# *Trans* fatty acids in the Scottish diet

## An assessment using a semi-quantitative food-frequency questionnaire*

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***Trans* fatty acids produced during hardening of oils have been associated with higher cholesterol levels and increased risk of heart disease. The potential risk from *trans* fatty acids may be greater in populations with relatively low intakes of essential fatty acids such as the Scots, who also have a high prevalence of heart disease. Means and ranges of *trans* fatty acid intakes are reported here for a Scottish population. A semi-quantitative food-frequency questionnaire was used to survey the diet of 10359 Scottish men and women aged 40–59 years in 1984–6 as part of the baseline Scottish Heart Health Study. *Trans* fatty acid levels were calculated for each food item on the questionnaire and the total subdivided into that which is derived naturally (primarily by bacterial fermentation in ruminants) and that which is produced during industrial hydrogenation (hardening) of vegetable and fish oils. Means and ranges of intakes of each *trans* fatty acid variable were calculated by sex, age, smoking and social class groups. Mean total *trans* fatty acid intakes for men were 7·1 (SD 3·1) g/d, 2·7 (SD 2·9) % energy and for women were 6·4 (SD 2·9) g/d, 3·3 (SD 3·0) % energy. Industrially hydrogenated *trans* fatty acids made up nearly 58% of the total intake for men and 61% for women, with about 60% coming from cakes, biscuits and sweets, and 20% coming from the cheaper hard margarines. The main sources of the naturally derived *trans* fatty acids were red meat (27%), milk (20%), butter (18–19%) and cheese (13–16%). Differences between age, smoking and social class groups were apparent. However, apart from the social class differences of up to 1 g/d, these were so small that they are unlikely to be of any biological significance unless compounded by other factors such as marginal essential fatty acid adequacy. The possibility of *trans* fatty acid intakes up to 48 g/d and 12% total energy (compared with the Department of Health (1991) recommendations of 5 g/d or 2% energy) highlights the need for careful monitoring of the health risks at these high levels of intake.**

***Trans* fatty acids: Margarine: Food-frequency questionnaire: Social class**

Recent reports on the effects of dietary *trans* fatty acids (tFA) on blood lipid levels (Mensink & Katan, 1990; Troisi *et al.* 1992; Lichtenstein *et al.* 1993; Judd *et al.* 1994) and coronary risk in the USA (Willett *et al.* 1993; Ascherio *et al.* 1994) have fuelled new interest in tFA in relation to health. Before this resurgence in tFA-related research, the stance of government and health organizations has been that the evidence against tFA has been insufficient to merit warnings of health detriment to the general population (Federation of American Societies for Experimental Biology, 1985; British Nutrition Foundation, 1987). Recommendations for upper limits have nevertheless been set (Department of Health, 1991; Scottish Office, Home and Health Department, 1993).

* Dedicated to the fond memory of Dr Colin Andrew Brown: an outstanding scientist.

Since the mid 1950s when saturated fats were linked with CHD risk, margarine manufacturers have preferred to use hydrogenated vegetable and fish oils rather than naturally hard (high saturated fat) animal fat to provide the firmness and texture of their products. This has meant that the tFA content of margarines has in general been greater than that of natural products such as butter and lard.

Functionally it may be important to differentiate between naturally occurring tFA in meat and dairy products (mainly *trans*-11 C18:1, vaccenic acid derived from bacterial fermentation in the rumen) and tFA which are produced as a result of hydrogenation (hardening) of liquid vegetable (mainly *trans*-9 C18:1, elaidic acid) and fish oils (*trans* isomers of C18:1 to C24:1) (Peacock & Wahle, 1988; Willett *et al.* 1993). Specifically, elaidic acid may interfere with essential fatty acid metabolism, such that people with only a marginally adequate linoleate intake may be at greater risk of ill effects from tFA (Wahle & James, 1993). The Scots, who are renowned for their high prevalence of CHD, may have a high risk of CHD due to low intakes of linoleic acid (Reimersma *et al.* 1986; Wahle *et al.* 1991; Bolton-Smith *et al.* 1992*a*), and so may also be particularly susceptible to tFA in their diet.

Reports on tFA intakes in UK populations are sparse: an assessment of tFA was made in the *Dietary and Nutritional Survey of British Adults* (Gregory *et al.* 1990), but little difference was revealed between population subgroups. Since information on fat type, meat and dairy product consumption was available as part of the semi-quantitative food-frequency questionnaire data-set from the Scottish Heart Health Study (SHHS), it was both pertinent and possible to make an assessment of usual intakes of tFA in middle-aged Scottish men and women and to investigate differences between social and lifestyle groups. Values for total, natural hydrogenation (primarily ruminant) and industrial hydrogenation-derived tFA are reported here and these are compared with the current recommendations and previously reported values.

## SUBJECTS AND METHODS

The subjects were 10359 men and women aged 40–59 years who participated in the Scottish Heart Health Study between 1984 and 1986. These people were recruited from general practitioner registers across Scotland in a cross-sectional manner in 5-year age-stratified bands. Health and socio-demographic details were elicited by questionnaire and a blood sample and body measurements were obtained at a clinic visit. The overall response rate was 74% (excluding Post Office returns) after one reminder letter. The full recruitment details and study protocol have been reported previously (Smith *et al.* 1989).

Diet was assessed by a validated semi-quantitative food-frequency questionnaire (FFQ) (Bolton-Smith *et al.* 1991*c*, *b* for the macronutrients and antioxidant vitamins respectively, and Bolton-Smith *et al.* 1992*b* for linoleic acid). Specific validation of the FFQ for tFA intake was not possible since the adipose tissue fatty acid analysis did not include *trans* isomers. The FFQ consisted of sixty questions on the usual frequency of consumption of foods/food groups and family consumption of fats, cheese, milk and sugar. The frequency options were 1–7 d/week, fortnightly, and rarely or never. Alcohol intake was determined by a 7 d recall question.

tFA levels were assigned to the food or food groups used in the FFQ based on values from a variety of sources, including the Ministry of Agriculture, Fisheries and Food (MAFF), literature values and 'confidential' product information from industry. Since the survey was carried out in the mid 1980s, care was taken to use tFA values obtained from food analysis at that time, as far as was possible. Total tFA values were subdivided into naturally occurring (N-tFA) or industrial hydrogenation-derived (H-tFA) fat. Thus N-tFA included the naturally occurring tFA in ruminant meat and meat products, lard, butter and dairy produce as well as the tFA reported to be in fish, poultry, eggs and potatoes. H-tFA

Table 1. *Intakes of* trans *fatty acids for men and women in Scotland*
(Mean values, standard deviations and ranges)

| | Men | | | Women | | |
|---|---|---|---|---|---|---|
| | Mean | SD | Range | Mean | SD | Range |
| Total | | | | | | |
| (g/d) | 7·1 | 3·1 | 0·8–33·7 | 6·4 | 2·9 | 0·4–47·6 |
| (% En) | 2·7 | 0·9 | 0·45–11·6 | 3·3 | 1·1 | 0·33–11·6 |
| (% Fat) | 7·8 | 2·1 | 2·8–21·5 | 8·2 | 2·3 | 1·2–22·4 |
| N-tFA | | | | | | |
| (g/d) | 2·9 | 1·3 | 0–11·4 | 2·5 | 1·1 | 0–9·1 |
| (% En) | 1·1 | 0·4 | 0–3·0 | 1·3 | 0·5 | 0–3·4 |
| (% Fat) | 3·2 | 0·9 | 0–6·4 | 3·2 | 0·9 | 0–5·6 |
| H-tFA | | | | | | |
| (g/d) | 4·2 | 3·0 | 0·2–24·6 | 3·9 | 2·8 | 0·2–44·0 |
| (% En) | 1·6 | 0·1 | 0·2–10·4 | 1·9 | 1·2 | 0·2–10·8 |
| (% Fat) | 4·6 | 2·7 | 0·5–20·6 | 5·0 | 2·9 | 0·5–21·0 |

Total, total *trans* fatty acids; N-tFA, natural sources of *trans* fatty acids (primarily ruminant); H-tFA, *trans* fatty acids formed during hydrogenation of oils; % En, percentage of total energy intake, inclusive of alcohol; % Fat, percentage of total fat intake.

included the tFA occurring naturally and as a result of hydrogenation of vegetable and fish oils used in household and commercial margarines and oils for spreading, cooking and baking. No detailed information was available from the FFQ regarding the proportion of cooking oil which was reused in deep frying. It was therefore necessary to set a value (10% of the total oil consumed) and assign to this an appropriate tFA level of 35% of total fat. The tFA values were integrated into the FFQ analysis programme which used the McCance and Widdowson food composition tables (Paul & Southgate, 1978) and appropriate updates of the time. (The precise tFA values set for each item on the FFQ are available from the authors.)

Of the 10359 men and women who participated in the SHHS, 164 were excluded from the sub-population analyses of tFA intake due to missing information regarding the type of spreading fat or cooking oil used. These people were otherwise representative of the whole population (i.e. they did not belong to any one particular subgroup).

### *Statistical analysis*

The mean and standard deviation for tFA intakes (g/d and percentage of total dietary energy) are reported by sex and 5-year age group, smoking habit (current, ex-, never smokers) and occupational social class (non-manual I–IIIN; manual IIIM–V; Office of Population Censuses and Surveys, 1980). Women were classified according to their husbands' occupation if pertinent, or otherwise by their own occupation. The classification of the unemployed and retired was based on their last previous employment. Spearman rank correlation coefficients were determined between tFA intake and dietary total, saturated and polyunsaturated fat (all as g/d). Skewed distributions of intakes were normalized (by logarithm and square root transformation) before ANOVA to detect significant differences between the population subgroups. The untransformed values are reported in the tables and figures.

## RESULTS

Table 1 gives the mean and range of tFA intake for men and women. The 5th and 95th percentiles for total tFA were 3·3 g/d (1·5% energy) and 12·7 g/d (4·3% energy) for men,

Table 2. Trans *fatty acid intake by age group in Scottish adults*

(Mean values and standard deviations)

| | Men | | | | | Women | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Age (years)... | 40–44 | 45–49 | 50–54 | 55–59 | | 40–44 | 45–49 | 50–54 | 55–59 | |
| *n*... | 1223 | 1172 | 1328 | 1250 | *P*† | 1330 | 1251 | 1327 | 1262 | *P*† |
| g/d | | | | | | | | | | |
| Total | 7·1 | 7·1 | 7·1 | 7·2 | NS | 6·3 | 6·4 | 6·5 | 6·6 | * |
| (SD) | (3·0) | (3·3) | (3·2) | (3·1) | | (2·3) | (3·0) | (2·9) | (3·1) | (3·0) |
| N-tFA | 2·9 | 3·0 | 2·9 | 3·0 | NS | 2·4 | 2·5 | 2·5 | 2·6 | * |
| (SD) | (1·3) | (1·3) | (1·3) | (1·3) | | (1·0) | (1·1) | (1·2) | (1·2) | (3·7) |
| H-tFA | 4·2 | 4·1 | 4·2 | 4·2 | NS | 3·9 | 3·9 | 4·0 | 4·0 | NS |
| (SD) | (2·8) | (3·1) | (3·1) | (3·0) | | (2·7) | (2·8) | (2·7) | (3·0) | |
| % Energy | | | | | | | | | | |
| Total | 2·7 | 2·7 | 2·8 | 2·8 | **** | 3·2 | 3·2 | 3·3 | 3·3 | *** |
| (SD) | (0·86) | (0·94) | (0·94) | (0·98) | (12·4) | (1·08) | (1·08) | (1·11) | (1·08) | (5·5) |
| N-tFA | 1·1 | 1·1 | 1·1 | 1·2 | *** | 1·2 | 1·3 | 1·3 | 1·3 | ** |
| (SD) | (0·35) | (0·39) | (0·41) | (0·42) | (7·5) | (0·43) | (0·46) | (0·46) | (0·47) | (4·4) |
| H-tFA | 1·6 | 1·5 | 1·6 | 1·7 | ** | 2·0 | 1·9 | 2·0 | 2·0 | * |
| (SD) | (0·94) | (1·04) | (1·06) | (1·08) | (4·2) | (1·23) | (1·22) | (1·25) | (1·24) | (2·7) |

Total, total *trans* fatty acids; N-tFA, natural sources of *trans* fatty acids (primarily ruminant); H-tFA, *trans* fatty acids formed during hydrogenation of oils.

† Significance of differences by ANOVA (*F* values in parentheses) on the transformed variables.

* $P < 0·05$, ** $P < 0·01$, *** $P < 0·001$, **** $P < 0·0001$.

Table 3. Trans *fatty acid intake by smoking group in Scottish adults*

(Mean values and standard deviations)

| | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| Smoking status... | Current | Ex- | Never | | Current | Ex- | Never | |
| *n*... | 1927 | 1267 | 1144 | *P*† | 1944 | 1052 | 2121 | *P*† |
| g/d | | | | | | | | |
| Total | 7·3 | 7·1 | 7·1 | NS | 6·4 | 6·2 | 6·6 | ** |
| (SD) | (3·3) | (3·2) | (3·0) | | (3·1) | (2·9) | (2·9) | (8·0) |
| N-tFA | 3·2 | 2·8 | 2·7 | **** | 2·7 | 2·3 | 2·4 | **** |
| (SD) | (1·3) | (1·3) | (1·2) | (63) | (1·2) | (1·1) | (1·1) | (65) |
| H-tFA | 4·1 | 4·3 | 4·4 | **** | 3·7 | 3·9 | 4·2 | **** |
| (SD) | (3·2) | (3·0) | (2·8) | (9·8) | (2·9) | (2·7) | (2·7) | (31) |
| % Energy | | | | | | | | |
| Total | 2·6 | 2·8 | 2·9 | **** | 3·2 | 3·2 | 3·4 | **** |
| (SD) | (0·97) | (0·96) | (0·89) | (34) | (1·09) | (1·08) | (1·08) | (26) |
| N-tFA | 1·2 | 1·1 | 1·1 | *** | 1·4 | 1·2 | 1·2 | **** |
| (SD) | (0·41) | (0·39) | (0·39) | (7·5) | (0·47) | (0·45) | (0·44) | (51) |
| H-tFA | 1·5 | 1·7 | 1·8 | **** | 1·8 | 2·0 | 2·1 | **** |
| (SD) | (1·08) | (1·04) | (1·00) | (49) | (1·26) | (1·18) | (1·22) | (57) |

Total, total *trans* fatty acids; N-tFA, natural sources of *trans* fatty acids (primarily ruminant); H-tFA, *trans* fatty acids formed during hydrogenation of oils.

† Significance of differences by ANOVA (*F* values in parentheses) on the transformed variables.

** $P < 0·01$, *** $P < 0·001$, **** $P < 0·0001$.

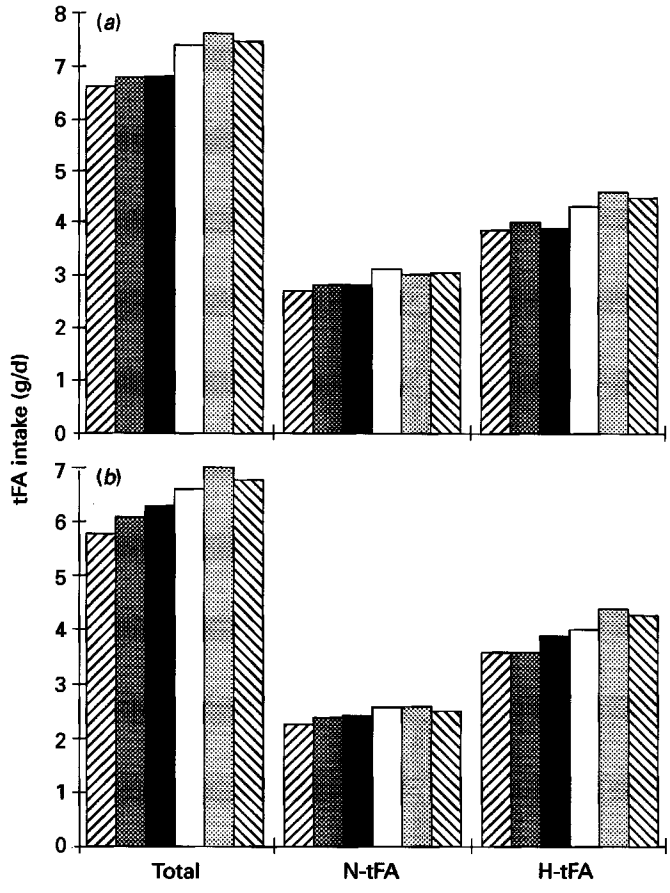


Fig. 1. *Trans* fatty acid (tFA) intakes (g/d) in Scottish adult men (*a*) and women (*b*) according to social class group. (▨), Group I; (▩), group II; (■), group IIIN; (□), group IIIM; (▧), group IV; (▧), group V. Total, total tFA; N-tFA, natural sources of tFA (primarily ruminant); H-tFA, tFA formed during hydrogenation of oils. Differences between social class groups were significant (ANOVA, $P < 0{\cdot}001$) for each tFA variable for both sexes.

and 2·7 g/d (1·8% energy) and 11·7 g/d (5.2% energy) for women. Quantitatively, tFA intake was greater in men than women, but as a percentage of total energy or total fat it was lower in men than women. H-tFA made up nearly 58% of total tFA for men and 61% for women. For men, total, N-tFA and H-tFA correlated significantly (all $P < 0{\cdot}001$) with dietary total fat ($r$ 0·75, 0·73 and 0·39 respectively), with saturated fat ($r$ 0·64, 0·87 and 0·21 respectively), and with polyunsaturated fat ($r$ 0·43, −0·15 and 0·54 respectively). For women the correlation coefficients were very similar, if not identical, to those for men.

tFA intakes by 5-year age groups are shown in Table 2. There was no significant difference in intake (g/d) for men with age, while a small increase in total and N-tFA occurred with age for women ($P < 0{\cdot}05$). Expressed as a percentage of energy (% energy), significant differences occurred in tFA intakes with age for men and for women. However the magnitudes of the differences were small (0·1% energy) and unlikely to be of biological significance.

Mean tFA intakes for the different smoking groups are reported in Table 3. N-tFA were higher in current than never smokers, and the reverse was true for H-tFA. The differences

Table 4. *Percentage of* trans *fatty acids from each food group in the diet of Scottish adults*

(Mean values and standard deviations)

| | Total | | | | H-tFA | | | | N-tFA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Men | | Women | | Men | | Women | | Men | | Women | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Breads | 2·2 | 1·7 | 1·7 | 1·4 | 6·4 | 12·0 | 5·0 | 10·0 | 0 | | 0 | |
| Red meat | 11·8 | 6·6 | 11·2 | 6·7 | 0 | | 0 | | 27·4 | 12·4 | 27·2 | 13·1 |
| Meat products | 3·5 | 3·4 | 2·5 | 2·8 | 0 | | 0 | | 8·4 | 7·7 | 6·3 | 6·8 |
| Puddings* | 31·1 | 15·4 | 34·9 | 15·8 | 59·7 | 27·3 | 64·4 | 27·4 | 0 | | 0 | |
| Milk | 8·9 | 6·0 | 8·4 | 6·1 | 0 | | 0 | | 20·6 | 12·2 | 20·3 | 13·1 |
| Cream | 0·4 | 0·88 | 0·5 | 1·10 | 0 | | 0 | | 0·8 | 2·0 | 1·1 | 2·4 |
| Cheese | 5·4 | 4·2 | 6·4 | 5·1 | 0 | | 0 | | 12·9 | 9·1 | 16·1 | 11·3 |
| Butter | 10·6 | 13·2 | 11·3 | 13·7 | 0 | | 0 | | 17·6 | 19·5 | 19·4 | 20·7 |
| PUFA margarines | 4·7 | 11·1 | 4·9 | 11·6 | 7·5 | 18·1 | 7·7 | 1·0 | 0 | | 0 | |
| Other margarines + lard | 15·4 | 21·9 | 14·3 | 21·5 | 21·2 | 30·7 | 19·8 | 29·6 | 2·2 | 3·4 | 1·3 | 2·0 |
| Vegetable oils | 2·2 | 3·0 | 1·2 | 1·6 | 5·2 | 10·4 | 3·1 | 7·6 | 0 | | 0 | |
| Other† | 3·4 | 5·2 | 2·2 | 4·1 | 0 | | 0 | | 9·2 | 10·3 | 7·2 | 9·8 |
| Total | 100 | | 100 | | 100 | | 100 | | 100 | | 100 | |
| Mean t-FA (g/d) | 7·1 | 3·1 | 6·4 | 2·9 | 4·1 | 3·0 | 3·9 | 2·8 | 2·9 | 1·3 | 2·5 | 1·1 |

Total, total *trans* fatty acids; N-tFA, natural sources of *trans* fatty acids (primarily ruminant); H-tFA, *trans* fatty acids formed during hydrogenation of oils; PUFA, polyunsaturated fat.

* Including cakes and biscuits of all types.

† 'Other' foods supplying *trans* fatty acids are fish, poultry, eggs and potatoes.

between the groups (up to 0·5 g/d or 0·3 % energy) were statistically significant ($P < 0·01$) for all except total tFA for men, and represented a variation of 12–15 %.

Fig. 1 presents the mean t-FA intakes (g/d) by occupational social class. Total, N- and H-tFA intakes were higher in the lower social class groups, IIIM–V ($P < 0·001$ for all). When expressed as % energy the significant differences between the social class group persisted for women but were lost for men (results not shown).

Table 4 shows the nutrient source data for the total and component tFA by sex. The 'pudding' group of foods (including all cakes, biscuits and sweets) was the largest provider of total tFA (and also of H-tFA) followed by other margarines (+ lard), red meat, butter and milk. The 'puddings' group provided about 60 % of the dietary intake of H-tFA, with approximately 20 % coming from other margarines. N-tFA came predominantly from ruminant meat (27 % of total), followed by milk and butter (20 %) and cheese at 13 % for men and 16 % for women. The sex difference in the contribution of cheese to N-tFA intakes was made up by more coming from the meat products and 'other foods' group for men than for women.

## DISCUSSION

In order to discuss these tFA results in relation to previous reports, the methods of assessment need comparison between studies. These data are based on a FFQ, and these, in general, are able to estimate nutrient intakes (to varying degrees of adequacy) in populations. The validity and results derived from this FFQ have been widely reported (e.g. Bolton-Smith *et al.* 1991*a–c*), although specific validation of tFA has not been possible. The tFA data which were incorporated into this FFQ came from a range of sources

including 'confidential' and published values for individual products, and the food group values used in the Total Diet Study (courtesy of MAFF) as appropriate. Hence the 'average' tFA value which was assigned to each food question on the FFQ was generally the mean of several estimates from different sources. Wherever possible (e.g. for branded margarines) the tFA value pertaining to the mid 1980s was used in preference to more up-to-date values. This is particularly pertinent when the large shift in types of oils used for margarine manufacture over the last 10 years is considered. In 1982 fish oil made up 43% of the oil used in the manufacture of margarines, and animal fat 13·7%. By 1992 these values were respectively 21·8% and 6·0% (from MAFF production figures for margarines and table spreads). The shift from hydrogenated fish oil to hydrogenated seed oils will have reduced the tFA content of margarines in general, while the reduction in the use of animal fats will have increased the potential for H-tFA in margarines.

An estimate of tFA intake based on the National Food Survey data (Burt & Buss, 1984) in the early 1980s produced a value of 7 g/d (men and women combined) and calculations based on possible extremes of intakes by these authors suggested a range of 5–27 g/d. Their average value is remarkably similar to that of 7·1 g/d for men and 6·4 g/d for women reported in this Scottish population; however, a greater range of intake appears possible (1–48 g/d).

In the only other population estimate of tFA levels in the UK diet (Gregory *et al.* 1990), intake was assessed by 7 d weighed records during 1986–7. While this is considered to be the most accurate method for determining intake of individuals, this can only improve the accuracy of population estimates if the nutrient values exist for all the individual foods recorded. Since such complete information on tFA is not available, the tFA intakes will have been culled from estimated and average values in a similar manner to that reported here. The lower mean intakes reported in *The Dietary and Nutritional Survey of British Adults* (Adult Survey) (5·6 and 4·0 g/d for men and women respectively compared with 7·1 and 6·4 g/d) may be partly accounted for by the high degree of 'under-reporting' (Pryer *et al.* 1994) which tends to be characteristic of weighed-record methodologies (Black *et al.* 1991). The range of intakes was also lower (men 1–21 g/d; women 1–14 g/d; MAFF, 1994*b*) than in the SHHS population.

It is interesting that the approximated H-tFA/N-tFA split in the Adult Survey was 51/49% for men and women, whereas that estimated from the National Food Survey data (Burt & Buss, 1984) was 57/43, and the values for the SHHS population were 58/42 for men and 61/39 for women. The SHHS values are nearer to those of 60/40 reported for American women in 1980 (Willett *et al.* 1993).

Reported mean intakes of tFA in the USA vary greatly depending on the method of assessment. A semi-quantitative FFQ has consistently provided estimates of about 4 g/d in surveys of men and women between 1980 and 1990 (Troisi *et al.* 1992; Willett *et al.* 1993; Ascherio *et al.* 1994). In contrast, *per capita* intake calculations by Hunter and Applewhite in 1984 (Hunter & Applewhite, 1986) and 1989 (Hunter & Applewhite, 1991) suggest intakes of 7·6 and 8·3 g/d respectively. However, different *per capita* calculations by Enig *et al.* (1990) 're-evaluated' previous estimates up to a mean of 13·3 g/d, with a range of 1·6–38·7 g/d. Clearly, with such disagreement of mean intakes from the same *per capita* data in the USA, it is difficult to judge how tFA intakes in America compare with the UK figures. Although hydrogenated vegetable oils are widely used in the USA, hydrogenated fish oils are virtually absent from the US diet (British Nutrition Foundation, 1987). In contrast, fish oils were widely used in the UK in the mid 1980s, and thus it may be reasonable to expect mean US intakes to be less than those of the UK. As such, the values reported by Willett and colleagues from FFQ data could be the most appropriate, although the range of intakes reported by Enig *et al.* (1990) is feasible. Estimates of mean tFA intakes

from other countries include 5 g/d in Sweden (Akesson *et al.* 1981), 6·5 g/d in Israel (Enig *et al.* 1984) and 2·4 g/d in Spain (Boatella *et al.* 1993).

Regarding the tFA intakes in subgroups of the SHHS population, the differences between groups were frequently significant but they were not large. Taken in isolation these differences may not be important; however, in conjunction with low linoleic acid intakes, for example in the manual social class groups, they may take on biological significance (Wahle & James, 1993). The difference in tFA intake between the social class groups may be due to the higher proportion of fat which comes from hard margarines and meat products (e.g. sausages, pies) in the manual compared with the non-manual groups (Bolton-Smith *et al.* 1991*a*). The Adult Survey (Gregory *et al.* 1990; MAFF, 1994*b*) reported no significant differences in tFA intakes between age, social class or regional groups but did find significantly higher intakes in those receiving benefits and in women with partners and dependants compared with lone mothers.

The differences in tFA intakes between the smoking groups appear to indicate that the potential coronary risk from H-tFA acts in the opposite direction compared with most other aspects of smoking. Nutrient source data (unpublished results) indicate that this may be due to a higher consumption of animal fats from spreads and meat products in smokers than non-smokers. Interestingly, the same pattern of higher N-tFA and lower H-tFA in smokers was reported by Willett *et al.* (1993) for American women.

The upper limits of tFA intake recommended by the Department of Health (1991) and the Scottish Office Home and Health Department (1993) of 5 g/d or 2% energy are presumably based on the results of the Adult Survey. Clearly the SHHS population mean is greater than this, and 5% of men and women consumed more than 12·7 and 11·7 g/d respectively. The need for recommending upper limits may be particularly important in populations which have low linoleic acid intakes (such as the Scots) due to the ability of certain tFA (primarily elaidic) to impede essential fatty acid metabolism. Since tFA are reported to alter the LDL:HDL-cholesterol ratio unfavourably, they would also be contra-indicated in groups, such as the Scots, which are at high risk of CHD. If the reported link between CHD and H-tFA intake (Willett *et al.* 1993) is confirmed, then maybe the recommendations should be specific for dietary H-tFA and not total tFA. However, we do not yet have sufficient information on which to base such a decision. The most recent reports of adipose tissue tFA levels in relation to sudden cardiac death (Roberts *et al.* 1995) and myocardial infarction (Aro *et al.* 1995) appear only to complicate the issue further, and an additional analysis of tFA intake and prevalent CHD from the SHHS data-set (Bolton-Smith *et al.* 1995) is by no means conclusive.

Further population assessments of tFA intakes are clearly needed in the 1990s since the National Food Survey data (MAFF, 1992) demonstrate a disproportionate decline in intake of fat from milk and milk products (39%) compared with total fat (18%) between 1981 and 1991. While this may have given rise to an increase in the H-tFA:N-tFA ratio over this period, the current situation is unclear since recent trends suggest a greater relative decline in margarine consumption than in milk-derived fats between 1991 and 1993 (MAFF, 1994*a*) and intake of vegetable oils is still increasing. Either way, the situation deserves monitoring particularly with regard to the health of vulnerable groups.

Although adherence to the current guidelines for an overall reduction in fat intake will also have the effect of reducing dietary tFA, given the increasing publicity regarding the potential harm from tFA, individuals may actively try to reduce their H-tFA intakes. From this public health perspective it is interesting that the proportion of H-tFA intake which may be most amenable to direct modification by an individual (i.e. that from spreading fats) makes up less than a third of total intake. The majority of H-tFA enter the diet as 'hidden' fat in cakes and biscuits (very few of these are made only with butter or pure oils). Thus

if further scientific evidence does support a need to reduce tFA intake from hydrogenated vegetable and fish oils, support from the cake and biscuit manufacturers would be required since only a limited reduction could be achieved by a shift in use from high H-tFA margarines to dairy and other equivalent low H-tFA spreads.

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