

Energy, macronutrient and fatty acid intake of French elderly community dwellers and association with socio-demographic characteristics: data from the Bordeaux sample of the Three-City Study

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Few data are available regarding dietary habits of the elderly, in particular about fatty acid consumption, whereas these are major risk or protective factors of several age-related diseases. The aim of the present study was to characterise the dietary intake of a French elderly population in terms of energy, macronutrients and fatty acids based on their socio-demographic characteristics. The study population (age range 67.7–94.9 years) consisted of 1786 subjects from Bordeaux (France), included in the Three-City cohort. Dietary assessment was performed by a 24 h recall, allowing the estimation of energy, protein, carbohydrate, total fat, SFA, MUFA and PUFA intakes. Socio-demographic characteristics (age, sex, marital status, educational level and income), practice of sports and BMI were registered. Total energy intake (EI) was lower in women and in older participants (≥ 85 years) but higher in single subjects. Higher EI was associated with higher income, but not with educational level. Mean contribution of macronutrients to EI (protein 18 %, carbohydrate 46 % and total fat 31 %) was higher in women than men, except for alcohol. The oldest individuals consumed less protein and more mono- and disaccharides. Excess saturated fat intake (43 % of total fat), associated with a relative deficit in MUFA consumption (36 % of total fat), was observed. The mean 18:2n-6:18:3n-3 ratio was 9.9 and decreased with higher educational level. The present results suggest that being female, older age, being widowed and low income level could be considered as risk factors of inadequate dietary intake.

Cohort studies: Nutrition: Ageing: Fatty acids

The increasingly higher life expectancy observed in developed countries is in most part attributed to a decline of mortality at older ages. Besides considerable improvement in healthcare of older individuals, better living conditions and, in particular, healthy dietary practices, may explain this greater longevity¹. In addition to the general recommendations for adults, the older population has specific nutritional requirements in order to avoid protein–energy malnutrition and also more subtle deficiencies due to imbalanced diets. In particular, there is a growing interest in the putative protective effects of *n*-3 PUFA against CVD², cancer³ and neuro-psychiatric disorders⁴, such as dementia⁵ or depression⁶, whose incidence sharply increases with age. The respective essential fatty acid precursors of the *n*-3 (18:3n-3; α -linolenic acid) and *n*-6 (18:2n-6; linoleic acid) families cannot be endogenously synthesised and must therefore be provided by diet. The dietary ratio of essential fatty acids (*n*-6:*n*-3) must also be considered. This has led to the recommendation of about 2 % of total energy for adults provided by 18:2n-6, 1 % by 18:3n-3 and 0.3 % by EPA and DHA taken together

(with at least 0.05 % each)^{7,8}. Knowing that the biosynthesis of long-chain PUFA occurs only at a very low rate in young adults as in the elderly⁹, and that experimental evidence indicates that the activity of the desaturase enzyme, which converts essential precursors in longer-chain PUFA, might be decreased in ageing^{10,11}, the needs for EPA and DHA must be mostly covered by way of diet. Therefore, the evaluation of the adequacy of fatty acid intake in the older population requires an estimation of the dietary intake of both precursors and long-chain PUFA. However, few data have been published regarding dietary fat intake of free-living elderly individuals and insufficient data are available on the actual intake of individual PUFA in human populations. Moreover, a good knowledge of dietary patterns is necessary to improve dietary counselling provided to high-risk individual groups whose characteristics have yet to be identified.

In France, where life expectancy is among the highest in the world¹², very few epidemiological studies have focused on nutrient intake of representative samples of elderly community dwellers. Surveys of the food habits of the French population

Abbreviations: EI, energy intake.

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were conducted in 1998–9 and in 2002 in representative samples but they did not include individuals over age 75 years¹³. The SU.VI.MAX study reported very detailed data on dietary fat intake of French adults but did not include subjects over age 60 years¹⁴. Therefore, we lack data on fatty acid intake of the elderly, whereas this might contribute to the particularly high life expectancy¹⁵ and low CHD mortality rate observed in France (the so-called ‘French paradox’)¹⁶.

The aim of the present study was to describe patterns of energy and macronutrient intakes and their link to socio-demographic characteristics in a population-based sample of elderly community dwellers in south-western France, with a special focus on dietary fat intake.

Subjects and methods

The data come from the Three-City Study, a prospective cohort study of vascular risk factors of dementia whose methodology is described in detail elsewhere^{17,18}. The protocol of the Three-City Study was approved by the Consultative Committee for the Protection of Persons participating in Biomedical Research of the Kremlin-Bicêtre University Hospital (Paris, France). To be eligible for recruitment into the Three-City Study, individuals had to be (a) living in Bordeaux, Dijon or Montpellier (three French cities), (b) aged 65 years and over and (c) not institutionalised. A personal letter was sent to each potential subject inviting them to participate and including a brief description of the study protocol and an acceptance and refusal form. Subjects from the Bordeaux sample were randomly chosen from the electoral rolls of ten districts of the urban area of Bordeaux in order to ensure a representative socio-economical variability. Hence, a sample of 9294 community dwellers was selected in 1999–2000 from the electoral rolls of Bordeaux (*n* 2104), Dijon (*n* 4931) and Montpellier (*n* 2259). All participants signed a written consent. The baseline (wave 1) data collection included socio-demographic information, lifestyle, symptoms and complaints, main chronic conditions, neuropsychological testing, a physical examination and a blood sampling. The present study is based on the second wave (wave 2) of data collection conducted in 2001–2 in Bordeaux, which placed a particular emphasis on nutritional data.

Dietary assessment

In Bordeaux, 1811 individuals already visited at wave 1 participated in the nutritional survey included in wave 2 of the Three-City Study. We did not intend to be representative of the whole Three-City cohort but of the Bordeaux sample. All these participants were visited at home by one of the four specifically trained dietitians who administered a FFQ and a 24 h dietary recall during a face-to-face interview. These dietitians received a collective training and monitoring to optimise the standardisation of the nutritional interviews. The 24 h recall was used to estimate nutrient intake. During the 24 h recall the dietitian registered all the meals and beverages consumed in a period of exactly 24 h before the subject awoke on the day of the interview. No weekend day was recorded. Quantities were assessed according to a book of photographs¹⁹ edited for the SU.VI.MAX study²⁰. The book showed three portion sizes for each food and proposed two

intermediate categories plus one below the smallest one and one above the largest one; i.e. seven portion sizes were available for each of the 236 foods or beverages. A table gave the correspondence between the portion size and the weight of the food item. Photographs of dishes and glasses with the corresponding volume were also available. The same dietitian then entered the data of the 24 h recall in the BILNUT[®] software (SCDA Nutrisoft, Cerelles, France) to obtain an estimation of the daily nutrient intake of each participant. Food composition tables for France²¹ are included in the BILNUT[®] software. Detailed data for fatty acids from the food composition and nutrition tables edited by Souci *et al.*²² were added. As the 24 h recall was open-ended, additional data were found by consulting a French table developed by the Institut National de la Santé et de la Recherche Médicale (INSERM) and the University of Montreal²³, the United States Department of Agriculture National Nutrient Database, on food packaging, and by contact with food manufacturers. Some specific data for fatty acids were directly provided by the Institut des Corps Gras – Centre Technique Industriel (ITERG) in Bordeaux.

The results are expressed in quantities and in proportion of total energy intake (EI) with or without alcohol. For fatty acids, results are also expressed in percentage of total fat.

As suggested by Willett *et al.*²⁴ the validity of dietary questionnaires was assessed by the evaluation of the association between total fat intake estimated from the 24 h recall and ln(TAG) assessed at wave 1²⁴.

Other variables

Age was recorded at the time of the dietary survey. Three age groups were defined as follows: less than 75 years, between 75 and 84 years and 85 years and over. Socio-demographic information recorded at wave 1 included sex and education (in four classes: no education or primary school only, secondary (middle) school, high school, vocational school or university). Socio-demographic characteristics also included marital status (married, divorced or separated, widowed, single), and income in five categories (less than €750, €750 to €1500, €1500 to €2250, more than €2250 per month and refuse to answer). Individuals who did not know their monthly income were added to the group of subjects who refused to answer this question.

Practice of physical exercise was assessed between waves 1 and 2 on a self-administered questionnaire by two questions: ‘Do you practise sports?’ (yes or no) and ‘Do you perspire when you practise sports?’ (never, sometimes, most of the time, always). A three-level variable was computed to describe intensity of physical exercise: no physical exercise (answer no to the first question); moderate intensity (answer yes to the first question and never or sometimes to the second one); high intensity (answer yes to the first question and most of the time or always to the second one). Subjects who did not answer the first question were represented in another group (‘no answer’).

Height (m) was measured at wave 1. Weight (kg) was measured by the dietitian at the time of the dietary survey. BMI was computed as the weight/height² ratio and then grouped in five categories (less than 21, 21–23, 23–27, 27–30 and more than 30 kg/m²) according to Guigoz *et al.*²⁵ and Heiat *et al.*²⁶ as previously established by Deschamps *et al.*²⁷.

The calculation of the BMR (MJ/d) was predicted using Henry's equations based on age, sex and body weight²⁸. For men aged 60–69.9 years, the equation used is $BMR = 0.0543 \text{ weight} + 2.37$; for men aged 70 years and over, $BMR = 0.0573 \text{ weight} + 2.01$. For women aged 60–69.9 years, the equation used is $BMR = 0.0429 \text{ weight} + 2.39$; for women aged 70 years and over, $BMR = 0.0417 \text{ weight} + 2.41$.

The macronutrient and fatty acid intakes were compared with the French RDA⁸ and, for 20:5n-3, with the recommended levels of EPA intake of Simopoulos *et al.*⁷.

Statistical methods

Intakes of energy and macronutrients were described by their mean, standard deviation, median and quartiles. The cross-sectional associations of total EI and nutrient intake with socio-demographic characteristics of the participants were assessed by Student's *t* test (when comparing two categories) or by ANOVA (when comparing more than two categories) followed by Dunnett's *post hoc* tests to compare means of categories with one of them taken as the reference group. Dunnett's statistical significance was accepted at $P < 0.05$. Stepwise backward linear regression was used to identify the socio-demographic variables associated with total EI. The normal distribution of EI was verified since the mean and the median were similar and the mean ± 2 SD included about 95% of the total EI of the subjects.

The SAS statistical package (version 9.1; SAS Institute Inc., Cary, NC, USA) was used for these analyses.

Results

After exclusion of twenty-two participants who gave incomplete information on the 24 h recall and three with extremely low reported EI (less than 2000 kJ/d), the sample included 1786 participants aged 67 (range 67.7–94.9) years and over (62.7% women, mean age 76.8 years and 37.3% men, mean age 76.1 years). Their total EI based on their socio-demographic characteristics is given in Table 1. Men had a significantly higher EI mean than women (8389 v. 6335 kJ; $P < 0.0001$). Mean EI was significantly lower after age 85 years, for widowed individuals and for individuals with incomes below €750. Mean EI was significantly higher in participants with a higher educational level (significant Dunnett's tests).

The total EI was described based on BMI and the practice of physical exercise (Table 2). Weight and height data were absent in 152 subjects. In the remaining 1634 participants, total EI was not significantly different between the five predefined categories of BMI of the whole population, as was the case in men, although the EI was lower in the group of subjects whose BMI was the highest. However, the reported EI was significantly higher in women with BMI higher than 23 kg/m² (significant Dunnett's test). As expected, the mean EI significantly increased with the intensity of the practice of physical exercise.

Since all these socio-demographic characteristics are closely linked, they were entered as dummy explanatory variables in a multilinear regression model on total EI (Table 3). In the whole population, female sex and age 85 years and over were significantly related to a lower EI whereas being

Table 1. Total energy intake based on socio-demographic characteristics of elderly community dwellers from Bordeaux (France), 2001–2002

| Socio-demographic characteristic | <i>n</i> | Energy intake (kJ) | | | | | | <i>P</i> † |
|----------------------------------|----------|--------------------|------|--------------|--------|--------------|-------------|------------|
| | | Mean | SD | 1st quartile | Median | 3rd quartile | Range | |
| Total | 1786 | 7100 | 2272 | 5427 | 6933 | 8556 | 2176, 16900 | |
| Sex | 1786 | | | | | | | <0.0001 |
| Men | 666 | 8389 | 2243 | 6983 | 8242 | 9774 | 3046, 16900 | |
| Women | 1120 | 6335 | 1912 | 5004 | 6130 | 7422 | 2176, 14519 | |
| Age (years) | 1786 | | | | | | | 0.006 |
| < 75 (reference group) | 769 | 7259 | 2368 | 5494 | 7037 | 8719 | 2200, 16900 | |
| 75–84 | 904 | 7025 | 2180 | 5418 | 6912 | 8460 | 2176, 15322 | |
| ≥ 85 | 113 | 6594 | 2230 | 5050 | 6381 | 7858 | 2498, 13146 | * |
| Marital status | 1782 | | | | | | | <0.0001 |
| Married (reference group) | 946 | 7506 | 2218 | 5895 | 7268 | 8941 | 2351, 15322 | |
| Divorced or separated | 141 | 7054 | 2335 | 5197 | 7029 | 8510 | 2335, 13644 | |
| Widowed | 577 | 6448 | 2155 | 4954 | 6121 | 7719 | 2176, 14343 | * |
| Single | 118 | 7125 | 2410 | 5335 | 6979 | 8519 | 2402, 16900 | |
| Education | 1777 | | | | | | | <0.0001 |
| No or primary (reference group) | 619 | 6791 | 2159 | 5243 | 6699 | 8021 | 2200, 14975 | |
| Secondary | 479 | 7058 | 2163 | 5468 | 6933 | 8481 | 2276, 15192 | |
| High school | 366 | 7234 | 2397 | 5456 | 7000 | 8749 | 2176, 16900 | * |
| University | 313 | 7594 | 2389 | 5824 | 7385 | 9100 | 2347, 14494 | * |
| Monthly income (€) | 1786 | | | | | | | <0.0001 |
| < 750 (reference group) | 139 | 6167 | 2008 | 4720 | 5996 | 7372 | 2200, 13506 | |
| 750–1500 | 545 | 6736 | 2180 | 5188 | 6468 | 8000 | 2402, 14518 | * |
| 1500–2250 | 434 | 7226 | 2234 | 5427 | 7058 | 8569 | 2176, 16900 | * |
| ≥ 2250 | 519 | 7623 | 2322 | 5837 | 7456 | 9100 | 2598, 15192 | * |
| Refused to answer | 149 | 7113 | 2297 | 5619 | 7004 | 8514 | 2276, 15322 | * |

* Mean value was significantly different from that of the reference group ($P < 0.05$; Dunnett's test).

† By ANOVA comparing mean energy intake.

Table 2. Total energy intake based on body mass index and physical exercise of elderly community dwellers from Bordeaux (France), 2001–2002

| Variable | n | Energy intake (kJ) | | | | | | P† |
|--------------------------|------|--------------------|------|--------------|--------|--------------|--------------|---------|
| | | Mean | SD | 1st quartile | Median | 3rd quartile | Range | |
| BMI (kg/m ²) | 1634 | | | | | | | 0.10 |
| All subjects | | | | | | | | |
| < 21 | 181 | 7259 | 2293 | 5519 | 7063 | 8648 | 2874, 15 322 | |
| 21–23 | 249 | 7155 | 2167 | 5594 | 6945 | 8468 | 2176, 13 510 | |
| 23–27 | 669 | 7293 | 2222 | 5627 | 7138 | 8757 | 2347, 15 192 | |
| 27–30 | 322 | 7088 | 2406 | 5259 | 6837 | 8807 | 2276, 14 974 | |
| ≥ 30 | 213 | 6824 | 2289 | 5259 | 6586 | 8180 | 2335, 16 900 | |
| Men | 635 | | | | | | | 0.16 |
| < 21 | 33 | 8502 | 2464 | 6895 | 8594 | 9464 | 3824, 15 322 | |
| 21–23 | 63 | 9067 | 2130 | 7372 | 8899 | 10 636 | 4912, 13 510 | |
| 23–27 | 294 | 8318 | 2113 | 7071 | 8167 | 9531 | 3046, 15 192 | |
| 27–30 | 164 | 8326 | 2310 | 6586 | 8230 | 9924 | 3339, 14 974 | |
| ≥ 30 | 81 | 8284 | 2351 | 6786 | 8138 | 9447 | 3230, 16 900 | |
| Women | 999 | | | | | | | <0.0001 |
| < 21 (reference group) | 148 | 6983 | 2167 | 5364 | 6908 | 8217 | 2874, 13 297 | |
| 21–23 | 186 | 6506 | 1766 | 5322 | 6280 | 7460 | 2176, 11 594 | |
| 23–27 | 375 | 6489 | 1958 | 5146 | 6381 | 7519 | 2347, 14 518 | * |
| 27–30 | 158 | 5803 | 1475 | 4481 | 5489 | 6971 | 2276, 11 184 | * |
| ≥ 30 | 132 | 5925 | 1724 | 4699 | 5636 | 6966 | 2335, 11 104 | * |
| Physical exercise | 1786 | | | | | | | <0.0001 |
| No (reference group) | 923 | 7004 | 2226 | 5343 | 6858 | 8297 | 2402, 16 900 | |
| Moderate | 288 | 7468 | 2435 | 5640 | 7205 | 8874 | 2176, 15 322 | * |
| Intensive | 122 | 7971 | 2469 | 6075 | 7598 | 9916 | 3230, 14 343 | * |
| No answer | 453 | 6824 | 2121 | 5268 | 6707 | 8196 | 2200, 14 974 | |

* Mean value was significantly different from that of the reference group ($P < 0.05$; Dunnett's test).

† By ANOVA comparing mean energy intake.

single, having a monthly income greater than €2250 or unknown were associated with a higher EI. There was no significant association of EI with educational level. The model explained 20 % of total variance of EI (adjusted R^2). Given that dietary intakes of men are significantly higher than those of women, we performed the analyses of the association between EI and socio-demographic characteristics stratified by sex. As in the whole population, education was not associated with EI in men or in women. However, a significant interaction between sex and education ($P=0.015$) was found. Although no significant association was observed for each educational level, the coefficients were in the opposite direction in men and women. Mean EI tended to decrease drastically with age in men whereas a lowest decrease was observed only in the oldest women. EI was significantly related to marital status in women, with a noticeable decreased intake in widowed women. The association between income and EI showed similar trends in men and women.

In comparison with the recommendation concerning EI (125 kJ/kg per d), 73.1 % of the subjects on average, and mainly women, had an insufficient daily EI (70.4 % of men v. 74.8 % of women; $P=0.046$). This proportion did not vary significantly between the three age groups defined previously (ANOVA; $P=0.57$). The total reported EI was lower than the estimated BMR for 20.2 % of men and 27.2 % of women.

Intake of macronutrients based on sex is given in Table 4. The macronutrient intakes expressed in g/d were all significantly different between men and women. Men had a higher intake of every macronutrient in terms of quantities but, when expressed in proportion of EI, they had a lower intake of protein ($P < 0.0001$), carbohydrate ($P < 0.0001$),

with significant differences between the mono- and disaccharide and polysaccharide intakes, and total fat ($P=0.017$), mainly saturated fat ($P=0.006$). Concerning alcohol, men had a higher alcohol intake ($P < 0.0001$) than women as expressed in g/d or in proportion of EI. Alcohol was an important component of total EI since the mean daily intake of alcohol was 21.6 (range 0.0–115.2) g in men and 6.9 (range 0.0–76.8) g in women. In men, 70.5 % of proteins were of animal origin v. 72.1 % for women ($P=0.007$).

Table 5 reports the intake of macronutrients based on age in three groups. Mean consumption of alcohol was not different between the three age groups ($P=0.19$). The intake of macronutrients expressed in proportion of EI based on age in three groups showed that protein intake decreased with age (ANOVA; $P=0.007$) notably after 85 years (significant Dunnett's test). This is particularly true for proteins of animal origins (ANOVA; $P=0.013$) but less marked for the proteins of vegetable origins (ANOVA; $P=0.044$). Furthermore, there was no difference in total carbohydrate intake between the three age groups (ANOVA; $P=0.12$). Nevertheless, the consumption of mono- and disaccharides significantly increased with age (ANOVA; $P=0.001$), notably after 75 years (significant Dunnett's test). The consumption of carbohydrates (46 % of EI on average) was below recommended levels (about 50 to 55 % of daily total EI provided by carbohydrates) for almost 63 % of the subjects. Concerning fat intake, there were no significant differences between the three age groups in terms of total fat, saturated fat, MUFA or PUFA intake. As expected, the total fat intake reported at wave 2 was inversely linked to ln(TAG) levels ($r = -0.05$; $P=0.038$).

Table 3. Influence of socio-demographic characteristics on total energy intake in a multilinear regression model in the whole study population of elderly community dwellers from Bordeaux (France) and stratified by sex (*n* 1773)

| Socio-demographic characteristic | Whole population | | | Men | | | Women | | |
|----------------------------------|---------------------|--------------|----------|---------------------|-------------|----------|---------------|-----------|----------|
| | β Coefficient | 95% CI | <i>P</i> | β Coefficient | 95% CI | <i>P</i> | B Coefficient | 95% CI | <i>P</i> |
| Sex | | | | | | | | | |
| Men (reference group) | | | <0.0001 | | | | | | |
| Women | -1970 | -2184, -1754 | <0.0001 | | | | | | |
| Age (years) | | | | | | | | | |
| \leq 75 (reference group) | | | 0.08 | | | 0.11 | | | 0.10 |
| 75–84 | -50 | -250, 150 | 0.62 | -309 | -663, 45 | 0.09 | 142 | -99, 383 | 0.25 |
| \geq 85 | -470 | -882, -58 | 0.025 | -617 | -1389, 154 | 0.12 | -330 | -809, 148 | 0.18 |
| Marital status | | | | | | | | | |
| Married (reference group) | | | 0.002 | | | 0.64 | | | 0.001 |
| Divorced or separated | 391 | 3, 779 | 0.048 | 453 | -419, 1325 | 0.31 | 262 | -172, 696 | 0.24 |
| Widowed | -123 | -376, 131 | 0.34 | 147 | -357, 652 | 0.57 | -289 | -585, 6 | 0.055 |
| Single | 572 | 154, 991 | 0.007 | 441 | -634, 1517 | 0.42 | 448 | -3, 899 | 0.051 |
| Education | | | | | | | | | |
| No or primary (reference group) | | | 0.86 | | | 0.10 | | | 0.37 |
| Secondary | -2 | -256, 251 | 0.98 | -166 | -658, 324 | 0.50 | 96 | -193, 384 | 0.52 |
| High school | 107 | -176, 391 | 0.46 | 363 | -173, 899 | 0.18 | -59 | -388, 270 | 0.72 |
| University | 7 | -316, 329 | 0.97 | -232 | -788, 324 | 0.41 | 291 | -122, 704 | 0.17 |
| Monthly income (€) | | | | | | | | | |
| < 750 (reference group) | | | 0.064 | | | 0.66 | | | 0.21 |
| 750–1500 | 195 | -195, 584 | 0.33 | 31 | -1463, 1526 | 0.97 | 196 | -189, 583 | 0.32 |
| 1500–2250 | 290 | -142, 723 | 0.19 | 229 | -1282, 1739 | 0.77 | 184 | -273, 640 | 0.43 |
| \geq 2250 | 521 | 58, 984 | 0.027 | 390 | -1133, 1913 | 0.61 | 481 | -24, 987 | 0.06 |
| Refused to answer | 587 | 91, 1082 | 0.020 | 560 | -1072, 2192 | 0.50 | 483 | -29, 995 | 0.06 |

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Table 4. Macronutrient intake based on sex of elderly community dwellers from Bordeaux (France), 2001–2002 (*n* 1786)

| Nutrient | Intake (g/d) | | | | | Proportion of total EI (%) | | | Proportion of EI without alcohol (%) | | |
|-------------------------|--------------|------|--------------|--------|--------------|----------------------------|-----|------------|--------------------------------------|-----|------------|
| | Mean | SD | 1st quartile | Median | 3rd quartile | Mean | SD | <i>P</i> * | Mean | SD | <i>P</i> * |
| Alcohol | 12.4 | 16.2 | 0.0 | 7.2 | 19.2 | 4.7 | 5.8 | <0.0001 | | | |
| Men | 21.6 | 20.1 | 5.8 | 17.6 | 32.0 | 7.5 | 6.6 | | – | | |
| Women | 6.9 | 10.0 | 0.0 | 1.9 | 11.3 | 3.1 | 4.4 | | – | | |
| Proteins | 74.9 | 26.9 | 55.4 | 71.4 | 90.6 | 18.0 | 4.7 | <0.0001 | 18.9 | 4.9 | 0.067 |
| Men | 85.0 | 27.2 | 66.3 | 82.8 | 101.2 | 17.2 | 4.3 | | 18.7 | 4.7 | |
| Women | 68.9 | 24.8 | 51.7 | 65.5 | 83.0 | 18.5 | 4.9 | | 19.1 | 5.1 | |
| Animal proteins | 53.5 | 24.0 | 36.4 | 49.8 | 66.4 | 12.9 | 5.0 | <0.0001 | 13.6 | 5.3 | 0.009 |
| Men | 59.9 | 25.0 | 43.2 | 55.9 | 74.6 | 12.2 | 4.5 | | 13.2 | 5.0 | |
| Women | 49.7 | 22.6 | 34.1 | 46.5 | 62.0 | 13.4 | 5.3 | | 13.8 | 5.5 | |
| Vegetable proteins | 21.4 | 9.1 | 15.1 | 20.3 | 26.3 | 5.1 | 1.6 | 0.63 | 5.3 | 1.6 | 0.006 |
| Men | 25.1 | 9.2 | 19.2 | 23.9 | 30.1 | 5.0 | 1.4 | | 5.5 | 1.5 | |
| Women | 19.2 | 8.2 | 13.6 | 17.7 | 23.4 | 5.1 | 1.7 | | 5.2 | 1.7 | |
| Carbohydrates | 194.0 | 70.0 | 144.8 | 187.3 | 233.9 | 46.1 | 9.8 | <0.0001 | 48.4 | 9.5 | 0.96 |
| Men | 223.3 | 73.1 | 172.7 | 216.8 | 263.9 | 44.8 | 9.7 | | 48.4 | 9.4 | |
| Women | 176.5 | 61.8 | 133.5 | 171.3 | 213.2 | 46.9 | 9.7 | | 48.4 | 9.6 | |
| Mono- and disaccharides | 89.1 | 39.9 | 61.2 | 83.7 | 111.5 | 21.7 | 8.7 | <0.0001 | 22.7 | 8.8 | <0.0001 |
| Men | 96.1 | 44.3 | 64.0 | 89.9 | 121.0 | 19.5 | 8.2 | | 21.0 | 8.5 | |
| Women | 85.0 | 36.4 | 59.0 | 80.3 | 106.3 | 23.0 | 8.7 | | 23.7 | 8.9 | |
| Polysaccharides | 104.8 | 49.6 | 70.2 | 98.9 | 134.4 | 24.5 | 8.2 | 0.0003 | 25.7 | 8.4 | <0.0001 |
| Men | 127.2 | 51.1 | 92.9 | 122.3 | 155.0 | 25.4 | 7.6 | | 27.4 | 7.7 | |
| Women | 91.5 | 43.5 | 60.9 | 87.3 | 114.8 | 24.0 | 8.4 | | 24.7 | 8.6 | |
| Total fat | 59.4 | 27.5 | 40.5 | 54.1 | 74.4 | 31.1 | 8.7 | 0.017 | 32.7 | 9.0 | 0.30 |
| Men | 69.0 | 29.7 | 47.7 | 64.3 | 85.4 | 30.5 | 8.5 | | 33.0 | 9.0 | |
| Women | 53.7 | 24.3 | 36.8 | 49.6 | 67.4 | 31.5 | 8.9 | | 32.5 | 9.1 | |
| Saturated fat | 25.5 | 12.9 | 16.1 | 23.2 | 32.6 | 13.3 | 4.6 | 0.006 | 14.0 | 4.8 | 0.88 |
| Men | 29.5 | 13.8 | 19.7 | 27.4 | 37.6 | 13.0 | 4.2 | | 14.0 | 4.5 | |
| Women | 23.2 | 11.8 | 14.9 | 21.1 | 29.6 | 13.6 | 4.8 | | 14.0 | 4.9 | |
| MUFA | 21.2 | 10.9 | 13.4 | 19.0 | 27.6 | 11.1 | 3.9 | 0.30 | 11.6 | 4.2 | 0.10 |
| Men | 24.8 | 12.1 | 16.1 | 22.1 | 30.7 | 10.9 | 4.0 | | 11.8 | 4.3 | |
| Women | 19.0 | 9.5 | 12.4 | 17.2 | 24.1 | 11.1 | 3.9 | | 11.5 | 4.1 | |
| PUFA | 8.4 | 6.0 | 4.8 | 6.9 | 10.1 | 4.4 | 2.6 | 0.37 | 4.7 | 2.7 | 0.45 |
| Men | 9.8 | 6.6 | 5.8 | 8.3 | 11.9 | 4.4 | 2.4 | | 4.7 | 2.6 | |
| Women | 7.6 | 5.5 | 4.4 | 6.3 | 9.0 | 4.5 | 2.7 | | 4.6 | 2.8 | |

EI, energy intake.

*By Student's *t* test comparing alcohol and macronutrient intakes as proportions of energy intake with or without alcohol consumption between men and women.

The proportion of participants with a daily intake of proteins below the recommended value of 1 g/kg body weight per d was 44.1% with a slight and insignificant difference between men (41.4%) and women (45.7%; *P*=0.07). There was no significant effect of age on this proportion (43.4% of subjects under age 75 years; 43.9% of subjects aged between 75 and 84 years and 50.5% of those aged 85 years and over; *P*=0.37).

Fatty acid intake is described in Table 6. The main contributor to fat intake in proportion of EI was 18:1*n*-9 (oleic acid), followed by 16:0 (palmitic acid). The mean consumption of 18:2*n*-6 (3.35% of EI) was just below recommended levels (4% of EI) whereas the mean 18:3*n*-3 intake (0.40% of EI) was half the recommendation (0.8% of EI). The 18:2*n*-6:18:3*n*-3 ratio (9.90 on average) was twice as high as the recommended threshold of 5, which corresponded to approximately the first quartile. Concerning the long-chain *n*-3 PUFA, the intake of EPA (0.07% of EI) was below recommended levels according to Simopoulos *et al.* (0.1% of EI)⁷. Moreover, 61.6% of the subjects consumed less than 50% of the recommended DHA intake (about 0.05% of EI); however, the mean consumption of DHA as a proportion of EI (0.15%) was about three-fold above recommended levels. This intake of DHA highlights the great inter-individual

variability observed, which is also shown for EPA but less obvious for 20:4*n*-6 (arachidonic acid).

The consumption of 18:2*n*-6 and 18:3*n*-3 PUFA and the 18:2*n*-6:18:3*n*-3 ratio based on socio-demographic characteristics are described in Table 7. There was no significant difference in the proportion of each *n*-6 and *n*-3 PUFA precursor as a proportion of EI according to sex, age group and education or income levels. Compared with married individuals, being widowed was significantly linked to a lower 18:2*n*-6 intake, but not to 18:3*n*-3 intake, as expressed as a percentage of EI (significant Dunnett's test). The 18:2*n*-6:18:3*n*-3 ratio was significantly associated with educational level (ANOVA; *P*=0.011), with a significant difference between the least educated participants who had the highest ratio and the subjects with secondary or high school, but not university, levels (significant Dunnett's test). The 18:2*n*-6:18:3*n*-3 ratio did not change according to sex, age, marital status and income. Concerning long-chain *n*-6 PUFA, the intake of 20:4*n*-6 (g/d) was lower in women than in men (*P*<0.0001) and significantly decreased as age increased (ANOVA; *P*=0.011). The intake of 20:5*n*-3 (g/d) significantly increased with higher income levels (ANOVA; *P*=0.044). When the long-chain *n*-6 or *n*-3 PUFA intakes were expressed as proportions of EI, there was no significant

Table 5. Macronutrient intake based on age of elderly community dwellers from Bordeaux (France), 2001–2002 (*n* 1786)

| Variable | Intake (g/d) | | | | | Proportion of total EI (%) | | | Proportion of EI without alcohol (%) | | |
|-------------------------|--------------|------|--------------|--------|--------------|----------------------------|-----|------------|--------------------------------------|-----|------------|
| | Mean | SD | 1st quartile | Median | 3rd quartile | Mean | SD | <i>P</i> † | Mean | SD | <i>P</i> † |
| Alcohol | | | | | | | | 0.19 | | | |
| < 75 years | 13.3 | 17.7 | 0.0 | 7.7 | 19.2 | 4.9 | 6.0 | | – | | |
| 75–84 years | 12.0 | 15.3 | 0.0 | 7.4 | 19.2 | 4.7 | 5.6 | | – | | |
| ≥ 85 years | 9.5 | 12.2 | 0.0 | 4.8 | 16.0 | 3.9 | 4.9 | | – | | |
| Proteins | | | | | | | | 0.007 | | | 0.002 |
| < 75 years | 77.8 | 27.7 | 57.9 | 74.9 | 93.4 | 18.3 | 4.8 | | 19.3 | 5.0 | |
| 75–84 years | 73.6 | 25.9 | 55.4 | 70.0 | 88.8 | 17.9 | 4.7 | | 18.8 | 4.9 | * |
| ≥ 85 years | 66.1 | 26.1 | 48.2 | 60.8 | 79.4 | 17.0 | 4.3 | * | 17.7 | 4.5 | * |
| Animal sources | | | | | | | | 0.013 | | | 0.006 |
| < 75 years | 55.7 | 25.0 | 38.4 | 51.9 | 69.5 | 13.2 | 5.2 | | 13.9 | 5.4 | |
| 75–84 years | 52.7 | 23.1 | 35.6 | 49.6 | 65.1 | 12.9 | 5.0 | | 13.5 | 5.2 | |
| ≥ 85 years | 45.7 | 22.6 | 28.4 | 41.4 | 58.6 | 11.7 | 4.2 | * | 12.2 | 4.5 | * |
| Vegetable sources | | | | | | | | 0.044 | | | 0.043 |
| < 75 years | 22.1 | 9.4 | 15.5 | 20.8 | 27.3 | 5.1 | 1.6 | | 5.4 | 1.7 | |
| 75–84 years | 20.9 | 8.8 | 14.8 | 20.0 | 25.5 | 5.0 | 1.5 | | 5.2 | 1.6 | * |
| ≥ 85 years | 20.5 | 8.4 | 14.2 | 19.6 | 26.2 | 5.3 | 1.6 | | 5.5 | 1.7 | |
| Carbohydrates | | | | | | | | 0.12 | | | 0.23 |
| < 75 years | 197.3 | 73.4 | 145.2 | 190.0 | 238.5 | 45.8 | 9.8 | | 48.1 | 9.5 | |
| 75–84 years | 192.0 | 67.5 | 145.0 | 184.3 | 231.4 | 46.2 | 9.9 | | 48.4 | 9.8 | |
| ≥ 85 years | 186.3 | 63.7 | 144.0 | 183.4 | 225.5 | 47.8 | 8.2 | | 49.8 | 7.9 | |
| Mono- and disaccharides | | | | | | | | 0.001 | | | 0.003 |
| < 75 years | 88.3 | 40.4 | 59.1 | 84.6 | 112.6 | 20.9 | 8.4 | | 21.9 | 8.6 | |
| 75–84 years | 90.0 | 39.7 | 62.3 | 83.0 | 111.6 | 22.1 | 8.9 | * | 23.1 | 9.0 | * |
| ≥ 85 years | 88.3 | 37.5 | 63.7 | 82.0 | 103.4 | 23.4 | 8.8 | * | 24.2 | 8.7 | * |
| Polysaccharides | | | | | | | | 0.08 | | | 0.06 |
| < 75 years | 109.0 | 51.7 | 72.7 | 101.8 | 138.8 | 25.0 | 8.1 | | 26.2 | 8.3 | |
| 75–84 years | 102.1 | 47.8 | 69.2 | 98.0 | 129.8 | 24.1 | 8.2 | | 25.3 | 8.5 | * |
| ≥ 85 years | 98.0 | 46.3 | 64.1 | 95.1 | 131.0 | 24.5 | 7.8 | | 25.5 | 8.1 | |
| Total fat | | | | | | | | 0.70 | | | 0.83 |
| < 75 years | 60.2 | 25.6 | 40.1 | 54.4 | 75.5 | 30.9 | 8.6 | | 32.6 | 9.0 | |
| 75–84 years | 59.3 | 27.5 | 40.8 | 54.2 | 74.4 | 31.3 | 8.9 | | 32.8 | 9.3 | |
| ≥ 85 years | 55.6 | 27.1 | 37.5 | 52.5 | 64.9 | 31.3 | 7.8 | | 32.5 | 7.9 | |
| Saturated fat | | | | | | | | 0.13 | | | 0.25 |
| < 75 years | 25.7 | 12.8 | 16.1 | 23.3 | 33.4 | 13.1 | 4.5 | | 13.8 | 4.6 | |
| 75–84 years | 25.5 | 13.0 | 16.2 | 23.3 | 32.5 | 13.4 | 4.7 | | 14.1 | 4.9 | |
| ≥ 85 years | 25.0 | 13.8 | 15.2 | 21.8 | 30.3 | 13.9 | 4.4 | | 14.5 | 4.4 | |
| MUFA | | | | | | | | 0.50 | | | 0.33 |
| < 75 years | 21.8 | 11.1 | 13.8 | 19.6 | 27.6 | 11.2 | 4.0 | | 11.8 | 4.2 | |
| 75–84 years | 20.9 | 11.8 | 13.3 | 18.7 | 26.2 | 11.0 | 3.9 | | 11.6 | 4.1 | |
| ≥ 85 years | 19.1 | 9.9 | 12.8 | 17.1 | 24.0 | 10.8 | 3.8 | | 11.3 | 3.9 | |
| PUFA | | | | | | | | 0.42 | | | 0.45 |
| < 75 years | 8.4 | 5.8 | 5.1 | 7.0 | 10.0 | 4.4 | 2.4 | | 4.6 | 2.5 | |
| 75–84 years | 8.6 | 6.3 | 4.6 | 6.9 | 10.2 | 4.5 | 2.8 | | 4.7 | 2.9 | |
| ≥ 85 years | 7.5 | 4.8 | 4.4 | 6.6 | 9.3 | 4.3 | 2.1 | | 4.4 | 2.3 | |

EI, energy intake.

* Mean value was significantly different from that of the reference group (subjects aged less than 75 years) (*P* < 0.05; Dunnett's test).

† By ANOVA comparing alcohol and macronutrient intakes as proportions of EI with or without alcohol consumption among the three age groups.

association with the socio-demographic characteristics studied (data not shown).

Discussion

In the present cross-sectional study, we observed a significant association between total EI and several socio-demographic characteristics such as age, sex, marital status, levels of income, but not educational level, in a multivariate analysis. Despite an adequate intake of total fat, our findings indicate an excessive intake of saturated fat concomitant to a relative deficit of MUFA intake according to the current French recommendations. Being widowed was significantly associated with lower 18:2*n*-6 PUFA intakes as expressed as a

percentage of EI. The 18:2*n*-6:18:3*n*-3 ratio was linked to education.

The accuracy of food-intake assessment is crucial in dietary studies^{29,30}. In the present study, a single 24 h recall was used to assess the dietary EI as a surrogate measure of the total quantity of food intake even if this method presents limitations. Indeed, it cannot capture long-term dietary intake patterns for each subject because of high intra-individual variation. Thus, a reported single day of intake is unlikely to be representative of usual individual intake. However, if sample sizes are sufficiently large, it may be used to determine average intake in defined subgroups of a population³¹. Moreover, it is usually recognised that the mean total EI was generally underestimated with such methodology³². Indeed, we

Table 6. Fatty acid intake of elderly community dwellers from Bordeaux (France), 2001–2002 (*n* 1786)

| Fatty acid | Intake (g/d) | | Proportion of total fat intake (%) | | Proportion of total energy intake (%) | | | | |
|---|--------------|------|------------------------------------|------|---------------------------------------|------|--------------|--------|--------------|
| | Mean | SD | Mean | SD | Mean | SD | 1st quartile | Median | 3rd quartile |
| 14:0 | 2.85 | 1.82 | 4.80 | 2.12 | 1.49 | 0.77 | 0.92 | 1.41 | 1.93 |
| 16:0 | 12.71 | 6.69 | 21.22 | 4.33 | 6.63 | 2.41 | 4.96 | 6.35 | 7.93 |
| 18:0 | 5.43 | 3.21 | 9.11 | 3.07 | 2.85 | 1.29 | 1.97 | 2.65 | 3.48 |
| 16:1 <i>n</i> -7 | 1.53 | 1.60 | 2.49 | 1.79 | 0.78 | 0.67 | 0.48 | 0.65 | 0.89 |
| 18:1 <i>n</i> -9 | 18.22 | 9.85 | 30.32 | 6.78 | 9.55 | 3.77 | 6.86 | 8.96 | 11.75 |
| Total <i>n</i> -6 PUFA | 6.55 | 5.27 | 11.15 | 6.51 | 3.44 | 2.36 | 2.00 | 2.79 | 4.07 |
| 18:2 <i>n</i> -6 | 6.38 | 5.23 | 10.86 | 6.48 | 3.35 | 2.35 | 1.91 | 2.70 | 3.97 |
| 20:4 <i>n</i> -6 | 0.16 | 0.17 | 0.29 | 0.34 | 0.09 | 0.09 | 0.02 | 0.06 | 0.13 |
| Total <i>n</i> -3 PUFA | 1.23 | 1.40 | 2.17 | 2.34 | 0.65 | 0.69 | 0.30 | 0.43 | 0.63 |
| 18:3 <i>n</i> -3 | 0.78 | 0.80 | 1.30 | 0.84 | 0.40 | 0.32 | 0.25 | 0.33 | 0.44 |
| EPA | 0.14 | 0.34 | 0.26 | 0.66 | 0.07 | 0.18 | 0.00 | 0.00 | 0.05 |
| DHA | 0.28 | 0.69 | 0.54 | 1.35 | 0.15 | 0.38 | 0.00 | 0.02 | 0.10 |
| 18:2 <i>n</i> -6:18:3 <i>n</i> -3 ratio | 9.90 | 7.05 | – | – | – | – | – | – | – |

observed a relatively high proportion of subjects who declared to consume less than 125 kJ/kg body weight per d. However, in only 4% of men and 6% of women, the reported EI was under 80% of the estimated BMR. In other studies, the intakes recorded in reports were more than 20% below the estimated BMR³³. Nevertheless, the validity of the BMR estimation seems to be questionable in the sample studied of the very elderly^{34,35}.

Even so, mean total EI observed in this sample of French elderly community dwellers is very close to the figures reported in elderly participants (mean age 77 years) in the New Mexico Aging Process Study (8698 kJ (2079 kcal) for men and 6251 kJ (1494 kcal) for women), although the methodology of the dietary survey differed³⁶. Furthermore, in the EPIC-Elderly study, Bamia *et al.* reported that among almost 100 000 individuals aged 60 years and over living in nine European countries, the mean EI estimated by FFQ ranged from 8135 to 10 820 kJ for men and from 5945 to 9439 kJ for women³⁷. The mean EI estimated in the present study was also close to that observed by Drewnowski *et al.* in French community dwellers aged 65 years and over³⁸. In addition, the food photographs, as used here, generally have a positive influence on the relative validity for absolute food group intake³⁹. In the present study, the mean EI was positively associated with the intensity of the practice of physical exercise. Altogether, these observations allowed us to validate the methodology employed in the present study to estimate the mean EI and macronutrient intake for this group of elderly subjects.

The decreased mean EI in the oldest group might be due in part to dental and digestive disturbances which increase with age^{40,41}. A decrease of perceived attractiveness of food with increased age in terms of taste, appetite and palatability of food was also commonly admitted^{42,43}. As already observed in the literature^{30,44}, there was a trend to lowest EI for the subjects who had the highest BMI. The low energy reporters with high BMI may be individuals who have difficulties estimating their actual food intake. They are also more likely to be dieters or they tend to have higher levels of energy restraint^{44,45}. Since the present study is cross-sectional, we cannot assert that the socio-demographic characteristics identified as markers of unbalanced dietary patterns are responsible for this

poor dietary pattern. Moreover, the differences in mean EI with marital status described in this sample of subjects already enrolled in the Three-City cohort were expected. Indeed, according to the FFQ administered to all participants of the Three-City Study at wave 1, subjects living alone had poorer dietary habits¹⁸. However, the association between mean EI and educational level already demonstrated in the Three-City cohort at wave 1 disappeared in the present study when adjusted on the other socio-demographic characteristics. This result could be in part due to the association of income with EI because of the collinearity between income and educational level. The association between income and dietary habits was not assessed at wave 1 in the Three-City Study¹⁸. An association between energy density and diet cost was also demonstrated in a population of 837 French adults⁴⁶. Altogether, these results obtained at wave 1 in the Three-City cohort and wave 2 in this Bordeaux sample suggest that these particular socio-demographic characteristics are associated with a specific dietary pattern. According to these studies and others, these lifestyle characteristics, which are known to be associated with age-related disorders such as cognitive decline or dementia⁴⁷, should be considered as potential confounding factors in the relationship between nutritional and pathological status in older individuals. However, since the present study is cross-sectional and because of the methodology employed, some associations between EI and socio-demographic characteristics could be due to chance findings. This could partly explain why some of these associations disappeared in men or in women when they were analysed separately by sex. Moreover, another explanation is that stratifying on sex may also have generated insufficient statistical power to detect associations.

In comparison with the French RDA⁸, the food patterns in this sample of the French elderly seem to be low in carbohydrates, rich in proteins and acceptable for total fatty acids, yet showing an excess in saturated fat and deficiency in MUFA intakes. The decreased consumption of polysaccharides with age might be due in part to changes in behaviour with advanced age, suggesting that the elderly have a greater taste for sweet foods. A previous study on dietary patterns prevailing among the elderly across Europe reported that the 'sweet- and fat-dominated' diet reflected the choice of older

Table 7. *n*-6 and *n*-3 Polyunsaturated fatty acid intakes and 18:2*n*-6:18:3*n*-3 ratio based on socio-demographic characteristics (sex, age, marital status, education, income) of elderly community dwellers from Bordeaux (France), 2001–2002 (*n* 1786)

| Socio-demographic characteristic | 18:2 <i>n</i> -6 | | | | | | 18:3 <i>n</i> -3 | | | | | | 18:2 <i>n</i> -6:18:3 <i>n</i> -3 ratio | | |
|----------------------------------|------------------|------|------------|----------------------------|------|------------|------------------|------|------------|----------------------------|------|------------|---|------|------------|
| | Intake (g/d) | | | Proportion of total EI (%) | | | Intake (g/d) | | | Proportion of total EI (%) | | | Mean | SD | <i>P</i> † |
| | Mean | SD | <i>P</i> † | Mean | SD | <i>P</i> † | Mean | SD | <i>P</i> † | Mean | SD | <i>P</i> † | | | |
| Sex | | | <0.0001 | | | 0.75 | | | <0.0001 | | | 0.92 | | | 0.54 |
| Men | 7.50 | 5.70 | | 3.33 | 2.17 | | 0.92 | 0.92 | | 0.40 | 0.33 | | 9.78 | 6.03 | |
| Women | 5.72 | 4.82 | | 3.36 | 2.45 | | 0.69 | 0.70 | | 0.40 | 0.32 | | 9.97 | 7.59 | |
| Age (years) | | | 0.30 | | | 0.43 | | | 0.15 | | | 0.29 | | | 0.70 |
| < 75 | 6.36 | 4.98 | | 3.29 | 2.19 | | 0.78 | 0.76 | | 0.39 | 0.30 | | 9.75 | 6.50 | |
| 75–84 | 6.49 | 5.54 | | 3.42 | 2.52 | | 0.79 | 0.86 | | 0.41 | 0.35 | | 10.00 | 7.44 | |
| ≥ 85 | 5.69 | 4.33 | | 3.21 | 1.96 | | 0.64 | 0.42 | | 0.36 | 0.18 | | 10.19 | 7.42 | |
| Marital status | | | <0.0001 | | | 0.034 | | | 0.002 | | | 0.42 | | | 0.57 |
| Married (reference group) | 7.02 | 5.71 | | 3.50 | 2.51 | | 0.84 | 0.89 | | 0.41 | 0.36 | | 10.07 | 6.67 | |
| Divorced or separated | 5.91 | 4.04 | | 3.20 | 2.02 | | 0.75 | 0.58 | | 0.40 | 0.28 | | 9.41 | 6.48 | |
| Widowed | 5.52 | 4.70 | * | 3.16 | 2.22 | * | 0.70 | 0.73 | * | 0.39 | 0.29 | | 9.66 | 7.79 | |
| Single | 6.17 | 4.37 | | 3.22 | 1.95 | | 0.68 | 0.39 | | 0.36 | 0.18 | | 10.08 | 6.60 | |
| Education | | | 0.90 | | | 0.07 | | | 0.15 | | | 0.95 | | | 0.011 |
| No or primary (reference group) | 6.42 | 4.91 | | 3.55 | 2.49 | | 0.73 | 0.67 | | 0.39 | 0.29 | | 10.64 | 7.87 | |
| Secondary | 6.26 | 5.05 | | 3.27 | 2.12 | | 0.78 | 0.74 | | 0.40 | 0.29 | | 9.45 | 6.58 | * |
| High school | 6.38 | 5.69 | | 3.26 | 2.43 | | 0.81 | 0.90 | | 0.41 | 0.35 | | 9.35 | 6.15 | * |
| University | 6.54 | 5.66 | | 3.21 | 2.33 | | 0.84 | 0.96 | | 0.40 | 0.38 | | 9.83 | 6.95 | |
| Monthly income (€) | | | 0.006 | | | 0.77 | | | 0.021 | | | 0.74 | | | 0.44 |
| < 750 (reference group) | 5.30 | 3.63 | | 3.24 | 2.09 | | 0.63 | 0.44 | | 0.38 | 0.22 | | 10.16 | 7.84 | |
| 750–1500 | 5.99 | 4.60 | | 3.35 | 2.34 | | 0.72 | 0.68 | | 0.40 | 0.29 | | 9.94 | 7.53 | |
| 1500–2250 | 6.71 | 5.39 | * | 3.45 | 2.36 | | 0.80 | 0.83 | | 0.40 | 0.31 | | 10.13 | 7.19 | |
| ≥ 2250 | 6.82 | 5.68 | * | 3.34 | 2.41 | | 0.83 | 0.86 | * | 0.40 | 0.36 | | 9.89 | 6.44 | |
| Refused to answer | 6.37 | 6.32 | | 3.18 | 2.44 | | 0.86 | 1.03 | * | 0.43 | 0.40 | | 8.89 | 5.92 | |

EI, energy intake.

* Mean value was significantly different from that of the reference group (*P* < 0.05; Dunnett's test).

† By Student's *t* test or ANOVA comparing mean 18:2*n*-6:18:3*n*-3 ratio or 18:2*n*-6 and 18:3*n*-3 intakes in g/d or as a proportion of total EI.

women with low educational achievement³⁷. Indeed, a notably lower carbohydrate intake (38 to 40 % of EI) was observed in a population of younger French individuals⁴⁸. The proportion of proteins was on average higher than the recommendation (about 10 to 15 % of total EI). In younger French adults, Czernichow *et al.* reported a similar protein intake (16 to 17 % of EI)⁴⁸. However, the protein intake decreased with age and almost half of the population enrolled in the present study ate less than 1 g protein/kg body weight per d. Taking into account that lower weights were observed in the oldest group, these observations suggest that some protein–energy malnutrition occurs in the oldest individuals, putting them at risk of sarcopenia⁴⁹. It is worth noting that foods from animal protein sources are generally high in fats, particularly in saturated fat and cholesterol. In the average French adult diet, 30 to 35 % of energy was estimated to come from total fat⁸, which is the case in the population sample enrolled in the present study but notably lower than the values found in younger French adults where 36 to 40 % of EI comes from total fat in men and women aged no more than 65 years^{14,48,50}. In the present study, as previously described by Willett *et al.*²⁴, an inverse association between the ln(TAG) and total fat intake was observed whereas the food questionnaire completion and blood collection were within 2 years of each other and not 1 year as Willett *et al.*²⁴. This result could be interpreted as a relative stability of dietary intake of the elderly during these 2 years. Concerning saturated fat, the consumption was almost twice higher than recommendations (8 % of EI) as already observed in the elderly³⁷ and also reported in the literature for French adult consumers⁵⁰. According to these authors, the higher intake of saturated fat is largely the consequence of high intakes of butter, cheese, meat products and baked products. Indeed, 93 % of the population enrolled in the Three-City Study were regular consumers of dairy products¹⁸. Hence, the common opinion of the elderly French that ‘there is no good meal without cheese’ seems to be held in the population studied. Recent analysis on dietary habits among Americans reported that they consumed too much saturated fat, as was observed in the present study in French elderly individuals⁵¹. Moreover, we observed that the excess of saturated fat was associated with a relative deficit in MUFA consumption, compared with the dietary allowances (about 20 % of EI). Concerning PUFA, the intake of 18:3n-3, despite it being an essential fatty acid, was below the recommendations (about 0.8 % of EI) and quantitatively comparable with that observed by others in a younger French population¹⁴. As a consequence, the 18:2n-6:18:3n-3 ratio is fairly high (9.90 on average) and close to the ratio observed in younger populations¹⁴. The very large range of intake and the asymmetric quartiles of distribution for EPA and DHA have already been observed in various studies and countries¹⁴. Knowing that the main source of EPA and DHA is fish, a food not consumed daily in the Three-City cohort⁵², this result might also be due in part to the single 24 h recall used which allows a good estimation of the mean but not of the variance of the consumption. The analysis of the FFQ assessed at wave 2 allowed us to ensure that in this sample the fish consumption frequency was linked to the estimated EPA and DHA intake (Spearman coefficient; r 0.16; $P < 0.0001$). As well, the analysis of the FFQ allowed us to identify about 17.3 % of subjects who consumed only rarely

(i.e. less than once per week) poultry or eggs which are rich in 20:4n-6. This pattern of food consumption could explain the large distribution of arachidonic acid intake observed in this sample of elderly and not mentioned by others in younger French populations¹⁴. Indeed, there was a significant correlation between the poultry or egg consumption estimated by FFQ and the 20:4 intake (Spearman coefficient; r 0.12; $P < 0.0001$). Since essential n-6 and n-3 fatty acid intakes were below the recommendations and that the biosynthesis of long-chain PUFA occurs only at a very low rate and seems to decrease with age^{10,11}, the intake of long-chain PUFA seems to be insufficient for a non-negligible part of the sample compared with the recommendations. Moreover, the present findings indicate a statistical association between educational level and the 18:2n-6:18:3n-3 ratio in the elderly. A difference from 9.35 to 10.64 of this ratio between the lowest educated subjects and subjects with a higher educational level seems apparently too small to have any nutritional consequences. However, the effects of n-3 PUFA intake or educational level on age-related disorders such as dementia have already been demonstrated^{2–6,53}. Likewise, marital status was associated with the intake of the precursor of n-6 PUFA. Knowing that the intake of long-chain n-3 fatty acids was correlated to indicators for healthy dietary habits⁵⁴, socio-demographic characteristics, such as marital status and education, associated with inadequate intake of fatty acids could be considered as markers of vulnerability in the elderly.

Thanks to the present cross-sectional study, it was possible to identify socio-demographic characteristics associated with quantitatively and qualitatively poor dietary patterns in a French elderly group. Older individuals at risk of malnutrition, mainly women, the very elderly, the widowed or single subjects, or individuals with low educational or income level, all of whom seem particularly vulnerable to age-related diseases, should be targeted for nutritional counselling. Our findings suggest that the elderly of southwestern France have an unbalanced fatty acid intake, characterised by, on average, an excessive intake of saturated fats related to a deficit of MUFA and PUFA, notably in n-3, intake.

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