*1991*	*1995*	*1990*	*1980/84*	*1992*	*1993/94*	*1988/89*	*1991*	*1989*	*1996*
Type of survey:[a]	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*HH*	*Ind*	*Ind*	*Ind*	*HH*	*Ind*	*HH*
Number of subject:	*323*	*650*	*870*	*300*	*794*	*141*	*483*	*10 000*	*1 822*	*1 257*	*78*	*21 155*	*646*	*7 921*
Age group (years):	*18–65*	*19–64*	*25–64*	*19–64*	*19–64*	*23–64*	*19–64*	*1–80*	*19–64*	*19–64*	*38*	*0–70+*	*19–64*	*0–75+*
Sex.[b]	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m+f*	*m*	*m+f*
$C_{14:1t9}$														
Mean	0.19	0.21	0.14	0.25	0.32	0.04	0.33	0.14	0.05	0.17	0.10	0.10	0.14	0.11
s.d.	0.10	0.09	0.07	0.12	0.16	0.04	0.19		0.00	0.10	0.07		0.08	
P50	0.17	0.20	0.12	0.23	0.31	0.02	0.28		0.05	0.15	0.09		0.13	
P10	0.08	0.11	0.06	0.12	0.15	0.00	0.13		0.05	0.07	0.01		0.05	
P90	0.32	0.34	0.22	0.42	0.51	0.09	0.62		0.05	0.29	0.19		0.2	
$C_{16:1t9}$														
Mean	0.30	0.14	0.14	0.33	0.36	0.12	0.77	0.17	0.14	0.46	0.17	0.17	0.20	0.18
s.d.	0.16	0.07	0.08	0.16	0.16	0.14	0.41		0.08	0.26	0.10		0.11	
P50	0.27	0.12	0.12	0.31	0.34	0.09	0.67		0.12	0.41	0.15		0.19	
P10	0.13	0.06	0.06	0.16	0.17	0.00	0.35		0.07	0.22	0.06		0.08	
P90	0.52	0.25	0.23	0.54	0.55	0.23	1.29		0.21	0.74	0.30		0.30	
$C_{18:1t}$														
Mean	3.2	2.0	1.6	1.5	1.35	0.82	4.23	1.00	3.9	3.49	1.10	1.40	2.3	2.00
s.d.	1.6	1.0	0.9	0.8	0.52	0.89	2.27		2.0	2.40	0.60		1.1	
P50	2.8	1.9	1.4	1.4	1.28	0.61	3.75		3.3	2.79	0.97		2.1	
P10	1.5	0.9	0.7	0.7	0.79	0.03	1.78		2.2	1.44	0.48		1.0	
P90	5.2	3.3	2.7	2.3	1.97	1.61	6.97		6.4	6.47	1.81		3.8	
$C_{18:2t}$														
Mean	0.47	0.30	0.26	0.40	0.34	0.18	0.65	0.23	0.55	0.24	0.17	0.25	0.3	0.28
s.d.	0.19	0.13	0.12	0.21	0.12	0.18	0.35		0.22	0.12	0.11		0.1	
P50	0.45	0.28	0.24	0.35	0.32	0.14	0.58		0.50	0.22	0.15		0.3	
P10	0.25	0.15	0.13	0.20	0.20	0.02	0.27		0.34	0.12	0.06		0.1	
P90	0.70	0.45	0.41	0.69	0.49	0.36	1.10		0.82	0.40	0.28		0.5	
$C_{18:3t}+C_{20:1}$														
Mean	0.16	0.09	0.08	0.04	0.03	0.06	0.49	0.02	0.09	0.31	0.05	0.06	< 0.1	0.17
s.d.	0.08	0.05	0.04	0.04	0.03	0.13	0.35		0.06	0.20	0.04		< 0.1	
P50	0.15	0.06	0.07	0.03	0.02	0.02	0.42		0.08	0.26	0.04		< 0.1	
P10	0.07	0.04	0.03	0.01	0.01	0.00	0.20		0.04	0.13	0.01		< 0.05	
P90	0.25	0.15	0.13	0.07	0.06	0.20	0.84		0.16	0.50	0.09		0.1	
$C_{20:2t11,14}$														
Mean	0.04	0.10	0.06	0.02	0.02	0.01	0.03	0.02	0.0	0.02	0.05	0.48	< 0.05	0.02
s.d.	0.06	0.06	0.10	0.02	0.01	0.02	0.03		0.0	0.01	0.11		–	
P50	0.03	0.09	0.02	0.02	0.01	0.00	0.03		0.0	0.02	0.01		< 0.05	
P10	0.01	0.04	0.01	0.01	0.01	0.00	0.01		0.0	0.01	0.00		0	
P90	0.06	0.18	0.18	0.05	0.04	0.04	0.07		0.0	0.03	0.05		< 0.05	
$C_{22:1t}$														
Mean	0.02	0.02	0.00	0.16	0.00	0.00	0.36	0.00	0.02	0.14	0.01	0.03	< 0.05	0.06
s.d.	0.02	0.01	0.00	0.12	0.00	0.00	0.38		0.04	0.12	0.02		–	
P50	0.01	0.01	0.00	0.13	0.00	0.00	0.26		0.01	0.12	0.01		< 0.05	
P10	0.00	0.01	0.00	0.04	0.00	0.00	0.11		0.01	0.05	0.00		0	
P90	0.04	0.04	0.00	0.31	0.00	0.00	0.69		0.03	0.26	0.03		< 0.05	
$C_{18:1c9}$														
Mean	28.3	26.8	22.6	19.6	17.6	32.3	29.3	32.6	25.7	17.9	22.8	36.9	25.0	19.3
s.d.	9.2	10.3	9.1	7.3	6.1	19.8	14.0		7.4	8.4	10.2		9.1	
P50	27.5	25.8	20.9	17.9	16.5	29.8	26.8		24.7	16.5	20.5		24.1	
P10	16.9	15.7	12.4	12.2	11.0	10.2	13.3		17.5	9.3	13.7		14.4	
P90	39.8	39.4	34.4	28.5	25.8	55.8	46.9		35.6	28.1	34.5		37.3	
$C_{18:2c9,12}$														
Mean	16.6	12.0	8.1	8.3	9.3	9.3	10.2	14.5	19.0	12.2	12.1	21.6	6.7	11.4
s.d.	6.7	4.1	3.7	5.0	3.6	8.2	4.9		7.1	8.6	8.9		2.9	
P50	16.1	9.8	7.6	7.1	8.7	7.2	9.4		17.9	10.0	9.6		6.4	
P10	8.6	5.0	4.0	3.8	5.6	2.5	4.7		11.1	4.5	4.6		3.6	
P90	25.4	22.1	13.1	12.6	14.0	18.6	16.7		27.9	22.8	20.0		10.8	
$C_{18:3c9,12,15}$														
Mean	1.7	2.2	1.8	0.6	0.9	0.6	2.5	0.8	1.7	1.6	0.7	0.8	1.4	1.4
s.d.	0.8	0.9	0.9	0.3	0.5	0.5	1.5		0.7	1.2	0.4		0.7	
P50	1.6	2.1	1.6	0.6	0.8	0.5	2.0		1.6	1.3	0.7		1.2	
P10	0.9	1.3	0.9	0.4	0.5	0.2	1.0		0.9	0.5	0.4		0.6	
P90	2.6	3.2	3.0	0.9	1.6	1.2	4.5		2.7	3.1	1.2		2.3	
$C_{18:0}$														
Mean	11.6	9.6	8.0	7.3	9.9	4.4	12.8	6.1	9.4	8.7	6.2	7.8	8.1	6.0
s.d.	4.0	3.3	3.3	2.7	3.3	3.6	6.8		2.5	4.2	3.1		3.1	
P50	11.3	9.0	7.6	6.8	9.4	3.3	11.4		9.2	7.9	5.6		7.7	
P10	6.7	5.6	4.3	4.6	6.4	1.2	5.6		6.5	4.5	3.6		4.7	
P90	16.2	14.1	12.2	10.6	13.9	8.0	22.2		12.7	13.6	9.6		12.0	

[a]Ind = individual survey; HH = household survey (only mean intake available).
[b]m = male; f = female.

Table 8 Daily intake of individual (*trans*) fatty acid isomers (g methylesters/day) among women in different countries

Country:	*BEL*	*DEN*	*FIN*	*FRA*	*GER*	*GRE*	*ICE*	*NET*	*NOR*	*SWE*
Survey year:	*1991/92*	*1995*	*1992*	*1993/94*	*1991*	*1995*	*1990*	*1992*	*1993/94*	*1988/89*
Type of survey:[a]	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*	*Ind*
Number of subject:	*169*	*702*	*991*	*463*	*881*	*107*	*510*	*2 203*	*1 330*	*697*
Age group (years):	*18–65*	*19–64*	*25–64*	*19–64*	*19–64*	*23–64*	*19–64*	*19–64*	*19–64*	*19–64*
Sex:[b]	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*
$C_{14:1t9}$										
Mean	0.16	0.16	0.11	0.19	0.26	0.05	0.21	0.04	0.12	0.10
s.d.	0.09	0.07	0.05	0.08	0.12	0.05	0.11	0.04	0.07	0.05
P50	0.14	0.15	0.10	0.18	0.24	0.04	0.18	0.03	0.10	0.09
P10	0.05	0.08	0.05	0.10	0.11	0.00	0.09	0.01	0.05	0.05
P90	0.28	0.25	0.18	0.30	0.41	0.12	0.33	0.08	0.19	0.20
$C_{16:1t9}$										
Mean	0.27	0.11	0.11	0.26	0.29	0.13	0.47	0.11	0.33	0.14
s.d.	0.16	0.06	0.05	0.13	0.13	0.10	0.23	0.06	0.19	0.07
P50	0.24	0.09	0.10	0.24	0.27	0.11	0.43	0.10	0.29	0.13
P10	0.09	0.04	0.05	0.13	0.13	0.01	0.22	0.06	0.16	< 0.05
P90	0.50	0.19	0.18	0.42	0.45	0.27	0.72	0.17	0.51	0.20
$C_{18:1t}$										
Mean	2.6	1.6	1.3	1.13	1.07	1.17	2.60	3.1	2.29	1.8
s.d.	1.3	0.8	0.7	0.50	0.40	1.03	1.59	1.8	1.48	0.9
P50	2.2	1.5	1.2	1.02	1.03	1.06	2.19	2.6	1.88	1.7
P10	1.2	0.7	0.6	0.54	0.63	0.15	1.08	1.6	0.99	0.8
P90	4.6	2.6	2.1	1.86	1.58	2.26	4.77	5.1	4.02	3.0
$C_{18:2t}$										
Mean	0.37	0.22	0.21	0.30	0.28	0.23	0.39	0.43	0.17	0.20
s.d.	0.17	0.10	0.09	0.13	0.10	0.17	0.20	0.19	0.08	0.09
P50	0.35	0.20	0.20	0.27	0.26	0.20	0.36	0.39	0.16	0.18
P10	0.18	0.10	0.11	0.16	0.17	0.04	0.18	0.25	0.09	0.10
P90	0.60	0.34	0.33	0.49	0.40	0.41	0.65	0.66	0.26	0.30
$C_{18:3t}+C_{20:1}$										
Mean	0.14	0.06	0.06	0.03	0.03	0.08	0.30	0.07	0.22	0.06
s.d.	0.08	0.03	0.03	0.02	0.02	0.14	0.20	0.05	0.15	0.03
P50	0.13	0.06	0.05	0.02	0.02	0.02	0.26	0.05	0.19	0.05
P10	0.05	0.03	0.02	0.01	0.01	0.00	0.13	0.03	0.10	< 0.05
P90	0.24	0.10	0.10	0.05	0.05	0.27	0.51	0.11	0.35	0.1
$C_{20:2t11,14}$										
Mean	0.03	0.06	0.05	0.02	0.02	0.01	0.02	0.0	0.01	< 0.05
s.d.	0.04	0.04	0.08	0.02	0.01	0.02	0.01	0.0	0.01	–
P50	0.02	0.05	0.02	0.01	0.01	0.00	0.01	0.0	0.01	< 0.05
P10	0.01	0.02	0.01	0.00	0.00	0.00	0.01	0.0	0.01	0
P90	0.05	0.12	0.15	0.04	0.03	0.04	0.03	0.0	0.02	< 0.05
$C_{22:1t}$										
Mean	0.02	0.01	0.00	0.14	0.00	0.00	0.22	0.01	0.11	< 0.05
s.d.	0.02	0.01	0.00	0.14	0.00	0.00	0.21	0.03	0.09	–
P50	0.01	0.01	0.00	0.10	0.00	0.00	0.18	0.01	0.09	< 0.05
P10	0.00	0.001	0.00	0.03	0.00	0.00	0.07	0.00	0.04	0
P90	0.04	0.03	0.00	0.29	0.00	0.00	0.43	0.02	0.18	< 0.05
$C_{18:1c9}$										
Mean	21.1	18.8	16.4	15.6	13.7	28.5	17.5	19.0	12.4	18.4
s.d.	7.7	7.6	6.2	5.7	4.5	16.6	8.2	6.0	5.5	6.5
P50	20.9	18.2	15.6	14.6	13.0	26.6	15.9	18.3	11.6	17.6
P10	13.2	10.3	9.3	9.5	9.0	10.9	8.8	12.0	6.5	10.6
P90	32.3	27.6	24.4	23.1	19.4	49.3	28.0	26.8	19.0	26.7
$C_{18:2c9,12}$										
Mean	12.8	9.0	5.8	6.8	8.0	9.9	6.9	13.2	7.8	5.3
s.d.	5.5	2.9	2.6	4.1	3.5	10.9	3.8	5.2	5.2	2.1
P50	12.0	7.9	5.5	5.7	7.3	6.4	5.9	12.5	6.5	5.0
P10	5.9	3.9	2.8	2.7	4.7	2.0	3.0	7.4	2.9	2.8
P90	20.2	15.6	9.0	11.3	12.0	20.2	12.0	19.8	14.4	7.9
$C_{18:3c9,12,15}$										
Mean	1.4	2.1	1.3	0.5	0.7	0.7	1.4	1.2	1.0	1.0
s.d.	0.6	1.0	0.6	0.2	0.4	0.9	0.9	0.6	0.7	0.5
P50	1.3	2.0	1.3	0.4	0.6	0.5	1.2	1.1	0.8	0.9
P10	0.7	1.0	0.6	0.3	0.4	0.2	0.6	0.7	0.4	0.5
P90	2.1	3.3	2.1	0.8	1.2	1.3	2.5	2.0	2.0	1.7
$C_{18:0}$										
Mean	9.1	8.0	6.0	5.5	7.9	4.5	7.8	7.2	6.1	6.0
s.d.	3.4	2.8	2.4	1.8	2.7	2.7	3.7	2.1	2.8	2.2
P50	9.0	7.5	5.6	5.2	7.4	4.0	7.2	7.0	5.7	5.8
P10	4.9	4.7	3.3	3.4	5.0	1.5	3.9	4.7	3.2	3.6
P90	13.0	11.8	9.0	8.2	11.2	7.0	12.6	9.8	9.4	8.6

[a] Ind = individual survey; f = female.

Table 9 Contributions (%) of selected food groups to the intake of total fat in the diet of population groups in European countries

	BEL m+f	*FIN* m+f	*FRA* m+f	*GER* m+f	*GRE* m+f	*ICE* m+f	*ITA* m+f	*NET* m+f	*NOR* m+f	*POR* m	*SPA* m+f	*SWE* m+f	*UKI* m+f
Milk and milk products (ice-cream included)	5.0	15.4	6.4	5.5	7.0	16.9	7.3	8.6	13.6	7.6	10.4	13.1	12.1
Cheese	9.8	6.7	14.0	6.9	8.7	8.6	12.9	10.4	9.7	7.2	3.0	13.5	6.2
Eggs	1.3	2.0	2.7	3.8	0.7	1.6	2.6	1.9	2.2	2.9	2.8	3.3[a]	2.0
Meat, meat products	26.7	23.0	23.4	28.9	11.4	17.6	13.3	21.2	18.6	28.3	23.7	19.3[a]	18.5
Fish	1.6	3.1	1.5	1.1	2.8	4.8	0.4	1.5	5.6	4.2	1.6	3.4[a]	1.1
Butter	4.7	9.8	19.3	26.7	0.1	5.3	5.3	2.5	3.4	5.1	0.6	8.7	6.1
Oils and fats	18.6	24.2	9.7	15.3	31.2	20.3	46.5	22.3	16.1	25.6	43.1	8.0	26.0
Biscuits, buns, cakes, fruit pies, etc.	7.4	3.5	7.5	5.2	5.6	7.0	6.6	8.8	5.1	6.1	5.2	9.6	9.3
Pizza, meat pies, vegetable pies, etc.	0.1	2.5	(b)	(b)	7.1	0.5	0.4	1.0	1.7	(b)	0.4	2.4	3.9
Other grain and grain products	5.8	< 0.1	0.7	1.8	4.6	3.0	3.7	3.9	7.6	1.3	2.6	4.8	3.5
Seeds, kernels, nuts	0.7	(b)	1.9	0.3	3.6	0.8	0.0	5.2	1.6	(b)	1.6	0.7	1.5
Chocolate, candybars and confectionery	3.2	1.7	2.1	1.9	2.4	2.9	0.7	2.6	3.1	0.7	1.2	2.0	1.9
Soups and sauces	5.4	0.8	2.4	< 0.1	1.3	4.9	0.2	3.9	6.4	3.7	< 0.1	5.3	1.5
Savoury snacks	0.7	0.3	(b)	0.2	0.3	0.0	< 0.1	2.1	2.1	0.8	0.8	0.7	3.6
Chips, french fries	7.1	0.3	4.0	< 0.1	2.8	1.4	(b)	1.8	2.0	5.6	1.0	3.7	1.7
Industrial meals, restaurant foods	< 0.1	3.5	2.5	0.1	5.0	0.0	< 0.1	1.0	(b)	(b)	(b)	(b)	1.0
Miscellaneous	1.7	3.2	1.7	2.1	4.3	4.2	(b)	0.5	1.2	0.9	0.7	1.7	0.2

[a]Data also included dishes.
[b]No information/data not able unambiguously to distinguish.

Table 10 Contributions (%) of selected food groups to the intake of total Trans fatty acids in the diet of population groups in European countries

	BEL m+f	*FIN* m+f	*FRA* m+f	*GER* m+f	*GRE* m+f	*ICE* m+f	*ITA* m+f	*NET* m+f	*NOR* m+f	*POR* m	*SPA* m+f	*SWE* m+f	*UKI* m+f
Milk and milk products (ice-cream included)	5.6	20.7	8.7	8.2	13.1	14.2	16.1	5.4	9.5	14.0	23.8	18.3	11.0
Cheese	10.6	8.4	16.8	14.0	24.0	5.4	33.8	8.4	7.4	16.3	7.5	14.2	7.8
Eggs	0.2	< 0.1	1.6	0.8	0.1	0.2	0.7	0.2	0.1	0.3	0.6	1.0[a]	0.9
Meat, meat products	20.7	4.8	11.4	5.3	14.6	15.0	13.4	12.3	6.6	26.2	29.8	10.1[a]	10.3
Fish	1.0	2.2	0.8	0.9	2.4	0.6	0.1	0.1	1.3	3.3	0.5	0.9[a]	0.6
Butter	6.2	10.2	35.4	49.6	0.4	4.6	12.1	2.9	2.8	9.0	1.4	8.2	5.9
Oils and fats	18.0	37.6	3.7	12.1	0.4	31.3	6.9	33.0	46.4	10.0	9.0	1.2	35.5
Biscuits, buns, cakes, fruit pies, etc.	13.5	6.6	14.6	7.5	15.7	14.2	14.5	13.2	10.5	12.7	13.3	20.6	16.5
Pizza, meat pies, vegetable pies, etc.	0.7	1.8	(b)	(b)	14.1	0.3	0.6	0.7	1.8	(b)	0.7	2.2	3.5
Other grain and grain products	3.4	0.0	0.3	< 0.1	5.9	4.0	0.2	1.6	10.1	1.8	10.0	3.9	0.5
Seeds, kernels, nuts	0.1	(b)	0.2	0.0	2.5	0.1	(b)	(b)	0.0	(b)	0.0	(b)	0.0
Chocolate, candybars and confectionery	2.9	0.9	1.0	0.4	2.3	2.5	0.3	2.8	1.8	0.1	0.2	1.8	1.4
Soups and sauces	3.8	1.0	0.7	0.2	0.4	2.1	0.8	1.1	0.4	0.3	0.4	2.4	0.1
Savoury snacks	1.0	0.4	(b)	0.0	0.1	0.0	< 0.1	4.5	0.3	0.4	0.5	0.7	0.9
Chips, french fries	12.6	2.9	2.3	0.2	0.6	3.2	< 0.1	12.5	0.9	5.8	0.7	13.7	4.5
Industrial meals, restaurant foods	< 0.1	1.5	2.7	< 0.1	4.1	0.0	< 0.1	0.5	(b)	(b)	(b)	(b)	0.5
Miscellaneous	0.6	0.6	0.0	0.8	0.2	1.8	(b)	0.1	0.0	0.0	(b)	0.7	0.4

[a]Data also included dishes.
[b]No information/data not able unambiguously to distinguish.

Table 11 Contributions (%) of selected food groups to the intake of saturated fatty acids in the diet of population groups in European countries

	BEL m+f	*FIN* m+f	*FRA* m+f	*GER* m+f	*GRE* m+f	*ICE* m+f	*ITA* m+f	*NET* m+f	*NOR* m+f	*POR* m	*SPA* m+f	*SWE* m+f	*UKI* m+f
Milk and milk products (ice-cream included)	7.9	23.6	9.3	7.6	10.4	21.1	14.0	13.9	21.5	12.5	20.5	18.6	19.3
Cheese	15.0	8.7	17.3	10.1	16.7	11.7	24.0	15.9	15.0	11.4	5.9	19.8	9.6
Eggs	0.9	1.5	1.9	2.5	0.6	1.0	2.2	1.2	1.5	2.3	2.7	2.5[a]	1.8
Meat, meat products	25.1	19.5	20.2	18.2	13.9	18.9	15.3	20.1	18.6	28.1	29.0	17.6[a]	17.1
Fish	0.8	1.5	(b)	0.5	2.2	2.1	0.3	0.6	3.2	2.5	1.1	1.2[a]	1.2
Butter	7.3	12.6	30.1	39.4	0.3	7.0	9.3	4.1	4.8	8.6	1.1	10.1	9.9
Oils and fats	15.1	19.1	2.4	11.6	17.0	20.1	21.6	17.2	11.6	19.8	23.7	8.1	14.1
Biscuits, buns, cakes, fruit pies, etc.	8.6	3.5	6.3	6.6	9.9	6.4	9.0	10.4	5.1	6.8	7.1	8.4	11.2
Pizza, meat pies, vegetable pies, etc.	0.1	2.1	(b)	(b)	10.1	0.5	0.4	1.1	2.4	(b)	0.3	2.5	3.8
Other grain and grain products	3.9	< 0.1	1.9	0.2	3.3	1.9	2.6	2.3	4.7	0.7	1.9	2.0	1.9
Seeds, kernels, nuts	0.3	(b)	(b)	< 0.1	2.6	0.3	(b)	2.3	0.5	< 0.1	0.5	0.2	0.9
Chocolate, candybars and confectionery	4.0	2.5	3.0	2.2	3.2	4.1	1.2	3.2	4.2	1.2	2.4	2.6	3.0
Soups and sauces	3.4	0.3	(b)	< 0.1	0.7	1.0	0.1	1.9	2.7	1.5	< 0.1	2.5	0.7
Savoury snacks	0.7	0.2	(b)	< 0.1	0.4	0.0	0.1	1.4	2.4	0.8	1.1	0.7	3.1
Chips, french fries	5.7	0.2	2.2	< 0.1	2.0	0.8	0.0	2.6	0.5	2.9	1.6	2.9	1.7
Industrial meals, restaurant foods	< 0.1	2.6	(b)	< 0.1	4.7	0.0	< 0.1	1.0	(b)	(b)	(b)	(b)	0.8
Miscellaneous	1.2	2.1	(b)	0.9	2.1	2.7	(b)	0.4	1.3	1.0	0.4	0.7	0.2

[a]Data also included dishes.
[b]No information/data not able unambiguously to distinguish.

Table 12 Contributions (%) of selected food groups to the intake of Cis Monounsaturated fatty acids in the diet of population groups in European countries

	BEL m+f	*FIN* m+f	*FRA* m+f	*GER* m+f	*GRE* m+f	*ICE* m+f	*ITA* m+f	*NET* m+f	*NOR* m+f	*POR* m	*SPA* m+f	*SWE* m+f	*UKI* m+f
Milk and milk products (ice-cream included)	3.6	11.1	2.9	5.2	5.3	14.1	3.9	4.7	10.7	4.4	6.1	10.6	8.4
Cheese	7.3	4.1	8.5	7.1	3.9	6.0	6.5	7.4	8.1	4.5	1.8	10.0	4.1
Eggs	1.4	2.4	2.8	6.1	0.7	2.0	2.1	2.6	3.2	3.3	2.3	3.9[a]	2.7
Meat, meat products	32.2	28.5	30.0	43.1	10.9	21.4	12.6	29.5	27.1	30.8	24.2	25.5[a]	19.2
Fish	2.0	3.1	(b)	2.1	1.9	6.2	0.2	2.1	5.1	2.9	0.3	2.4[a]	1.0
Butter	3.6	5.9	14.9	10.6	0.1	5.1	2.7	2.0	2.7	2.9	0.4	8.0	3.9
Oils and fats	15.2	27.2	16.2	19.0	48.4	18.5	63.0	16.8	12.9	34.7	56.5	9.9	31.3
Biscuits, buns, cakes, fruit pies, etc.	5.8	2.9	5.7	3.3	3.9	6.8	5.3	7.7	4.5	3.6	4.4	9.8	9.6
Pizza, meat pies, vegetable pies, etc.	< 0.1	3.1	(b)	(b)	5.1	0.6	0.4	1.1	1.7	(b)	0.2	2.2	4.6
Other grain and grain products	5.3	< 0.1	(b)	0.3	1.9	2.6	2.5	2.8	6.1	0.6	0.9	3.8	3.5
Seeds, kernels, nuts	1.5	(b)	(b)	< 0.1	3.5	1.1	(b)	7.2	2.3	0.1	0.0	1.1	2.2
Chocolate, candybars and confectionery	3.4	1.5	2.3	2.2	1.8	3.3	0.7	3.4	3.6	0.6	0.9	1.9	1.8
Soups and sauces	7.1	1.0	(b)	0.1	1.3	8.9	0.1	5.1	5.6	5.7	< 0.1	6.5	1.1
Savoury snacks	0.8	0.3	(b)	< 0.1	0.2	0.0	< 0.1	2.6	2.8	0.8	0.7	0.7	3.7
Chips, french fries	8.4	0.2	7.0	< 0.1	1.2	1.7	0.0	2.1	0.6	3.9	1.1	4.0	1.4
Industrial meals, restaurant foods	< 0.1	4.7	(b)	0.2	6.3	0.0	< 0.1	1.8	(b)	(b)	(b)	(b)	1.4
Miscellaneous	2.3	4.1	(b)	0.6	3.6	1.5	(b)	0.4	2.9	1.1	0.0	1.0	0.2

[a]Data also included dishes.
[b]No information/data not able unambiguously to distinguish.

Table 13 Contributions (%) of selected food groups to the intake of Cis Polyunsaturated fatty acids in the diet of population groups in European countries

	BEL m+f	*FIN* m+f	*FRA* m+f	*GER* m+f	*GRE* m+f	*ICE* m+f	*ITA* m+f	*NET* m+f	*NOR* m+f	*POR* m	*SPA* m+f	*SWE* m+f	*UKI* m+f
Milk and milk products (ice-cream included)	0.8	3.0	(b)	1.2	2.9	2.3	1.1	1.3	1.5	1.0	1.3	4.3	2.1
Cheese	1.2	1.0	2.1	1.4	1.9	1.3	2.0	1.1	1.1	0.9	0.5	2.0	0.7
Eggs	1.2	2.3	2.7	6.5	0.7	2.3	2.5	2.0	1.5	2.6	2.3	4.1	1.5
Meat, meat products	19.4	23.0	19.1	21.9	8.9	8.4	6.9	12.9	7.9	19.8	15.8	15.3	12.2
Fish	1.8	5.2	4.3	1.8	11.9	11.9	0.9	2.2	8.7	7.5	1.4	6.0	1.2
Butter	0.6	1.0	3.4	6.1	< 0.1	1.1	0.8	0.3	1.7	0.7	< 0.1	5.9	0.7
Oils and fats	39.1	41.7	29.2	57.5	33.1	35.3	73.9	44.9	27.8	30.4	67.3	12.7	48.0
Biscuits, buns, cakes, fruit pies, etc.	5.1	2.3	5.2	2.2	6.2	6.3	5.1	5.1	3.8	7.2	4.7	13.6	5.7
Pizza, meat pies, vegetable pies, etc.	< 0.1	2.9	(b)	(b)	3.3	0.6	0.3	0.6	0.6	(b)	0.6	2.6	3.5
Other grain and grain products	7.4	< 0.1	7.9	0.5	7.2	6.7	5.8	7.0	15.0	2.3	3.3	11.7	6.8
Seeds, kernels, nuts	1.0	(b)	1.2	0.0	8.5	2.5	0.0	8.5	2.3	< 0.1	0.0	2.1	2.3
Chocolate, candybars and confectionery	2.0	0.6	(b)	0.6	3.6	1.0	0.4	1.3	0.9	0.2	0.3	0.7	0.4
Soups and sauces	7.9	1.7	10.9	0.1	3.4	12.7	0.3	6.6	22.1	5.6	< 0.1	12.2	5.4
Savoury snacks	0.8	0.3	(b)	< 0.1	0.3	(b)	< 0.1	2.2	1.2	0.8	0.9	0.6	6.4
Chips, french fries	9.2	< 0.1	6.5	0.1	11.1	2.9	0.0	1.2	0.2	15.4	0.6	3.8	1.7
Industrial meals, restaurant foods	< 0.1	5.2	(b)	0.1	3.3	(b)	< 0.1	2.0	(b)	(b)	(b)	(b)	1.2
Miscellaneous	2.2	5.7	(b)	0.1	2.6	4.3	0.0	0.7	3.6	5.5	0.0	1.2	0.1

[a]Data also included dishes.
[b]No information/data not able unambiguously to distinguish.

Iceland. Therefore, it is interesting to have insight into the different dietary patterns in the various countries. In the Mediterranean countries more than half the intake of TFA came from animal sources. In most countries these products contributed about 40–70% of total fat intake (in Greece only 31%). Oils and fats from vegetable and animal origin provided from less than 10% of total fat intake in Sweden and France to more than 40% in Spain and Italy. More detailed information on the different types of fat (results not shown) indicate that, in preparing meals, vegetable oils are most popular in Greece, Italy, Portugal and Spain, and butter in Germany and France (partly in combination with vegetable oils in France), whereas in the other countries cooking and frying fats, sometimes combined with hard household margarines and/or butter, are the types most commonly used. This explains why edible fats (especially fats for frying and baking) contributed about 30–46% of mean TFA intake in Finland, Iceland, The Netherlands, Norway and the United Kingdom but much less in the other countries.

Since vegetable oils are good sources for UFA, differences in sources for the intake of SFA, MUFA and PUFA between the countries are evident. Differences in intake among the more Northern countries might also be a consequence of changes in fatty acid compositions in margarines and low-fat spreads. In Denmark (Ovesen *et al*, 1996), Finland, France (Bayard and Wolff, 1995), Germany (Fritsche & Steinhart, 1997a), Italy and Sweden, the proportion of TFA in margarines had already been reduced during the year preceding the sampling in 1995–1996. In The Netherlands and Norway, similar development was evident during or soon after sampling (Aro *et al*, 1988a). Indeed, analyses on new food products from The Netherlands in 1997 indicated that TFA intake would now be another 10–20% lower owing to new product formulations (unpublished data). In Belgium, The Netherlands and Sweden, french

fries/chips were also important sources of TFA (12–14%). The TRANSFAIR analyses showed high TFA in french fries/chips in these countries. In some types ≈30% of total fatty acid content came from TFA (Aro *et al*, 1998c). Also some bakery products, savoury snacks and popcorn contained relatively high proportions of TFA. For instance, the proportion of TFA in cookies and biscuits ranged from <1% to 28% and that in sweet pastry from almost 0% to 33% (Van Erp *et al*, 1998). The proportion of TFA in popcorn ranged from <1% to ~33% (Aro *et al*, 1998c). The TFA pattern (high C_{16t}, C_{20t} and C_{22t}) indicated use of partially hydrogenated fish oils in Iceland and Norway.

When we compare intake figures between countries, it should be realized that different dietary methodologies were used in different countries. Since the household survey data from Spain, the United Kingdom and Italy are based on food purchases, they may overestimate intakes as compared with individual survey data. On the other hand, household survey estimates include all age groups and may thus be somewhat lower than the individual survey estimates for 19 to 64 y as presented for the other countries, and in Spain and the United Kingdom outside consumption was not (fully) included. The individual survey data in the countries were also collected using different methods. All methods used are appropriate for getting valid information on mean intake (Cameron & van Staveren, 1988) and means can readily be compared. However, data based on long-term habitual consumption provide more stable intake estimates than data based on short-term intake in comparing 10th and 90th centiles. In our study, a 24-h recall was used only by Greece and Portugal, both countries with a very low TFA intake. For the Dutch data, based on a 2-d record, adjustment of distributions for within-person variance (National Research Council, 1986) was used to obtain more accurate values for the 10th and 90th centiles.

The comparison of food groups between countries also requires some caution, since the databases in some countries did not always allow for a complete standardisation of the food groups. In particular, mixed dishes may be treated differently in coding procedures. For instance, in Sweden fat used in cooking was included in the codes of dishes (e.g. partly in eggs, meat and meat products and fish) and therefore included in the contribution of these food groups. This explains the relatively low contribution of edible fats in this country to the intake of all types of fats.

Finally, data were not fully nationally representative for some countries. Data from Belgium used in this study refer only to the Flemish North. Owing to differences in fat intake (Kornitzer & Bara, 1989) and in the use of edible fats (Den Hond *et al*, 1994), the TFA intake for the total Belgian population could be somewhat lower than reported in this study. Data from Germany came from the former East Germany, just after reunification. In the former West Germany, median total fat intake was about 10% lower in 1985–1988 (Heseker *et al*, 1992). In 1992, Steinhart & Pfalzgraf estimated the daily TFA intake in the former Federal Republic of Germany to be 3.4 g/d for adult women and 4.1 g/d for adult men. In 1997, owing to decreased TFA contents in German margarine and lower meat consumption since 1992, estimated daily intake was 1.9 g/d for women and 2.3 g/d for men (Fritsche & Steinhart, 1997b), which is in agreement with our results. However, in the new states the supply of new and/or other foods might have changed dietary intake pattern. Data from Greece came from Crete only, but the nutrient intake pattern was quite similar to that earlier described (Kafatos *et al* 1998). For Portugal, recent consumption data in the age 19–64 y were available only for men aged 38 years. Calculations for 70 to 75-year-old men and women from the Seneca study (Moreiras *et al*, 1991) showed lower TFA intake. Thus, we do not expect that TFA intake was underestimated in countries that could not provide representative data.

For a valid estimate of the 10th and 90th centiles, a sample size of 80 is considered minimal (FASEB, 1995). Our data from Portugal with 78 subjects are just below this minimum. The 10th and 90th centiles in our data give an impression of subgroups with higher or lower TFA intake. In general, the 90th centile is 30–50% above the mean intake level. This indicates that higher intakes do occur, but that there seem to be no substantial groups with an extremely high intake in the age range 19–64 y. We cannot completely exclude a higher intake in younger age groups due to high consumption of snacks, chips and cakes. Other subgroups that have been suggested to have higher TFA intakes are those having a lower social class in a Scottish survey (Bolton-Smith *et al*, 1995), but a UK survey carried out in 1986/7 reported no significant differences in TFA intake between age, social class, or regional groups (Gregory *et al*, 1990; MAFF, 1994).

Concerns about possible adverse effects of TFA on health concentrate on whether the intake of TFA is associated with the development and/or acceleration of disease, thereby increasing morbidity and mortality. Some epidemiological evidence from estimates of TFA intake using food frequency questionnaires has suggested an association between TFA intake and the incidence of coronary heart disease (CHD) (Willett *et al*, 1993; Ascherio *et al*, 1994; Pietinen *et al* 1997). Using the same US Nurses Health Study that was used by Willett (*et al* 1993), Hu *et al* (1997) estimated that an increase of 2% of energy from TFA would result in 93% extra risk of cardiovascular diseases (CVD), whereas a 5% increase in SFA would result in a 17% increase of CVD risk. Other epidemiological studies, however, have not identified an association with CVD, and it has been suggested that the Nurses Health Study shows a biased association (Editorial, 1995). Scientists now fiercely debate whether TFA is more harmful than SFA, and whether 'natural' *trans* would be different from industrial *trans*. Our results cannot resolve this issue but show that the current TFA intake in most Western European countries (0.5–2.1% of energy) is lower than in the US Nurses' Health Study, with a mean TFA intake of 2.2% of energy at baseline of the study (Hu *et al*, 1997).

Discussions of the impact of TFA on coronary heart disease, however, cannot be separated from those of total fat and SFA intakes. Looking at the results of this part of the TRANSFAIR study, it is clear that in many countries total fat as well as SFA intake is higher than recommended from a health point of view. Furthermore, in most countries (except Spain and Greece (about 25–30%)) about 40–50% of the total fat intake is coming from SFA-rich sources. Numerous studies have shown the relation between coronary heart disease and SFA intake (Kris-Etherton & Yu, 1997). Major SFA sources are spreads, cooking and frying fats, butter, milk and milk products and meat and meat products. If TFA is as harmful as SFA with regard to CVD, then the further industrial introduction of 'low *trans*' spreads, cooking and frying fats and shortening fat will

contribute to only slightly the reduction of CVD. In practice, as described by Aro *et al* (1998a) the TFA in 'low *trans*' spreads and baking fats is only partially replaced by PUFA and partially by SFA, and as such results in an increase in the total SFA intake. If TFA is indeed more harmful than SFA, then industrial lowering of *trans* in products would have more pronounced effects, but only in those countries with the higher TFA intakes (ICE, BEL, NET, UKI, NOR). In the other European countries, intake of TFA is already low and in the majority of them TFA is of natural animal origin. Hence possibilities for industrial reductions are limited here. It has been suggested that 'natural' TFA would be less harmful than 'industrial'; TFA, but the metabolic basis for this remains unclear (Willlett *et al*, 1993). The reduction of TFA from natural sources can only be accomplished by consumption of low-fat or skimmed milk products and lean types of meat, and by reducing butter intake. Therefore, changing from high-fat products to low-fat variants will introduce a concomitant decrease of total fat as well as SFA intake, which is attractive from a public health perspective.

The importance of the TRANSFAIR study lies in the estimation of intake figures in 14 Western European countries, using for this purpose best available food consumption data and an accurate and recent analytical database. While the scientific debate on the metabolic effects of TFA continues, the current intakes of TFA in most Western European countries do not appear to be a reason for major concern. In several countries a considerably high proportion of energy was derived from saturated fatty acids. More health benefits would therefore be derived from efforts to reduce consumption of all cholesterol-raising fatty acids (both saturated and TFA) than from focusing on TFA alone.

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