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Socio-economic, demographic, lifestyle and health characteristics associated with consumption of fatty-sweetened and fatty-salted foods in middle-aged French adults

Caroline Méjean[1]*, Pauline Macouillard[1], Katia Castetbon[2], Emmanuelle Kesse-Guyot[1] and Serge Hercberg[1,2]

[1]*UREN (Unité de Recherche en Epidémiologie Nutritionnelle), UMR U557 Inserm/U1125 Inra/Cnam/Paris 13, CRNH IdF, SMBH Paris 13, 74 rue Marcel Cachin, F-93017 Bobigny Cedex, France*
[2]*USEN (Unité de Surveillance et d'Epidémiologie Nutritionnelle), Institut de Veille Sanitaire, Université Paris 13, 74 rue Marcel Cachin, F-93017 Bobigny Cedex, France*

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Abstract

Few studies have specifically focused on characteristics associated with consumption of combined fatty-salted and fatty-sweetened foods, whereas their identification could be useful for defining effective public health measures. The aim of the present study was to investigate the association between demographic, socio-economic, lifestyle and health characteristics and consumption of these types of food in a general sample of French adults. Dietary intake was assessed using a minimum of six 24 h dietary records collected over a 2-year period in 6240 subjects aged 35–60 years who participated in the Supplémentation en VItamines Minéraux et AntioXydants cohort study. Associations of individual characteristics with high and intermediate consumption of fatty-sweetened and fatty-salted foods were assessed using multivariate polytomic logistic regression models. Risk of moderate or high consumption of fatty-salted foods decreased with increasing age. Current smokers, drinkers, individuals with overweight and with hypertension were more likely to consume moderate or high amounts of such foods. Risk of moderate or high consumption of fatty-sweetened foods decreased with increasing age. Women, individuals living as a couple, moderate drinkers and persons with low or medium physical activity level were more likely to consume moderate or high amounts of such foods. Lower educated subjects, current smokers, heavy drinkers and individuals with severe hypertriacylglycerolaemia were less likely to have moderate or high consumption. Consumption of fatty-sweetened and fatty-salted foods varied according to demographic, lifestyle and health characteristics. Common unhealthy behaviours such as smoking, low physical activity and alcohol drinking, associated with high consumption of these food groups, may help to effectively target public health efforts.

Key words: Fatty-sweetened foods: Fatty-salted foods: Lifestyle: Socio-economic factors: Demographic factors

Dietary components such as fat, added sugar and Na are important nutritional factors involved in the risk of chronic diseases[1,2]. Indeed, a high consumption of foods containing added sugar, notably beverages, has been linked to the risk of obesity, diabetes and heart disease[3,4]. Moreover, overconsumption of high-fat products may play a role in the development of obesity, CVD and colorectal cancer[5,6]. Finally, excessive salt consumption may contribute to hypertension and gastric cancers, at least in some sensitive populations[7,8].

Most public health programmes worldwide target nutritional recommendations, which include limitations on fat, salt and sugar products[2]. Identification and characterisation of population subgroups whose consumption of these products is too high may help public health policy-makers to disseminate messages and take actions which could improve the dietary behaviour of the population in a more focused and efficient manner.

Several studies have investigated intakes of fat, added sugar and Na and their association with demographic, socio-economic, lifestyle and health characteristics[9–11], but few studies have specifically focused on the characteristics of combined fatty-salted or fatty-sweetened food consumers[12–14]. Nevertheless, elucidation of the combination of fatty and salted foods or fatty and sweetened products would be useful, since combining salt or sugar with fat may promote consumption of fat by increasing palatability[15,16]. The inference is that increased

Abbreviation: SU.VI.MAX, Supplémentation en VItamines Minéraux et AntioXydants.

* **Corresponding author:** Dr C. Méjean, fax +33 1 48 38 89 31, email c.mejean@uren.smbh.univ-paris13.fr

palatability could lead to overconsumption, thus creating an additional risk factor for obesity and health-related problems[17]. Elsewhere, available studies were mainly interested in demographic and socio-economic profiles of consumption of these foods, but rarely assessed associations with lifestyle[12].

The aim of the present study was to investigate the association between demographic, socio-economic, lifestyle and health characteristics and consumption of fatty-salted foods, on the one hand, and fatty-sweetened foods, on the other hand, in a large sample of middle-aged subjects participating in a French cohort.

Methods

Study population

We used data from the 'Supplémentation en VItamines Minéraux et AntioXydants' (SU.VI.MAX) cohort, a large group of middle-aged adults recruited throughout mainland France. The design, methods and rationale of the present study have been described elsewhere[18]. The SU.VI.MAX study was initially designed as a randomised, double-blind, placebo-controlled primary prevention trial to test the efficacy of daily supplementation with antioxidant vitamins and minerals at nutritional doses in reducing the incidence of IHD, cancers and overall mortality[18]. A total of 7876 women aged 35–60 years and 5141 men aged 45–60 years were included in 1994–5 for an initially planned follow-up of 8 years. They consisted of volunteers recruited in 1994 through a large national media campaign via television, radio and newspapers. To be eligible, volunteers had to return a completed screening questionnaire. Further eligibility criteria included: absence of disease likely to hinder active participation or threaten 5-year survival; acceptance of the possibility of being given a placebo and of constraints of participation; no previous regular supplementation with any of the vitamins or minerals in the supplement provided; absence of extremist beliefs or behaviour regarding diet. The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Ethical Committee for Studies with Human Subjects at the Paris-Cochin Hospital (CCPPRB no. 706) and the Commission Nationale Informatique et Liberté (CNIL no. 334641). Written informed consent was obtained from all subjects[19].

Assessment of fatty-sweetened and fatty-salted food consumption

Dietary data collection. Participants were invited to provide a 24 h dietary record every 2 months. These records were randomly distributed for 2 weekend days and 4 weekdays/year, so that each day of the week and all seasons were covered to account for individual variability in intake. Dietary data were collected using the Minitel Telematic Network, a small terminal that was widely used in France at the beginning of the study (1994–6). At enrolment, participants received a tiny central processing unit specifically developed for the study, containing specialised software that allowed subjects to fill out the computerised dietary record off-line and to transmit data during brief telephone connections. Conversational facilities of the software and an instruction manual for codification of foods, distributed to the participants at enrolment, guided them during completion of the records. A large choice of food and drink (990 food items) was displayed for each of three meals (breakfast, lunch and dinner) and for four other food intake occurrences. For each food or drink mentioned, subjects were asked to indicate the portion size eaten. They were helped by the instruction manual which included photographs of more than 250 foods (corresponding to 990 generic foods) presented in three different portion sizes. Along with the two intermediate and two extreme quantities, there were seven choices of amounts. Edible amounts corresponding to each food had been previously validated in a pilot study[19]. The nutritional values of the diet were estimated using a published French food composition table[20]. All dietary records with outlying values (<418 or $>25\,080$ kJ/d) were reviewed by dietitians. They checked and corrected data-entry mistakes in declared quantities and errors due to data transfer (record transferred into several pieces). When no error was identified, the aberrant record was deleted.

Definition of fatty-sweetened and fatty-salted food groups

Since there exists no internationally acknowledged recommendation for the classification of food groups, we defined two food groups taking into account their nutritional content in fat, sugar and salt: 'fatty-sweetened' foods and 'fatty-salted' foods. The fatty-sweetened food group included high-fat yogurt and sweetened cream desserts, chocolate products, croissant-like pastries and other sweetened pastries, cakes and biscuits. For these food groups, the nutrient standards were lipids ≥ 15 g/100 g and added sugars ≥ 10 g/100 g. The fatty-salted food group was composed of processed meats, cheese, appetisers, sandwiches, hamburgers, pizzas and savoury pastries and sauces. The nutrient standards for these food groups were lipids ≥ 15 g/100 g and Na ≥ 500 mg/100 g.

Scoring

To construct scores of fatty-sweetened and fatty-salted food consumption, we defined servings from commonly used portion sizes on the French market for each food. One point was attributed for each food belonging to the fatty-salted group or the fatty-sweetened group when the subject ate one serving. When the subject consumed less than or more than the defined servings, we assigned

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points proportionally to the quantity consumed. The number of points was summed up for each subject to obtain a total score for each fatty group divided by the number of days recorded, in order to standardise expression of the scores.

Assessment of demographic, socio-economic and lifestyle characteristics

At enrolment, subjects were asked to fill in a self-administered questionnaire to provide demographic and socio-economic information. Based on the eight initial categories, education level was recoded into three categories according to the highest level completed (primary, secondary or university level). The official French classification was used to classify subjects into occupational categories according to their self-reported occupation or most recent employment if they were retired or unemployed. Occupational category was recoded into four categories (from nine initial categories) and a fifth included retired persons, unemployed individuals and persons who had never worked. Marital status was coded into single and married or living with a partner. Smoking status was categorised into three categories: current smokers, former smokers and never smokers. Physical activity level was assessed using a non-validated method, via a single question. The subjects were asked to report whether they regularly practised physical activity and, if so, whether they practised the equivalent of at least 1 h of walking/d. Responses were coded into three categories (irregular or no physical activity, <1 h of walking/d, ≥ 1 h of walking/d)[21]. The subjects who stated that they were 'irregular' in engaging in physical activities were considered as having low physical activity (<30 min/d of equivalent walking). Those who indicated that they walked more than 1 h/d were considered as having high physical activity. The mean daily alcohol intake was estimated from at least six 24 h dietary records. For each record, the day of recording was randomly selected over a 2-week period to provide dispersion of survey days and thus to cover differences between days of the week, particularly between weekend days and weekdays. The mean daily alcohol intake was expressed as grams of alcohol consumed per day, corresponding to the sum of alcohol consumed per day from wine, beer, spirits and cider. According to French recommendations[22], male drinkers were categorised as non-drinkers (0 g alcohol/d), moderate (>0 and ≤ 30 g alcohol/d) or heavy drinkers (>30 g alcohol/d), and females as non-drinkers (0 g alcohol/d), moderate (>0 and ≤ 20 g alcohol/d) or heavy drinkers (>20 g alcohol/d).

Clinical examination and laboratory methods

A clinical examination was conducted in 1995–6. Weight and height were measured using standardised procedures[23]. BMI (kg/m^2) was calculated, and overweight was defined as a BMI of 25 kg/m^2[24]. Blood pressure was measured on each arm using a standard Hg sphygmomanometer in subjects who had been lying down for at least 10 min. The mean of these two measurements was used for analyses. Hypertension was defined using WHO/International Society of Hypertension cut-offs[25]: systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg and/or anti-hypertensive medication.

Blood samples were obtained at baseline after 12 h fasting, and all biochemical measurements were centralised. Serum total cholesterol and TAG levels were measured using an enzymatic method (Bayer Diagnostics, Tarrytown, NY, USA), and fasting glucose by a glucose-oxidase method (Bayer Diagnostics). According to French health authorities[26,27], limits were used for elevated levels of total cholesterol (5·2 $<$ moderate <7 mmol/l; severe ≥ 7 mmol/l), elevated levels of TAG (1·7 $<$ moderate $<$ 2·3 mmol/l; severe $\geq 2{\cdot}3$ mmol/l) and elevated levels of glycaemia (glycaemia ≥ 7 mmol/l). Individuals with hypercholesterolaemia, hypertriacylglycerolaemia or diabetes also included those who declared that they were being treated for each of these cardiovascular risks, respectively.

Statistical analyses

The present analyses focused on subjects aged 35–60 years who had completed at least six 24 h dietary records (some subjects had filled in more than six records, with the median number of 24 h records being 11) during the first 2 years of follow-up (1994–6). Given that missing data for demographic, socio-economic, lifestyle characteristics and variables represented less than 3 % of the sample, we deleted subjects with no available data for these variables[28]. For blood pressure, 14 % of the sample had missing values. Therefore, regression-based imputation taking into account sex, age and weight was performed. To explore bias in selection of the sample, we compared individuals from the entire SU.VI.MAX population with those who had completed at least six dietary records and those included in the final sample (without missing data), using a χ^2 goodness-of-fit test for categorical variables and one-sample t test for continuous variables.

Tertiles of score were estimated in order to define 'low', 'intermediate' and 'elevated' consumption of fatty-sweetened foods, on the one hand, and fatty-salted foods, on the other hand. Logistic regression analysis was used to assess demographic, socio-economic, lifestyle and health factors related to elevated and intermediate consumption of fatty-sweetened and fatty-salty foods (polytomic model[29], common reference = low consumption). Univariate logistic regressions were performed by calculating OR and 95 % CI to determine the strength of the association between levels of consumption and each explanatory variable (see afore-mentioned description; all were tested). Since we hypothesised that the sex would

probably modify the association of the other explanatory variables with the likelihood of consumption levels, interaction terms were also examined. The significance level for interactions was set at 0·20.

Only explanatory variables associated with food group consumption at the 0·20 significance level were retained for inclusion in the initial multivariate model. Subsequently, using stepwise backward elimination, multivariate logistic regression models were constructed. All models were adjusted for energy intake and for sex. Variables and interaction terms were removed from the model one by one using $P>0·10$ for exclusion. Variables whose exclusion from the model caused large fluctuations in OR (>10 %), as well as variables whose exclusion gave rise to significant likelihood-ratio tests ($P<0·05$), were re-entered into the model. Significance tests were two-sided, with a P value set at $<0·05$. All statistical analyses were performed using Statistical Analysis Systems (version 9.1; SAS Institute, Inc., Cary, NC, USA).

Results

Characteristics of consumers of fatty-salted and fatty-sweetened foods

Of the 13 017 participants in the SU.VI.MAX study, 6633 participants provided at least six valid 24 h dietary records during the first 2 years of follow-up. Next, the present analysis was performed on a subsample of 6240 subjects who had no missing values for covariates. In the sample which included individuals with at least six dietary records (n 6633) and in the final sample used for analyses here (n 6240), men and hypertensive individuals were proportionally more numerous, and single persons and current smokers were less numerous, than in the entire cohort (n 13 017) (Table 1). Significant differences in occupational categories and in alcohol consumption categories were also found.

Demographic, socio-economic, lifestyle and health characteristics of the total sample and of consumers of the fatty-salted and fatty-sweetened foods are presented in Table 2. Total intakes of energy ($P<0·0001$), lipids ($P<0·0001$), Na ($P<0·0001$) and added sugar ($P<0·0001$) increased according to the levels of consumption of fatty-salted foods (Table 1). In addition, the higher the increase in consumption of fatty-sweetened foods, the greater the increase in intakes of total energy ($P<0·0001$), lipids ($P<0·0001$), added sugar ($P<0·0001$) and Na ($P<0·0001$).

Characteristics of consumption of fatty-salted foods

Except for the variable concerning hypercholesterolaemia, all demographic, socio-economic, lifestyle and health variables tested here were selected from univariate analyses (Table 2) for introduction into the multivariate model. In addition, significant interactions of sex with education level ($P=0·003$), occupational category ($P=0·06$) and physical activity level ($P=0·06$) were found and therefore introduced into the multivariate model. After a stepwise backward elimination procedure, sex, marital status, education level, occupational category, physical activity level, variables relating to diabetes and hypertriacylglycerolaemia and interactions terms were excluded.

In the final model, age was inversely associated with the risk of being a medium or high consumer (Table 3). Moderate and heavy alcohol drinkers were more likely to have moderate or high consumption of fatty-salted foods than abstainers. In addition, compared with never smokers, current smokers were more likely to be medium or high consumers of these foods. Overweight subjects were more likely to eat higher quantities of fatty-salted products than individuals with normal or low body mass. Finally, individuals with hypertension were more likely to be medium or high consumers of fatty-salted products than those without hypertension.

Results of the stratified analyses by sex did not greatly differ from those in the model which included both sexes (detailed results not shown). Nevertheless, the association between fatty-salted food consumption and alcohol consumption was significant in both sexes, but was slightly less strong in men than in women. In addition, estimates of an association of consumption of fatty-salted foods with hypertension and smoking status were higher in men than in women.

Characteristics of consumption of fatty-sweetened foods

All demographic, socio-economic, lifestyle and health variables were selected from univariate analyses (Table 2) for introduction into the multivariate model. Moreover, significant interactions of sex with hypertension ($P=0·06$) and smoking status ($P=0·06$) were selected to be introduced into the multivariate model. After a stepwise backward selection procedure, occupational category, weight status, variables relating to diabetes, hypercholesterolaemia and hypertension and interaction terms were excluded.

In the final model (Table 4), the risk of moderate or high consumption of fatty-sweetened foods decreased when age increased. In addition, women and individuals who lived as a couple were more likely to consume such foods in moderate or high amounts. Compared with individuals with a high education level, individuals with a low education level were less likely to have moderate or high consumption of fatty-sweetened foods, and those with a medium education level were less likely to be high consumers. Moreover, current smokers were less likely to be moderate consumers than never smokers. Compared with abstainers, moderate alcohol drinkers were more likely to have moderate consumption of fatty-sweetened foods, whereas heavy alcohol drinkers were less likely to be high consumers of these foods. Subjects with low and medium physical activity levels were more likely to consume higher amounts of

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Table 1. Comparisons of demographic, socio-economic, lifestyle and health characteristics between the Supplémentation en VItamines Minéraux et AntioXydants (SU.VI.MAX) population and individuals with at least six dietary records and those without missing data

(Mean values and standard deviations or percentages)

Variables	SU.VI.MAX population (*n* 13 017)	Sample including individuals with at least six dietary records (*n* 6633)	*P*	Final sample for analysis (*n* 6240)	*P*
Age (years)			0·0002		0·0002
Mean	48·4	48·7		48·7	
SD	6·3	6·4		6·4	
Sex					
Men	39·5	42·4	0·0004	42·4	<0·0001
Women	60·5	57·6		57·6	
Occupational category					
Self-employed and farmers	5·9	4·7	<0·0001	4·7	<0·0001
Managerial staff and intermediate professions	54·8	55·1		55·3	
Manual workers and employees	16·6	16·0		16·0	
Unemployed, never employed and retired	22·7	24·2		24·0	
Education level					
Elementary school	21·3	20·7	0·40	20·5	0·25
Secondary school	38·1	38·6		38·6	
University or equivalent	40·6	40·7		40·9	
Marital status					
Single	17·7	14·8	<0·0001	14·8	<0·0001
Married or living with a partner	82·3	85·2		85·2	
Physical activity level					
Low (<30 min/d)	25·3	24·8	0·17	24·9	0·14
Medium (<1 h and ≥30 min/d)	31·3	30·6		30·5	
High (≥1 h/d)	43·4	44·6		44·6	
Smoking status					
Never smoker	47·0	48·2	<0·0001	48·0	<0·0001
Former smoker	37·0	38·3		38·6	
Current smoker	16·0	13·5		13·4	
Alcohol consumption (g ethanol)					
Non-drinker	21·2	11·5	<0·0001	13·9	<0·0001
Moderate drinker (M: >0 and ≤30 g/d; F: >0 and ≤20 g/d)	45·6	52·3		51·4	
Heavy drinker (M: >30 g/d; F: >20 g/d)	33·2	36·2		34·7	
Health status					
Overweight (BMI ≥25 kg/m^2)	35·9	34·4	0·09	34·1	0·11
Hypertension (SBP ≥140 mmHg and/or DBP ≥90 mmHg and/or medication)	23·6	26·7	<0·0001	26·7	<0·0001
Diabetes (glycaemia ≥7 mmol/l and/or medication)	4·3	4·0	0·25	4·0	0·25
Moderated hypertriacylglycerolaemia (1·7 mmol/l < triacylglycerolaemia <2·3 mmol/l and/or medication)	11·9	12·1	0·05	12·0	0·05
Severe hypertriacylglycerolaemia (≥2·3 mmol/l)	6·3	5·2		5·2	
Moderate hypercholesterolaemia (5·2 mmol/l <cholesterolaemia <7 mmol/l and/or medication)	62·4	62·5	0·83	62·6	0·96
Severe hypercholesterolaemia (≥7 mmol/l)	16·4	16·5		16·4	

M, male; F, female; SBP, systolic blood pressure; DBP, diastolic blood pressure.

fatty-sweetened foods. Finally, individuals with severe hypertriacylglycerolaemia were less likely to consume such foods in moderate or high amounts than those without hypertriacylglycerolaemia.

Results of the stratified analyses by sex did not differ from those of the model which included both sexes, except for smoking status (detailed results not shown). Male current smokers and former smokers were less likely to have moderate consumption of fatty-sweetened foods than male never smokers, whereas female former smokers were more likely to consume such foods in high amounts compared with female never smokers.

Discussion

The present study, which specifically focused on the consumption of fatty-salted and fatty-sweetened foods, emphasises the importance of considering fat, salt and added sugar not just as single components of the diet, but rather as components whose interactions could contribute to high consumption. Thus, the present results may help to identify high-risk profiles among consumers of these unhealthy food groups, which would be useful for setting up nutritional guidelines in public health. The findings from our research show that consumption of

Table 2. Dietary, demographic, socio-economic, lifestyle and health characteristics of consumers of fatty-salted and fatty-sweetened foods
(Mean values and standard deviations or percentages)

		Fatty-salted food consumption				Fatty-sweetened food consumption			
Variables	Total sample	Low	Intermediate	High	*P*	Low	Intermediate	High	*P*
Total energy intake (kJ/d)									
Mean	8870·1	7263·4	8695·6	10683·8	<0·0001	8200·6	8750·8	9642·8	<0·0001
SD	2466·0	1158·5	1925·0	2278·6		2429·2	2296·2	2463·1	
Lipid intake (g/d)									
Mean	88·9	70·2	87·0	110·0	<0·0001	80·9	87·6	98·2	<0·0001
SD	26·5	19·1	19·0	24·1		25·7	23·9	26·9	
Na intake (mg/d)									
Mean	3478·0	2796·8	3428·3	4222·4	<0·0001	3348·9	3455·8	3625·9	<0·0001
SD	1184·3	938·3	963·4	1175·4		1223·2	1128·5	1187·7	
Added sugar intake (g/d)									
Mean	40·8	35·2	41·4	45·9	<0·0001	32·1	39·0	51·1	<0·0001
SD	21·4	19·2	20·8	22·9		19·0	18·4	22·8	
Age (years)									
Mean	48·7	48·2	48·2	49·6	<0·0001	49·5	48·7	47·9	<0·0001
SD	6·4	6·5	6·4	6·0		6·2	6·4	6·4	
Sex									
Men	42·4	23·2	38·8	65·6	<0·0001	43·9	39·9	43·5	0·02
Women	57·6	76·8	61·2	34·4		56·1	60·1	56·6	
Occupational category									
Self-employed and farmers	4·7	3·8	5·0	5·3	<0·0001	4·7	4·4	5·0	0·003
Managerial staff and intermediate professions	55·3	51·6	56·8	57·6		51·9	56·0	58·0	
Manual workers and employees	16·0	18·8	14·6	14·5		17·7	15·3	14·9	
Unemployed, never employed and retired	24·0	25·8	23·6	22·6		25·8	24·3	22·0	
Education level									
Elementary school	20·5	20·7	18·9	21·9	0·006	24·0	20·1	17·5	<0·0001
Secondary school	38·6	40·2	37·2	38·4		39·7	39·2	37·0	
University or equivalent	40·9	39·1	43·9	39·7		36·4	40·8	45·4	
Marital status									
Single	14·8	17·0	14·3	13·0	0·001	13·5	14·9	15·9	0·09
Married or living with a partner	85·2	83·1	85·7	87·0		86·6	85·1	84·1	
Physical activity level									
Low (<30 min/d)	24·9	25·5	24·7	24·5	0·02	24·7	25·4	24·6	0·02
Medium (<1 h and ≥30 min/d)	30·5	32·1	31·2	28·3		28·2	30·7	32·7	
High (≥1 h/d)	44·6	42·4	44·2	47·2		47·2	43·9	42·8	
Smoking status									
Never smoker	48·0	54·7	49·5	39·7	<0·0001	47·5	51·0	45·3	0·003
Former smoker	38·6	31·0	38·4	46·6		38·2	36·6	41·1	
Current smoker	13·4	14·4	12·1	13·7		14·4	12·3	13·6	
Alcohol consumption (g ethanol)									
Non-drinker	13·9	22·7	12·2	6·8	<0·0001	16·4	12·4	13·2	0·0005
Moderate drinker (M: >0 and ≤30 g/d; F: >0 and ≤20 g/d)	51·4	57·3	56·5	40·2		48·2	52·7	53·2	
Heavy drinker (M: >30 g/d; F: >20 g/d)	34·7	20·0	31·3	52·9		35·5	34·9	33·6	
Health status									
Overweight (BMI ≥ 25 kg/m^2)	34·1	28·6	30·3	43·5	<0·0001	38·6	32·6	31·3	<0·0001
Hypertension (SBP ≥140 mmHg and/or DBP ≥90 mmHg and/or medication)	26·7	21·6	26·2	32·6	<0·0001	29·5	25·8	25·0	0·003

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Table 2. *Continued*

Variables	Total sample	Fatty-salted food consumption				Fatty-sweetened food consumption			
		Low	Intermediate	High	*P*	Low	Intermediate	High	*P*
Diabetes (glycaemia ≥7 mmol/l and/or medication)	4·0	3·0	3·2	5·8	< 0·0001	5·3	3·6	3·2	0·002
Moderate hypertriacylglycerolaemia (1·7 mmol/l < triacylglycerolaemia < 2·3 mmol/l and/or medication)	12·0	10·6	11·7	13·6	< 0·0001	13·7	11·8	10·5	< 0·0001
Severe hypertriacylglycerolaemia (≥ 2·3 mmol/l)	5·2	3·3	4·9	7·5		7·0	4·5	4·2	
Moderate hypercholesterolaemia (5·2 mmol/l < cholesterolaemia < 7 mmol/l and/or medication)	62·6	61·4	62·3	64·0	0·46	60·7	63·0	63·9	0·007
Severe hypercholesterolaemia (≥ 7 mmol/l)	16·4	17·2	16·3	15·6		18·7	16·3	14·4	

M, male; F, female; SBP, systolic blood pressure; DBP, diastolic blood pressure.

fatty-salted and fatty-sweetened foods is independently related to various characteristics, such as demographic, lifestyle and health factors, in this large national sample of French middle-aged women and men. Besides, the direction of the association between lifestyle characteristics (smoking and alcohol) and high consumption was opposite according to whether food was fatty-salted or fatty-sweetened.

Consumption of fatty-sweetened foods varied according to several demographic factors, whereas consumption of fatty-salted foods was related only to age. The intake of fatty-salted and fatty-sweetened foods decreased with age in our population. As discussed previously[30], the intake of energy-dense sweets and fast foods may decline with age due to physiological and psychological changes. Given that the present result concerned a population aged 35–60 years, these changes may occur during this period. In agreement with the literature[13,31], consumption of fatty-sweetened foods also varied with sex, showing a higher intake among women. A review on consumption of foods by men and women highlighted the fact that consumption of sweet foods such as cakes, biscuits, puddings and chocolate is tacitly treated by men and women as a marker of femininity in many cultures[31]. In addition, the present results showed that individuals who were married or living as a couple were higher consumers of fatty-sweetened foods. In general, marriage and living as a couple are related to healthy eating habits[32,33]. However, some studies also showed that people who lived as a couple ate more energy-dense foods such as sweets and desserts than single people[12,34,35]. Finally, the present results highlight the fact that low- and middle-educated individuals were lower consumers of fatty-sweetened foods; this result is not consistent with the previous literature, which showed a higher intake of high-fat dairy products, cakes and desserts in subjects having a lower education level[14,36]. However, fatty-sweetened foods, such as sweet cream desserts, chocolate products and pastries, in the period under study (1994–6), could represent up-to-date and sophisticated products, particularly in urban areas. After the later large-scale nutritional information campaigns, perception of these products changed and fruits were preferred to them among the more highly educated individuals.

The present study showed that a high consumption of fatty-salted or fatty-sweetened foods were associated with other unhealthy lifestyles, including low physical activity, smoking habits and alcohol consumption. Our findings were in agreement with previous studies, which showed that unhealthy dietary patterns (higher intake of fat, higher intake of high-fat dairy products, cakes, chocolate, etc.) and unhealthy physical activity patterns were correlated behaviours[37]. Regular physical activity seemed to be integrated into a 'healthy' lifestyle along with dietary aspects[38–40].

Table 3. Multivariate polytomic logistic analysis of the association between demographic, socio-economic, lifestyle and health characteristics and levels of fatty-salted food consumption*

(Odds ratios and 95% confidence intervals)

	Medium *v.* low consumers			High *v.* low consumers			
	OR	95 % CI†	*P*	OR	95 % CI†	*P*	Global *P*‡
Age (years)	0·98	0·97, 0·99	<0·0001	0·98	0·96, 0·99	0·0004	<0·0001
Sex							
Men	1·00			1·00			
Women	0·96	0·81, 1·14	0·67	0·90	0·74, 1·10	0·33	0·61
Smoking							
Never smoker	1·00			1·00			
Former smoker	0·85	0·69, 1·04	0·08	1·07	0·84, 1·35	0·58	0·006
Current smoker	1·15	1·00, 1·33	0·004	1·29	1·09, 1·53	0·01	
Alcohol consumption							
Non-drinker	1·00			1·00			
Moderate drinker (M: >0 and ≤30 g alcohol/d; F: >0 and ≤20 g alcohol/d)	1·46	1·22, 1·76	0·004	1·54	1·21, 1·98	0·14	<0·0001
Heavy drinker (M: > 30 g alcohol/d; F: >20 g alcohol/d)	1·45	1·16, 1·81	0·04	1·86	1·41, 2·45	<0·0001	
Body mass status							
Normal (BMI <25 kg/m^2)	1·00			1·00			
Overweight (BMI ≥25 kg/m^2)	1·06	0·91, 1·23	0·46	1·57	1·32, 1·86	<0·0001	<0·0001
Hypertension							
Normal	1·00			1·00			
Hypertensive (SBP ≥140 mmHg and/or DBP ≥90 mmHg and/or anti-hypertensive medication)	1·27	1·08, 1·49	0·004	1·33	1·11, 1·60	0·002	0·002

M, male; F, female; SBP, systolic blood pressure; DBP, diastolic blood pressure.

* Variables included in the model were age, sex, smoking status, alcohol consumption, BMI, presence of hypertension and total daily energy intake (in kJ/d, continuous variable).

† Determined by logistic regression analyses.

‡ Global *P* value represented the overall significance of each variable, retained in the final model (type 3 analysis of effects).

The present study also showed that, compared with individuals who never smoked, current smokers consumed more fatty-salted and less fatty-sweetened foods. While the literature showed that smoking is strongly associated with unhealthy dietary patterns[41], several studies have also found that current smokers had lower intakes of fatty-sweetened foods[42,43]. Indeed, behavioural research showed that cigarette smoking is accompanied by decreased consumption of sweet-tasting high-energy foods[44]. The association between smoking and fatty-salted foods in the literature was more difficult to evaluate[45,46]. However, sensory research showed that smoking reduces the perception of a salty taste due to long-term-induced sensory deficits[47]. Smokers might need to consume more salty products to attain taste sensations of the same magnitude as non-smokers.

The findings showing that alcohol drinkers were higher consumers of fatty-salted foods but lower consumers of fatty-sweetened foods were in concordance with previous studies[39,40]. Colditz *et al.*[39] evoked the possibility that sweet food items and alcohol may be competitors in the diet. For fatty-salted foods, one experimental study showed that participants who drank higher doses of alcohol ate more high-fat salty food items, reflecting changes in taste perception of salty foods following a dose of alcohol[48]. There may exist a behavioural explanation for combined consumption of alcohol and these foods. Indeed, fatty-salted foods such as appetisers and cheese are typically eaten with alcoholic beverages in France.

Causal inferences regarding a possible association between consumption and health characteristics must be viewed with caution, due to the cross-sectional design of the present study. On the one hand, individuals with severe hypertriacylglycerolaemia may change their diet after learning about their disease, by reducing their intake of unhealthy food, and therefore were lower consumers of fatty-sweetened foods than those with normal triacylglycerolaemia values even after adjustment. One the other hand, the present results showed that overweight and/or hypertensive subjects were higher consumers of fatty-salted products. Certain dietary behaviours, risk factors of these diseases, may be more difficult to modify. Thus, this finding encourages reinforcing dietary management in the treatment of these diseases[2].

Interpretation of the present results must take into account the characteristics of the study. The subjects were participants in a nutritional intervention study and may therefore have a healthier lifestyle than the general population. Thus, caution is needed when interpreting and generalising results to the adult population in France. However, the present study included a large sample of subjects from a free-living population; moreover, the characteristics of participants in the SU.VI.MAX study were close to those of the national population in terms of geographical density and socio-economic status[18].

Table 4. Multivariate polytomic logistic analysis of the association between demographic, socio-economic, lifestyle and health characteristics and levels of fatty-sweetened food consumption*

(Odds ratios and 95% confidence intervals)

	Medium *v.* low consumers			High *v.* low consumers			
	OR	95 % CI†	*P*	OR	95 % CI†	*P*	Global *P*‡
Age (years)	0·99	0·98, 1·00	0·008	0·97	0·96, 0·98	<0·0001	<0·0001
Sex							
Men	1·00			1·00			<0·0001
Women	1·51	1·27, 1·78	<0·0001	1·76	1·47, 2·11	<0·0001	
Marital status							
Single	1·00			1·00			0·03
Married or living with a partner	1·15	0·96, 1·37	0·13	1·28	1·06, 1·54	0·009	
Education level							
University or equivalent	1·00			1·00			0·004
Secondary school	0·92	0·80, 1·05	0·22	0·83	0·72, 0·96	0·01	
Elementary school	0·83	0·70, 0·98	0·03	0·71	0·59, 0·85	0·0002	
Smoking status							
Never smoker	1·00			1·00			0·006
Former smoker	0·90	0·78, 1·03	0·12	1·12	0·97, 1·30	0·13	
Present smoker	0·79	0·65, 0·96	0·02	1·01	0·82, 1·24	0·93	
Alcohol consumption							
Non-drinker	1·00			1·00			<0·0001
Moderate drinker (M: > 0 and ≤30 g alcohol/d; F: >0 and ≤20 g alcohol/d)	1·33	1·11, 1·61	0·003	1·07	0·88, 1·30	0·50	
Heavy drinker (M: >30 g alcohol/d; F: >20 g alcohol/d)	1·13	0·91, 1·41	0·27	0·61	0·49, 0·77	<0·0001	
Physical activity level							
High (≥1 h of walking/d)	1·00			1·00			0·04
Medium (<1 h and ≥30 min of walking/d)	1·12	0·97, 1·30	0·12	1·26	1·08, 1·47	0·004	
Low (<30 min of walking/d)	1·14	0·97, 1·33	0·11	1·19	1·01, 1·41	0·04	
Triacylglycerol							
Normal							0·02
Moderate hypertriacylglycerolaemia (1·7 mmol/l <triacylglycerolaemia <2·3 mmol/l and/or medication)	0·92	0·76, 1·12	0·41	0·83	0·68, 1·03	0·09	
Severe hypertriacylglycerolaemia (≥2·3 mmol/l)	0·70	0·53, 0·93	0·01	0·66	0·49, 0·89	0·006	

M, male; F, female; SBP, systolic blood pressure; DBP, diastolic blood pressure.

* Variables included in the model were age, sex, smoking status, alcohol consumption, BMI, presence of hypertension and total daily energy intake (in kJ/d, continuous variable).

† Determined by logistic regression analyses.

‡ Global *P* value represented the overall significance of each variable, retained in the final model (type 3 analysis of effects).

Another limitation was the use of the food record as a method for dietary assessment. A major disadvantage of the dietary record method is that it leads to bias due to selection of participants in the study and to reliability in dietary assessment[49]. First, the requirement for frequent dietary recording may have discouraged responders from participating. Indeed, numerous participants were excluded from the present analysis because they filled fewer than six computerised 24 h dietary records. The differences that were found in socio-economic, demographic and lifestyle profiles between the total sample of the SU.VI.MAX study and those individuals could have caused bias in the studied associations because of potential underestimation of fatty-sweetened and fatty-salted food consumption in men, single people, current smokers and alcohol drinkers. Nevertheless, selection of at least six dietary records is also a strength of the present study, since it enabled reliable dietary estimation and limited misclassification by decreasing intra-individual variations[50]. In addition, the knowledge that food requires recording and the demanding task of doing it might alter the dietary behaviour that the tool was intended to measure[51]. The combined effects of under-recording of foods considered to be unhealthy and the impact of the recording process on dietary behaviour changes, leading to under-eating, may have caused the participants to underestimate usual dietary habits. Indeed, the results of comparisons of dietary intake between the first day of recording and later days highlighted a significant difference in lipid intake, indicating slight under-reporting of fatty foods. In order to classify foods as fatty-sweetened or fatty-salted, we applied arbitrary thresholds based on nutritional content in fat, sugar and salt. However, the strength of the present study lies in the use of food groups rather than a nutrient approach, which may be more appropriate for analysing the association of dietary behaviour with lifestyle. Another strength of the present study was the use of a large number of covariates to assess potential socio-economic, demographic, lifestyle and health characteristics of consumers of fatty-salted and fatty-sweetened foods.

In conclusion, the sensory properties of combined fatty-sweetened or fatty-salted products contribute to eating

pleasure and might therefore lead to overconsumption, identified as a risk factor in obesity and related health problems[15–17]. In this respect, the present study provides original and useful information on the characteristics of consumers of these food groups, simultaneously taking into account demographic, socio-economic, lifestyle and health characteristics. In particular, the present results, which identify common correlates of unhealthy behaviours such as smoking, low physical activity and alcohol drinking and high consumption of fatty-sweetened or fatty-salted foods, may help to more accurately target public health efforts. Campaigns to improve diet and increase physical activity, along with encouraging a reduction in cigarette smoking and alcohol consumption, might be useful for improving the nutritional status of populations.

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