

# A Swiss population-based assessment of dietary habits before and after the March 1996 ‘mad cow disease’ crisis

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**Objective:** To assess differences in dietary habits in the general population of Geneva, Switzerland, after the 1996 (BSE) crisis.

**Design:** Repeated population-based survey during 1993, 1994, 1995 and 1996.

**Setting:** The Bus Santé 2000 epidemiological observatory of Geneva, Switzerland.

**Subjects:** A representative sample of 1190 men and 1154 women.

**Main outcome measure:** Dietary habits assessed by a semi-quantitative food frequency questionnaire.

**Results:** The proportion of women who reported not having eaten beef was 7.7% in 1993–1995 and went up to 14.6% in 1996 (age-adjusted difference +6.4%, 95% CI +2.4 to +10.4). Among men, the proportion of non-beef-eaters remained constant (5%). There was a sharp increase of women who did not eat liver (+14.7%, +9.1 to +20.3) but less so in men (+5.1%, -0.7 to +10.8). Among women who ate meat, the amount of beef intake decreased by 120 g/month (95% CI -208 to -36). While chicken intake increased (+44 g/month, -2 to 88), overall intake of meat (including poultry but not fish) declined by 204 g/month (or 2.7 kg per year). In men the decrease in beef intake was not statistically significant (-48 g/month, -172 to 80), but consumption of chicken increased (+56 g/month, +8 to +104). Fish intake was stable in both genders. The reduction in intake of animal protein (-3.5 g/day) in women and of retinol intake in both sexes (women -77 µg/day; men -56 µg/day) was statistically significant.

**Conclusions:** The BSE crisis coincided with spontaneous differences in food habits, especially in women, that may have nutritional consequences at the population level.

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**Descriptors:** beef; bovine spongiform encephalopathy; diet; survey

## Introduction

In April 1996, the British government expressed public concern about the possible transmission of the bovine spongiform encephalopathy (BSE) to humans (Brown, 1996). At that time, 10 cases of a new variant of Creutzfeldt–Jakob disease had been diagnosed among young English men and women (Will *et al*, 1996). There was no direct evidence that these cases could not be causally related to exposure to BSE-contaminated products, but the hypothesis of a transmission from cattle to humans could not be ruled out either (Will *et al*, 1996).

The BSE epidemic, more commonly known as the ‘mad cow disease’, has hit other European countries to a much smaller extent than the United Kingdom. The number of cows that died from BSE was about 160 000 from a cattle population of 11 million in the United Kingdom, but only about 300 from a cattle production of about 1.2 million in Switzerland, the country second most affected by the epidemic (Collee and Bradley, 1997).

Before April 1996, public apprehension about risk for humans related to BSE was essentially confined to the United Kingdom (Butler, 1997). After the announcement of a possible link between BSE and the new variant of

Creutzfeldt–Jakob disease, public apprehension about beef products became a European problem. The press has reported that the consumption of beef meat decreased by 5–45% across Europe. To our knowledge, these estimates were based on economic data relating to sales and stocks of meat, but no rigorous epidemiological assessment of individual dietary consumption has yet been reported.

A programme of surveillance of the diet of the adult population of Geneva has been on-going since 1993 and was active through the recent BSE crisis. It provides a unique opportunity to assess differences in dietary habits in an adult population from the country that has experienced the second largest incidence of BSE after the United Kingdom.

## Materials and methods

The Bus Santé 2000 project is a long-term, ongoing, community health, behavioural risk factor and nutrition survey conducted every year since 1993 (Morabia *et al*, 1997). Geneva (city and surroundings) has a population of 395 609 distributed over 242 km<sup>2</sup> of land. Data reported here comprise subjects randomly selected throughout 1993 to 1996 to represent the 89 000 male and 98 000 female non-institutionalized residents aged 35–74 years.

Subjects were identified from the residents’ register published every year using a standardised procedure. This list includes the first and last name, sex, age, nationality and address of each resident of Geneva. Random sampling in

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age- and sex-specific strata was proportional to the corresponding frequencies in the population. In the first letter mailed to a potential subject, the selected individual was asked to indicate a convenient day and time to visit a mobile epidemiology clinic. In case of non-response, up to seven attempts were made to reach the person by phone, at different times of the day and various days of the week, including Saturday and Sunday. Two more mailings were sent when a selected individual could not be reached by telephone. A person who could not be contacted after three mailings and seven phone calls was replaced using the same selection protocol. A systematic check in the following year's edition of the population register showed that over 90% of 'unreachable' subjects no longer resided in Geneva. Subjects who were contacted but refused to participate were not replaced. The recruitment of a potential subject was carried on within 2 weeks to 2 months. Yearly surveys are independent of one another. Each participant appears only once in the database. Overall participation rate was 63%.

The design of this survey was not considered apt to obtain a good participation of teenagers or subjects in their twenties, who are less stable and may feel less concerned by behavioural risk factors than middle-aged subjects. Also, it was felt that participation of subjects older than 75 y would be impaired by mental or motor problems.

Participants completed a self-administered, semiquantitative food frequency questionnaire (FFQ) at home. This FFQ covered the 4 weeks prior to day of completion. It was developed and tested in the target population (Bernstein *et al*, 1994, 1995). It comprised a list of about 80 food items and their serving sizes and food intake data were converted into daily energy, nutrient and alcohol intakes on the basis of a modified CIQUAL food composition table (Morabia *et al*, 1994).

All participants were invited to visit a mobile epidemiology clinic (Morabia *et al*, 1997) and to bring back the completed FFQ as well as a standardized questionnaire covering lifestyle factors, reproductive history and classic CVD risk factors. Both questionnaires were checked by trained technicians. No questionnaire was accepted if it could not be checked and completed in-person at the mobile clinic.

#### Statistical methods

The episode of the BSE crisis that we studied occurred in March 1996. The FFQ assessed food consumption over the 4 weeks prior to completion, questionnaires from May 1996 described the April diet and could be considered to reflect the population's diet after the 1996 BSE crisis. We therefore compared the diet of Genevans from May to December 1996 to the corresponding period before the BSE crisis, that is, May to December 1993, 1994 and 1995. Pooling of 1993 to 1995 data was reasonable because of the extreme stability of dietary habits during these three years (data shown only for beef and chicken intakes among women in Figures 1 and 2).

Food groups were defined as follows: fish (salmon, fried fish, tuna, lean fish, seafood), beef (all types of beef and veal meat), pork/lamb (cooked ham, pork ribs, lamb ribs, stew), chicken (not including turkey, duck or other poultry), liver (veal, heifer, chicken or pork liver), coldcuts (all types of sausages, saveloy, pâtés, pork pie, raw ham, bacon and salami). Beef, pork, lamb, chicken, coldcuts and liver were grouped as 'meat'. Non-consumers of any of these food

groups were defined as people who reported not having eaten these foods during the 4 weeks before interview.

Distributions of the intake of specific food groups over time were depicted by box-plots (Wilson, 1993). Differences in proportion of non-eaters of specific foods in 1996 compared to before 1996 were assessed as age-adjusted differences (with their 95% confidence intervals) computed using SAS procedure CATMOD for categorical data analysis. Differences in proportions were not influenced by education, smoking or nationality.

The nutrient intakes analysed here included total energy intake, total carbohydrate, complex carbohydrate, sucrose, total protein, protein from vegetable or animal sources, total fat, saturated fatty acids, polyunsaturated fatty acids, mono-unsaturated fatty acids, dietary fibres, calcium, cholesterol, iron, vitamin D,  $\beta$ -carotene and retinol intake, which is the fraction of vitamin A derived from animal foods.

Differences in absolute intakes of specific food groups and of retinol were computed after square root or natural logarithmic transformation of the variables to reach approximate normality but are presented after back-transformation to an arithmetic scale. The 95% confidence intervals of the back-transformed differences were computed using the delta method (Mood *et al*, 1963, p 181). Differences in intake before and after April 1996 were adjusted for age, education, nationality or current smoking using analysis of variance.

#### Results

A random sample of 1830 men and 1961 women completed the FFQ between January 1993 and December 1996. We excluded 640 men and 807 women who had been interviewed during the months of January to April between 1993 and 1996 because no data were available for the months of January to April after the BSE crisis. Table 1 presents the number of participants in each of the yearly surveys, by age and sex. Table 2 shows that the 1996 participants were not different from those of the previous surveys with respect to age, body mass index (BMI), education, nationality or current smoking status.

The proportion of non-consumers of meat was less than 2% in both genders before the crisis and did not change dramatically (Table 3). The proportion of women who reported not having eaten beef during the 4 weeks prior to interview was 7.7% in 1993–1995 and went up to 14.6% in 1996 (age-adjusted difference + 6.4%, 95% CI + 2.4 to + 10.4). Among men, the proportion of non-beef-eaters remained constant at about 5%. The proportion of people who did not eat either fish or chicken was stable in both sexes. There was a sharp increase in the proportion of non-consumers of liver, especially in women (+ 14.7%, + 9.1 to + 20.3). There were indications that women had tended to avoid coldcuts (+5.4% of non-eaters) but men had not (–3.9% of non-eaters).

**Table 1** Participants interviewed between May and December about their diet during the previous 4 weeks, for each year of the survey, by age and sex; Geneva, Switzerland

Sex	Age (years)	1993		1994		1995		1996		All	
		n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Men	35–74	243	(20.4)	239	(20.1)	350	(29.4)	358	(30.1)	1190	(100)
Women	35–74	200	(17.3)	275	(23.8)	315	(27.3)	364	(31.5)	1154	(100)

**Table 2** Characteristics of participants by sex and year of survey; Geneva, Switzerland

Sex	Variable	1993		1994		1995		1996	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE
Men	Age (years)	50.6	(0.7)	52.0	(0.7)	51.1	(0.6)	51.7	(0.6)
	BMI (kg/m <sup>2</sup> )	25.3	(0.2)	25.2	(0.2)	25.2	(0.2)	25.6	(0.2)
	Higher education (%)	32.9	(1.4)	26.0	(1.2)	28.0	(1.1)	29.1	(1.1)
	Swiss nationality (%)	65.8	(1.4)	69.9	(1.4)	58.0	(1.3)	69.6	(1.1)
	Current smoking (%)	32.1	(1.4)	26.8	(1.3)	21.4	(0.9)	29.9	(1.1)
Women	Age (years)	51.3	(0.8)	52.0	(0.6)	50.3	(0.6)	50.6	(0.6)
	BMI (kg/m <sup>2</sup> )	23.4	(0.3)	23.5	(0.2)	23.7	(0.2)	24.0	(0.2)
	Higher education (%)	33.5	(1.6)	33.4	(1.3)	35.6	(1.2)	34.6	(1.2)
	Swiss nationality (%)	73.5	(1.4)	76.4	(1.1)	69.2	(1.2)	74.0	(1.0)
	Current smoking (%)	27.0	(1.4)	19.6	(1.0)	27.9	(1.1)	22.0	(0.9)

**Table 3** Proportion of men and women who reported not having eaten specific food items during the 4 weeks previous interview, by time period; men and women aged 35–74 years; Geneva, Switzerland

Sex	Food item	May–December <sup>a</sup> 1993–1995 <sup>b</sup> (%)	May–December <sup>a</sup> 1996 <sup>c</sup> (%)	Difference (1996 minus 1993–1995)		
				Crude (%)	Age-adjusted (%)	Age-adjusted 95% CI
Women	No meat <sup>d</sup>	1.8	0.8	–1.0	–0.6	–2.0 to +0.8
	No beef	7.7	14.6	+6.9	+6.4	+2.4 to +10.4
	No pork/lamb	15.8	25.3	+9.5	+9.3	+4.2 to +14.4
	No liver	60.4	75.0	+14.6	+14.7	+9.1 to +20.3
	No coldcuts	23.7	28.3	+4.6	+5.4	0.0 to +10.9
	No chicken	5.6	5.8	+0.2	–0.2	–3.0 to +2.5
	No fish	3.7	4.1	+0.4	–0.3	–2.6 to +1.9
Men	No meat <sup>d</sup>	0.6	1.1	+0.5	+0.7	–0.5 to +1.9
	No beef	4.7	5.2	+0.5	+0.6	–2.0 to +3.2
	No pork/lamb	18.3	13.5	–4.8	–5.2	–9.5 to –0.8
	No liver	64.0	68.9	+4.9	+5.1	–0.7 to +10.8
	No coldcuts	13.3	9.5	–3.8	–3.9	–7.7 to –0.1
	No chicken	8.8	8.1	–0.7	–0.6	–3.9 to +2.8
	No fish	3.8	2.5	–1.3	–1.6	–3.6 to +0.4

<sup>a</sup>Month of interview.

<sup>b</sup>832 men and 790 women.

<sup>c</sup>358 men and 364 women.

<sup>d</sup>Pork, lamb, beef, chicken, liver and coldcuts.

Figure 1 depicts the evolution over time of the quantity of beef intake among female beef eaters before 1996 and in 1996, using box-plots. There was a great stability of the median and of the spread of intakes before the BSE crisis, but there was a drop of the median intake—and more generally of the whole distribution—in 1996. In men, stability of medians and spread persisted in 1996 (data not shown).

Quantities of intake before and after the crisis are given in Table 4. Among women who did not stop eating meat, total meat intake declined by 204 g/month (95% CI –344 to –60) and beef intake by 120 g/month (95% CI –208 to –36). Extrapolating to a year, this represents a reduction of about 2.7 kg of meat per year. Overall, the chicken intake did not increase substantially (+44 g/month, –2 to +88). However, Figure 2 shows an increase in chicken consumption during the months of September to December 1996 compared to 1993–1995. The trend of increased intake in 1996 was statistically significant ( $P=0.003$ ).

In men, consumption of beef and of total meat remained stable (Table 4) but there was a statistically significant increase in chicken intake (+56 g/month, +8 to +104).

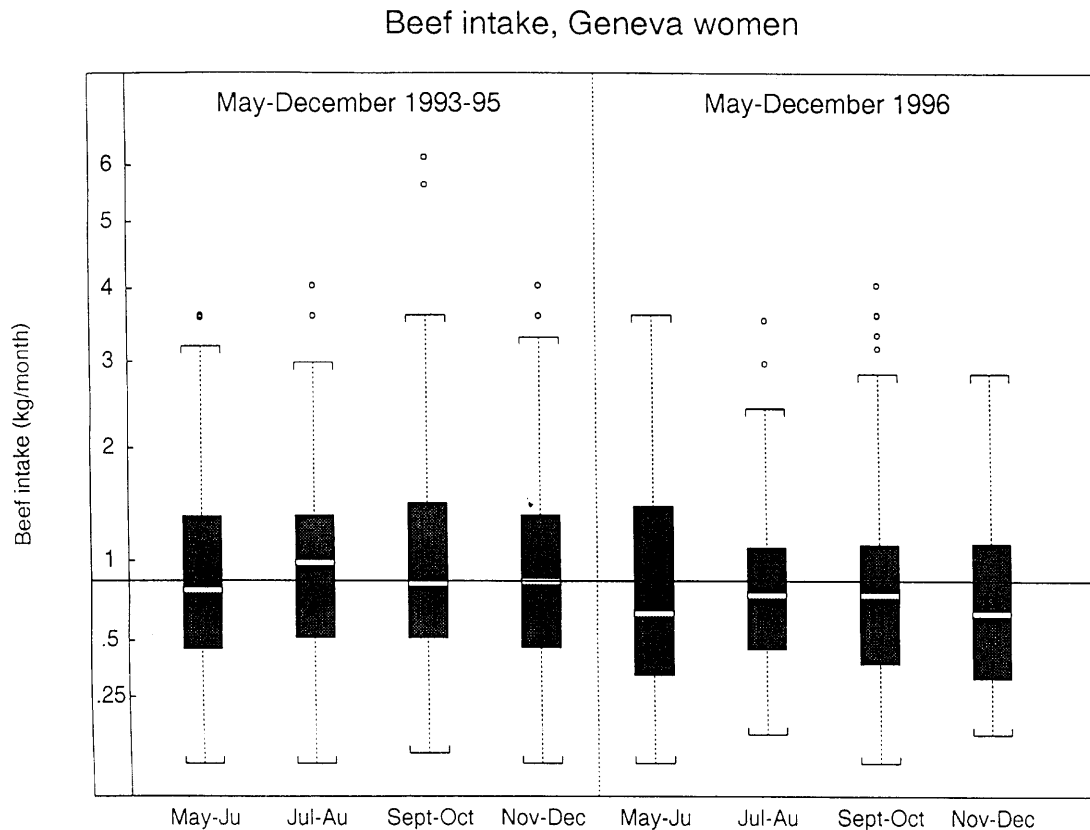
In both sexes, the average differences in quantities of coldcuts or liver intakes were not statistically significant (Table 4).

Table 5 assesses whether the change in dietary habits had any influence on nutrient intakes. Differences were small, but the reduced intakes of animal protein (–3.5 g/day) in women and of retinol intake in both sexes (women –77 µg/day; men –56 µg/day) were statistically significant. All other nutrients analysed, including those not shown in Table 5, remained stable.

The differences shown in Tables 3, 4 and 5 did not vary substantially according to education, nationality or current smoking (data not shown).

## Discussion

The present study shows that Genevan women either stopped eating beef, pork/lamb, and/or liver or reduced their intake of meat after the BSE crisis that followed the public announcement by the British government of a possible association between BSE-infected products and the risk of the new variant of Creutzfeldt–Jakob disease in March 1996. It seems that consumption of chicken increased during that same period. The only differences observed in men was a larger prevalence of subjects who did not eat liver and a greater intake of chicken among those who ate chicken. The only reduction in nutrient intake was



**Figure 1** Differences in quantity of beef intake among female beef eaters, by month and year of interview.

**Table 4** Median intake of specific food items before and after April 1996 among eaters of given food items; men and women aged 35–74 years; Geneva, Switzerland

Sex	Food item <sup>a</sup>	May–December <sup>b</sup> 1993–1995 (g/month)	May–December <sup>b</sup> 1996 (g/month)	Difference <sup>c</sup> (g/month)	95% CI
Women	No meat	1932	1728	–204	–344 to –60
	No beef	916	796	–120	–208 to –36
	Liver	144	124	–20	–44 to +4
	Coldcuts	248	232	–16	–48 to +16
	Chicken	428	472	+44	–2 to +88
	Fish	948	904	–44	–128 to +44
Men	Meat	2636	2716	+80	–120 to +276
	Beef	1336	1288	–48	–172 to +80
	Liver	152	136	–16	–36 to +4
	Coldcuts	364	364	0	–44 to +48
	Chicken	492	548	+56	+8 to +104
	Fish	916	980	+64	–32 to +160

<sup>a</sup>In the analysis, the variables meat, beef and chicken were square root transformed and the variables liver, coldcuts and fish were log transformed.

<sup>b</sup>Month of interview.

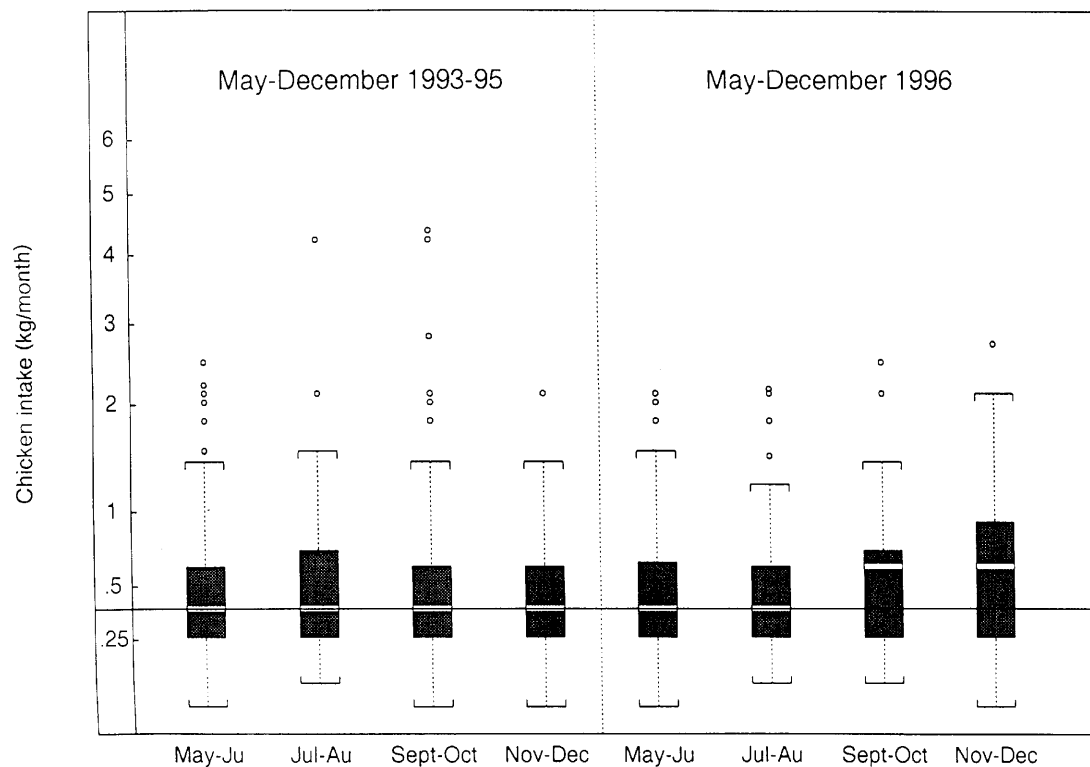
<sup>c</sup>Simultaneously adjusted for age, education, nationality and current smoking.

animal protein (–3.5 g/d) in women and retinol intake in both sexes (women –77 µg/d; men –56 µg/d).

This was a cross-sectional study and not a longitudinal follow-up of the diet of a cohort of subjects across time. Each subject appeared only once in the dataset. Because each year's sample was representative of the target population, we trust that the trends are valid at population level. Even so, it is in principle not acceptable to infer causality between the BSE crisis and the change in dietary habits. However, as shown in this paper, the dietary habits of the

Geneva population were extremely stable between 1993 and 1995. It is hard to conceive an alternative explanation that could have produced a sudden change in dietary habits in spring 1996. The BSE crisis may therefore accentuate a secular decline of meat intake in Western countries. Meat products have been criticised for their fat content or their influence on blood cholesterol levels as well as for their drug and hormone residues. A tendency towards consumption of less beef and more poultry, and perhaps more fish among the wealthiest, was already observable in Germany,

### Chicken intake, Geneva women



**Figure 2** Differences in quantity of chicken intake among women who ate chicken, by month and year of interview.

**Table 5** Average intake of specific nutrients before and after April 1996; men and women aged 35–74 years; Geneva, Switzerland

Sex	Nutrient	May–December <sup>a</sup> 1993–1995	May–December <sup>a</sup> 1996	Difference <sup>b</sup>	95% CI	
Women	Energy (kcal/d)	1779	1718	–61	–140	+17
	Vegetable protein (g/d)	21.2	20.8	–0.4	–1.5	+0.8
	Animal protein (g/d)	46.6	43.1	–3.5	–6	–1.0
	Total fat (g/d)	68.2	65.3	–2.9	–6.5	+0.6
	Saturated fatty acids (g/d)	24.9	23.6	–1.3	–2.8	+0.1
	Dietary fibre (g/d)	16.2	15.7	–0.5	–1.6	+0.5
	Retinol <sup>c</sup> (µg/d)	417	340	–77	–115	–39
	Iron (mg/d)	10.1	9.8	–0.3	–0.8	+0.1
Men	Energy (kcal/d)	2282	2339	+57	–42	+156
	Vegetable protein (g/d)	26.0	26.7	+0.8	–0.6	+2.1
	Animal protein (g/d)	59.4	60.5	+1.1	–2.1	+4.4
	Total fat (g/d)	87.2	88.2	+1.1	–3.6	+5.7
	Saturated fatty acids (g/d)	33.8	33.8	0.0	–2.1	+2.0
	Dietary fibre (g/d)	17.0	17.1	+0.1	–1	1.1
	Retinol <sup>c</sup> (µg/d)	533	476	–56	–106	–7.0
	Iron (mg/d)	12.6	13.0	+0.4	–0.2	+0.8

<sup>a</sup>Month of interview.

<sup>b</sup>Simultaneously adjusted for education, nationality and current smoking.

<sup>c</sup>In the analysis, the variable retinol was log transformed.

Switzerland and the United Kingdom (FAO, 1996). The British meat market had been suffering a marked downward trend in household consumption before 1989 when public concern about BSE first grew (Tilston *et al*, 1993). In Germany, between 1988 and 1992 consumption of pork and beef has declined by about 10% and chicken intake has increased by 12% (Brandscheid, 1993). The decline of beef consumption in Germany is strongest in women and young men (Schaeffler *et al*, 1996). In France, beef consumption has started to decline about 1980 in all social groups (Combris, 1997). In Italy (Zizza, 1997), a slow-down in

meat intake is noticeable in the wealthiest and youngest groups and fish consumption has increased despite price rises. Even Americans, traditionally consuming large amounts of meat, have started to eat less fatty red meat and more poultry and fish: red meat consumption fell 9 kg (15%) whereas poultry and fish consumption rose 11 kg (35%) from 1970 to 1990 (O'Brien, 1995).

The present survey indicates that there can be unwanted consequences of unstructured changes in dietary habits. The intake of liver decreased among women. Liver being the first source of retinol in the Genevan population

(Morabia *et al*, 1994), this phenomenon was sufficient to produce a decline in the absolute intake of retinol as other sources of retinol in the diet (butter, cheese, eggs, and milk; Morabia *et al*, 1994) did not compensate the deficit. In addition, the intake of green and yellow vegetables, which are rich in  $\beta$ -carotene, did not increase during the same period. The observed changes in nutrient intake seem to be different from those observed by Cade *et al* (1998) among meat-eating women who did not eat beef. Compared to beef eaters, the non-beef-eaters had lower energy, protein, zinc, fat and percentage of energy from fat, and higher fibre and vitamin C intakes. Additional changes may however occur among long-term non-beef-eaters. In any case, mass education campaigns are needed to explain ways of preparing a diet that compensates the decline of meat intake and prevents nutritional deficiencies.

The sex differences were striking but may have reasonable explanations. It is possible that stopping beef consumption was more difficult for men, who tend to have lunch outside their homes more often than women. Peer pressure against dietary changes reflecting fear may also be stronger on men than on women. Nevertheless, we cannot rule out that these sex differences reflect a more accurate description of their diet by women.

The objective of the study was to assess the consequences of the BSE crisis. However, as proposed by Gore *et al* (1997) for the United Kingdom, the description of the dietary habits of the population may also give clues to a possible dietary aetiology of the new variant of Creutzfeldt–Jakob disease. Unfortunately, participants were aged 35 years or more and we could not investigate potential differences in consumption of meat products between teenagers and older adults (Draper *et al*, 1990; Kenyon and Barker, 1998).

Fish did not appear as a popular beef substitute in our population. The available information does not allow us to determine the reasons for this, but it is probably not due to an underestimation of fish intake by the FFQ used in our survey since fish appeared as four different items (salmon, fried fish; tuna; lean fish such as cod, colin or trout; seafood).

The strength of this study is the continuous monitoring since 1993 of the diet of Genevans using a FFQ previously tested against dietary 24-hour recalls within that same population (Bernstein *et al*, 1994; Morabia *et al*, 1994). Changes in dietary habits may, however, have influenced the validity of the FFQ. Portions of food items such as meat or vegetables may have changed. Food items that contributed little to the total caloric intake in 1990 may have become more important today and, vice versa, and important food items in 1990 may have become marginal in 1996–97. However, these limitations are unlikely to have influenced the estimates of non-eaters of given food items (Table 3). We do not believe that a major misclassification bias due to a loss of validity of the FFQ may have resulted from changes in the diet for the following reasons: (a) most food items that could be consumed as alternatives to beef, pork and lamb belonged to the food list of the FFQ; (b) subjects had the possibility to indicate whether their portions of a specific food item were larger or smaller than the median portions. Nevertheless, the absence of poultry other than chicken and of soy products (other than tofu) among the food items listed in the FFQ may be two important

exceptions, since intakes of turkey and duck (which were not typical of the Genevan diet before 1996) and of soy products have probably risen in 1996. This limitation of the questionnaire may have led to an underestimation of the compensation of red meat by poultry or plant-based meat substitutes.

The BSE crisis coincided with spontaneous differences in food habits, especially in women, that may have nutritional consequences at the population level.

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