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Sociodemographic, lifestyle and dietary correlates of dietary supplement use in a large sample of French adults: results from the NutriNet-Santé cohort study

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Abstract

Information on the determinants of dietary supplement (DS) use in France is largely lacking, especially in population subgroups such as smokers. Also, little is known about the role of health professionals in DS purchases. The aim of the present study was to describe DS use along with its sociodemographic, lifestyle and dietary correlates in a large sample of French adults (age 18+years) participating in the NutriNet-Santé cohort study. Data were collected by self-administered Internet questionnaires. Food intakes were assessed by 24 h dietary records. Data on DS use were available for 79 786 participants. Supplement users were compared with non-users by logistic regression. Current DS use at least three times/week was reported by 14·6 % of men and 28·1 % of women. Mg, and vitamins B_6 and C were the most frequently consumed nutrients. DS were prescribed or recommended by a physician in 54·9 % of the cases. DS use was positively associated with knowledge of nutritional recommendations and organic product consumption, following a healthier diet and lifestyle (non-smoker, moderate leisure-time physical activity). Current smokers used less DS than did non-smokers, but their DS consumption was substantial (19·0 %) and they were more likely to self-medicate. The present study provides updated and detailed information on DS use determinants in a large French cohort, including a focus on smokers, for whom the long-term effects of DS use are poorly documented and could represent a risk. These findings pave the way for future aetiological studies.

Key words: **Dietary supplements: Motivation: Health behaviour: Smoking status**

Dietary supplements (DS) are defined as 'foodstuffs the purpose of which is to supplement the normal diet and which are concentrated sources of nutrients or other substances with a nutritional or physiological effect, alone or in combination, marketed in dose form [. . .]' (European Directive 2002/46/CE). In the USA, DS use is widespread and well documented[1–4]. In Europe, several studies have also investigated the determinants and prevalence of DS use, and showed that DS use was lower than that in the USA[5–7]. However, such knowledge as regards the French context is largely lacking. Since health and nutrition-related behaviours may strongly vary from one country to another, it is important to conduct country-specific studies regarding DS use. Traditionally in France, DS use has not been a practice as common as in other European countries or in the USA, partly due to the underlying differences in attitudes towards diet and nutrition. The few existing French studies about DS use were based on very small samples[8], are outdated[2] or were restricted to specific subgroups[9,10]. In 2005[11] and 2006[12], DS use was assessed in nationally representative samples of the French population, but the findings of these two studies have not been disseminated internationally. In addition, they were based on a relatively small sample of subjects, thereby not allowing specific analyses on DS use in population subgroups. These studies have suggested that the proportion of DS users increased steadily over time, and also revealed several sociodemographic and lifestyle correlates of DS use, such as a higher intake of fruits and vegetables, with a lower BMI and higher levels of physical activity. If DS use is indeed associated with several sociodemographic, economic, lifestyle and dietary factors, a precise assessment of these associations and of DS users' profile is an important parameter for future aetiological studies on nutritional intake, DS use and chronic disease risk. The objectives of the present study were to

Abbreviation: DS, dietary supplement.

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provide updated and detailed data on DS use and to explore sociodemographic, lifestyle and dietary correlates of DS use in the NutriNet-Santé study, which involves a large cohort of French volunteers. We also evaluated the role of physicians in the motivation for DS purchases and the proportion of self-medication, as limited information was available on this topic in France[13,14]. Finally, growing evidence of increased cancer risk exists regarding the association between tobacco smoking and the use of some DS such as β-carotene supplements[15–17]. Thus, we also described DS use (types, motivations, self-medication, etc.) according to smoking status.

Methods

Study population

The NutriNet-Santé study is the first Web-based, general population, prospective observational cohort study worldwide aimed at elucidating the link between nutrition and health. Specifically, it was launched in France in the spring of 2009 to evaluate the determinants of eating behaviour and the relationship between nutrition and chronic disease risk[18]. Participants were recruited by a vast multimedia campaign. Inclusion criteria pertain to residence in France, age ≥18 years and access to the Internet. Registration and participation took place online using a dedicated web site (www.etude-nutrinet-sante.fr). By January 2012, 102 988 volunteers had completed all of the baseline questionnaires and were included in the study. Follow-up is planned for at least 10 years. The present study was approved by the International Research Board of the French Institute for Health and Medical Research (IRB Inserm no. 0000388FWA00005831) and the 'Commission Nationale de l'Informatique et des Libertés' (CNIL no. 908450 and no. 909216).

Data collection

Participants filled in self-administered, Web-based questionnaires at baseline and then regularly during the follow-up. Written informed consert was obtained from all subjects.

Dietary supplement use

The questionnaire regarding DS use was administered 2 months after inclusion. In the present study, we considered as DS both true DS and medicinal supplements (supplements considered as pharmaceutical products in France, and mainly composed of vitamins and minerals). Participants were asked whether they were currently taking any supplement at least 3 d/week at the time of the DS questionnaire ('current DS users'), and were also asked to specify the type of DS using a list of thirty-four different nutrients and substances. They were also asked whether they took any DS in the past 12 months (at least once). The frequency and duration of use for each DS was assessed, thereby permitting the calculation of the average number of days of use in the last 12 months and the overall duration of use. The questionnaire also included assessment of the circumstances and motivations for DS use, the physician's role in DS purchases and the seasonality of DS use.

Sociodemographic, lifestyle and behavioural data

At inclusion, self-administered questionnaires collected data on sociodemographic and lifestyle characteristics, including age, sex, marital status, number of children, education, occupation, smoking status, anthropometry, following a restrictive diet, pregnancy and menopause in women, and leisure-time physical activity (estimated with the International Physical Activity Questionnaire[19]). The instruments were tested against traditional assessment methods (paper or interview by a health professional)[20–22].

Dietary data

At inclusion, participants were asked to complete three non-consecutive, self-administered, Web-based 24 h dietary records, the days for which were randomly assigned during a 2-week period (2 d during the week and 1 d during the weekend). Participants were included in the NutriNet-Santé cohort if they provided at least one 24 h dietary record at baseline. All foods and beverages consumed at breakfast, lunch or dinner were recorded. For foods with potentially high nutrient variability, participants were also asked to provide the brand name. Participants estimated the portion size for each reported food and beverage item using validated photographs[23]. A comparison of the Web-based dietary assessment with a traditional dietitian's interview showed good agreement between the two methods[21]. Daily dietary intakes of various nutrients were calculated using the 'NutriNet-Santé' food composition table, which included more than 2500 different foods.

Knowledge of official nutritional recommendations as provided in the 'French National Nutrition and Health Program'[24] was also assessed. It pertained to recommendations regarding five main food groups (fruits and vegetables, dairy products, meat, fish and starchy food). Finally, a specific questionnaire was used to assess the opinion and behaviour of the participants towards organic food consumption.

Statistical analyses

All participants of the cohort who were included before January 2012 and who answered the DS questionnaire were included in the analyses (n 79 786). Proportions of DS users (current users and users of at least one supplement during the past 12 months), types of DS consumed by current users, frequency, circumstances, motivations and seasonality of use were described in the full sample and also by smoking status (current, former and never smokers).

OR and 95 % CI were calculated by age- and sex-adjusted logistic regression analyses comparing DS users (i.e. those who reported DS use at least once during the past 12 months) and non-users regarding their sociodemographic characteristics (age, sex, geographical region, marital status, number of children, education and occupation), lifestyle and behavioural factors (smoking status, BMI, current practice of

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a restrictive diet, leisure-time physical activity, pregnancy, self-perceived emotional state and physical pain, knowledge of official nutritional recommendations and organic food consumption). *P* values from the Wald test were provided. Tests for linear trend were performed using the ordinal score on categories of each variable.

Only subjects who provided three dietary records at baseline and who were normo-energy reporters according to the Goldberg criterion[25] were included in the analysis relative to dietary data. The mean daily intakes of twenty-three different food groups, dietary micro- and macronutrients, energy, dietary fibre and alcohol were compared by logistic regression analyses between DS users and non-users after adjustment for sex, age and energy intake. The proportion of subjects with reported intake below the estimated average requirement for the French population[26] was estimated for each nutrient by sex. It was established that, at the population level, this proportion represents an unbiased estimate of the proportion of subjects whose intake is below their respective requirements, also called 'prevalence of inadequacy'[27]. When an individual has intake below his/her requirement, this may lead to a risk of chronic insufficient intake, and possibly, deficiency. The measurement error model proposed by the National Research Council[28] and developed by Nusser *et al.*[29] was applied to the observed daily dietary intake, in order to remove the effects of day-to-day intake variability. The prevalence of inadequate dietary nutrient intake was then compared between DS users and non-users in men and women by logistic regressions adjusted for age and energy intake.

A P value $<0{\cdot}05$ was considered as significant in all statistical tests. All tests were two-sided. All analyses were carried out with SAS software (release 9.1; SAS Institute, Inc.).

Results

Proportion of dietary supplement users, type, motivations and circumstances of dietary supplement use

The average age of the participants (n 79 786) was 45·2 (SD 14·5) years and women constituted 76% of the sample. Among the study population, 32·4% were executives or had an intellectual profession, 30·0% were employees, 25·9% had an intermediate profession, 5·3% were unemployed, 3·2% were manual workers, 2·8% were self-employed and 0·4% were farmers. The proportions of overweight (not including obesity) and obese subjects were 22 and 10%, respectively.

DS use among men and women is presented in Table 1. About 41% of the subjects reported the use of at least one DS during the 12 months preceding the survey. About 25% of the respondents were current users (DS use at least 3 d/week at the time of the DS questionnaire: 28·1% in women and 14·6% in men). In current DS users, Mg, vitamin B_6, vitamin C, Zn and Fe were the most frequently used nutrients, whereas n-3 fatty acids and herbal supplement use were relatively low (Table 1).

Motivations, circumstances of DS purchases and seasonality are presented in Table 2. The main reasons for DS use were to 'overcome tiredness' and to 'stay healthy', whereas 'compensating for an inadequate dietary intake' was quoted by only 5·4% of the DS users. DS were mainly purchased with a prescription, following medical advice or a recommendation by a pharmacist. DS use was increased during the autumn and winter months.

In the last 12 months, 61 359 DS were declared by the participants. Among them, 41·0% were used for less than 1 year, 22·1% were used 1–2 years, 19·3% were used over 3–5 years, 9·8% were used 5–10 years and 7·8% were used for more than 10 years. In the last 12 months, the average duration of DS use was 94·7 (SE 108) d (data not shown).

Sociodemographic, lifestyle and behavioural correlates of dietary supplement use

When compared with non-users, DS users were more likely to be women, older, more educated, better employed and more physically active (Table 3). DS use decreased with the number of children. Users were more likely to be non-smokers, to have a lower BMI and to follow a restrictive diet. Women who took supplements were more likely to be pregnant or postmenopausal. Users were more likely to report emotional problems, physical pain, increased familiarity with official nutritional recommendations (recommendations of the French National Nutrition and Health Program) and organic food consumption.

Dietary supplement use according to smoking status

In the study population, 17·4% were current smokers and 33·5% were former smokers. When compared with never smokers, current smokers were less likely to be current DS users (OR 0·76, 95% CI 0·72, 0·80; data not shown) or to have used DS during the past 12 months (Table 3). The proportion of current DS users was 19·0% in smokers, 27·2% in former smokers and 25·2% in never smokers. Hierarchy of nutrients consumed (Mg, vitamin B_6 and vitamin C) was the same regardless of the smoking status (data not shown). β-Carotene supplement use was low overall (1·5% in smokers, 2·0% in former smoker and 1·7% in never smokers, $P=0{\cdot}25$).

Motivations for DS use differed between current and never smokers (data not shown). Current smokers were less likely to indicate reasons such as 'overcome health problems' or 'meet specific needs related to a sports practice' (33·1 and 3·9%, respectively), and were more likely to give reasons such as 'to counter stress' (17·5%), 'to lose weight' (7·3%), 'to improve intellectual performance' (6·1%) and 'to compensate for an inadequate diet' (6·5%). In total, 7·3% of current smokers used DS because of specific needs related to pregnancy (almost as much as in never smokers: 7·7%). When compared with never smokers, current smokers were more likely to self-medicate with DS, whereas having a medical prescription or receiving advice by a dietitian was reported by 30·9 and 2·4%, respectively (*v.* 36·3 and 3·2%, respectively, among never smokers). Also, current smokers were more likely to purchase DS following non-medical advice (i.e. from

Table 1. Dietary supplement (DS) use in men (*n* 19 398) and women (*n* 60 388) in the NutriNet-Santé cohort study, 2012

(Number of subjects and percentages)

	All		Men		Women	
	n	%	*n*	%	*n*	%
DS use during the past 12 months* (yes)	32 582	40·8	4729	24·4	27 853	46·1
Current DS use ≥ 3 d/week (yes)	19 785	24·8	2828	14·6	16 957	28·1
Types of DS used (current users only)†						
Mg	8324	42·1	1166	41·2	7158	42·2
Vitamin B_6	5904	29·8	824	29·1	5080	30·0
Vitamin C	5387	27·2	966	34·2	4421	26·1
Zn	4974	25·1	767	27·1	4207	24·8
Fe	4800	24·3	586	20·7	4214	24·9
Vitamin E	4655	23·5	752	26·6	3903	23·0
Thiamin	4456	22·5	396	14·0	1846	10·9
Vitamin D	4421	22·3	710	25·1	3746	22·1
Riboflavin	4381	22·1	481	17·0	3940	23·2
Folate	4153	21·0	694	24·5	3687	21·7
Pantothenic acid	3912	19·8	532	18·8	3621	21·4
Ca	3885	19·6	550	19·4	3362	19·8
Niacin	3397	17·2	605	21·4	3214	19·0
Se	3358	17·0	531	18·8	2866	16·9
Vitamin B_{12}	3272	16·5	580	20·5	2778	16·4
Vitamin B_8	2882	14·6	529	18·7	2743	16·2
n-3 Fatty acids	2733	13·8	377	13·3	2505	14·8
Vitamin A	2242	11·3	292	10·3	2261	13·3
Evening primrose, borage or cod-liver oil	1815	9·2	124	4·4	1691	10·0
Acerola, guarana or cranberry supplement	1674	8·5	227	8·0	1147	6·8
I	1443	7·3	210	7·4	1233	7·3
β-Carotene	1389	7·0	203	7·2	1186	7·0
P	1121	5·7	237	8·4	884	5·2
Ginseng	1050	5·3	249	8·8	806	4·8
Fibres	846	4·3	131	4·6	715	4·2
Amino acids/proteins	681	3·4	186	6·6	495	2·9
Lutein	670	3·4	125	4·4	545	3·2
Phyto-oestrogens	376	1·9	38	1·3	338	2·0
F	310	1·6	63	2·2	247	1·5
Vitamin K	263	1·3	58	2·1	205	1·2
Zeaxanthin	252	1·3	62	2·2	190	1·1
Retinol	96	0·5	23	0·8	73	0·4
Other minerals‡	3819	19·3	437	15·5	3448	20·3
Other herbal supplements	2553	12·9	613	21·7	2120	12·5

* ≥1 DS during the 12 months preceding the DS questionnaire.
† Nutrients and other substances were taken alone or in combination.
‡ K, Cu, Li, Mn, Ce and others.

a friend/parent) than were non-smokers or former smokers (17·4, 14·4 and 13·8 %, respectively; data not shown).

Dietary intake associated with dietary supplement use

Among the 79 786 subjects with available DS data, 55 569 provided three dietary records and were normo-energy reporters, and thus were included in the following analyses.

Daily food intakes in DS users and non-users are compared in Table 4. Overall, DS users had a healthier diet than non-users – they ate more vegetables, fruits, soups/broth, wholegrain foods, pulses, fish/seafood, breakfast cereals, sugar/confectionery and meal substitutes, and drank more unsweetened drinks. They also ate less potatoes, dairy products, meat and offal, poultry, processed meat, cakes/biscuits/pastries, snacks/pizzas and drank less alcoholic beverages.

Daily dietary energy and nutrient intake in DS users and non-users are compared in Table 5. DS users had higher food intakes of energy, total and simple carbohydrates, fibres, unsaturated fatty acids, but had lower intakes of alcohol, proteins, total lipids and SFA. They also had higher dietary intakes for most vitamins and minerals (i.e. thiamin, riboflavin, niacin, pantothenic acid, vitamin B_6, folate, vitamin B_{12}, β-carotene, vitamins A, C, D and E, Ca, Fe, Mg, P and K). DS users had lower intakes of Na than did DS non-users.

The prevalences of dietary nutrient inadequacy (intakes from food) in DS users and non-users were compared by sex in Table 6. The prevalence of inadequacy was statistically significantly lower in DS users compared with non-users regarding most nutrients (thiamin, folate, vitamins B_6, A, C and E, Ca and Mg in men and women, plus riboflavin, pantothenic acid and Fe in women only). Only the prevalence of inadequacy for vitamin B_{12} intake was higher in women DS users than in non-users.

Table 2. Reasons for use, circumstances of dietary supplement (DS) purchases and seasonality of use in DS users in the NutriNet-Santé cohort study (*n* 32 582; men *n* 4729, women *n* 27 853), 2012*

(Number of subjects and percentages)

	All		Men		Women	
	n	%	*n*	%	*n*	%
Reasons for DS use						
Overcome tiredness	13 527	41·5	1733	36·6	11 794	42·3
Stay healthy	10 997	33·8	2207	46·7	8790	31·6
Solve or overcome health problems	10 511	32·3	1224	25·9	9287	33·3
Beauty	5001	15·3	224	4·7	4777	17·2
Counter stress	4800	14·7	459	9·7	4341	15·6
Stay young	2906	8·9	571	12·1	2335	8·4
Pregnancy	2276	7·0	4	0·1	2272	8·2
Lose weight	1620	5·0	151	3·2	1469	5·3
Compensate for an inadequate dietary intake due to a restrictive diet	1524	4·7	233	4·9	1291	4·6
Improve intellectual performance	1439	4·4	315	6·7	1124	4·0
Meet specific needs related to a sports practice	1396	4·3	675	14·3	721	2·6
Compensate for a dietary intake perceived as inadequate (without a restrictive diet)	1770	5·4	360	7·6	1410	5·1
Do not know	83	0·3	19	0·4	64	0·2
Circumstances of DS purchases						
With a medical prescription	11 044	33·9	905	19·1	10 139	36·4
Following medical advice	6828	21·0	738	15·6	6090	21·9
Following the advice of a pharmacist	6763	20·8	666	14·1	6097	21·9
Following the advice of a dietitian	885	2·7	104	2·2	781	2·8
Following the advice of another health professional	2105	6·5	253	5·3	1845	6·6
Following the advice of a friend/family member	5264	16·2	850	18·0	4414	15·8
Following non-professional advice received on site	915	2·8	110	2·3	805	2·9
Discovered the DS in the store	4188	12·9	687	14·5	3501	12·6
Read about the DS in a book	3156	9·7	619	13·1	2537	9·1
Heard about the DS in the media	2458	7·5	466	9·9	1992	7·2
Saw an advertisement	1081	3·3	173	3·7	908	3·3
Other circumstances	3056	9·4	635	13·4	2421	8·7
Do not know	226	0·7	59	1·2	167	0·6
Higher DS use during a particular season (yes)	17 024	52·2	2638	55·8	14 386	51·6
Winter	9505	55·8	1405	53·3	8100	56·3
Autumn	7033	41·3	788	29·9	6245	43·4
Spring	4550	26·7	479	18·2	4071	28·3
Summer	1252	7·4	120	4·5	1132	7·9

* In subjects who reported use of ≥ 1 DS during the 12 months preceding the DS questionnaire.

Discussion

The present study sheds light on DS use in a large sample of French adults. In the present analyses, Mg emerged as the most frequently used supplement, followed by vitamins B_6 and C, which is in accordance with the results from the Comportements et consommations alimentaires en France (CCAF) study[30]. The principal reason cited for DS use in the present study was 'to overcome tiredness', in line with the results of the ECCA (Enquête sur les Consommateurs de Compléments Alimentaires) study[13]. There was consistency between the most frequently cited DS used and the main reasons for use. Indeed, the European Food Safety Authority has recently recognised a causal relationship between some nutrient deficiency (notably Mg, vitamin C and vitamin B_6) and fatigue, thus authorising claims related to the management of fatigue as regards dietary products that contain at least 15 % of the RDA/100 g[31–33]. In contrast, a well-founded reason that could motivate DS use (i.e. 'to compensate for inadequate dietary intake') was cited by only 10·1 % of the users. In addition, specific conditions (often associated with physical or psychological discomfort) such as undergoing a restrictive diet, pregnancy, menopause and chronic emotional or physical pain were associated with a higher DS use in the present study. DS use did not appear to be a temporary trend, as it was often reported over a long period of time, suggesting that long-term effects on health are possible. Winter was also reported as the main season for DS use in the INCA2 (Étude Individuelle Nationale des Consommations Alimentaires 2) and the ECCA studies[8,14].

About half of the DS users were self-medicated, whereas 21 % of the DS purchases followed medical advice and another 33 % were purchased with a prescription. In addition, the role of the pharmacist was noteworthy, as it represented more than 20 % of the reported motivations for DS purchases. These results were in accordance with the INCA2 study[14], where medical prescription or advice represented 52 % and advice from a pharmacist represented 18 %. It has been suggested that pharmacists might be ill-equipped to counsel patients on these products and an ethical issue stemming from the profit motive may occur[34].

Table 3. Sociodemographic, lifestyle and behavioural correlates of dietary supplement (DS) use in the NutriNet-Santé cohort, 2012 (*n* 32 582 DS users* and 47 204 non-users)

(Number of subjects and percentages; odds ratios and 95 % confidence intervals)

	n	Percentage of DS users in each category	Age- and sex-adjusted logistic regression analyses			
			OR	95 % CI	*P*	*P* for trend†
Sex					<0·0001	
Male	19 398	24·4	1·00			
Female	60 388	46·1	2·87	2·77, 2·98		
Age (years)					<0·0001	<0·0001
≤ 35	25 014	36·8	1·00			
35–44	15 862	40·7	1·25	1·20, 1·30		
45–55	16 047	43·0	1·37	1·32, 1·43		
> 55	22 863	43·8	1·63	1·57, 1·69		
Geographical region					<0·0001	
Paris	4041	46·0	1·00			
Paris suburb	12 384	42·1	0·81	0·76, 0·88		
North	5352	36·3	0·64	0·59, 0·69		
North-west	11 390	36·6	0·63	0·58, 0·68		
Central-west	6779	38·5	0·68	0·63, 0·74		
South-west	8518	41·0	0·76	0·70, 0·82		
North-east	10 163	39·6	0·74	0·68, 0·79		
Central-east	10 567	43·1	0·84	0·78, 0·90		
South-east	9563	44·5	0·87	0·80, 0·94		
Corsica and overseas departments/territories	1029	44·0	0·89	0·77, 1·02		
Marital status					0·08	
Married or living with a partner	57 671	40·5	1·00			
Divorced/separated/widowed	7869	41·6	1·02	0·97, 1·07		
Single	14 246	38·7	1·05	1·00, 1·09		
Number of children					<0·0001	0·0008
0	27 574	40·9	1·00			
1 or 2	36 964	41·6	0·78	0·75, 0·81		
≥ 3	15 248	38·7	0·66	0·63, 0·69		
Education					<0·0001	
< 12 years of schooling	16 765	34·4	1·00			
≥ 12 years of schooling	63 021	42·6	1·59	1·53, 1·65		
Socio-professional categories					<0·0001	
Executives and intellectual professions	25 879	43·5	1·00			
Intermediate professions	20 676	44·4	0·95	0·91, 0·98		
Employees	23 903	38·2	0·69	0·66, 0·71		
Manual workers	2531	24·7	0·50	0·45, 0·55		
Farmers	310	33·9	0·64	0·50, 0·81		
Self-employed	2264	38·1	0·79	0·72, 0·87		
Never employed	4223	35·5	1·05	0·54, 2·15		
Job status					<0·0001	
In service	49 619	41·6	1·00			
Retired	14 550	42·3	0·95	0·90, 1·01		
Student	6137	33·1	0·75	0·71, 0·80		
Unemployed	4794	36·9	0·80	0·75, 0·85		
Others‡	4686	42·9	0·83	0·78, 0·89		
Smoking status					<0·0001	
Never smoker	39 208	42·5	1·00			
Former smoker	26 708	42·4	1·02	0·98, 1·05		
Current smoker	13 870	33·2	0·70	0·67, 0·73		
BMI (kg/m^2)					<0·0001	<0·0001
Underweight (<18·5)	3816	48·7	1·00			
Normal weight (18·5–24·9)	50 278	44·2	0·87	0·82, 0·93		
Overweight (25–29·9)	17 787	34·4	0·61	0·57, 0·66		
Obese (≥30)	7905	30·3	0·45	0·42, 0·49		
Current practice of a restrictive diet					<0·0001	
No	68 099	39·6	1·00			
Yes	14 687	46·3	1·22	1·18, 1·27		
Pregnant women					<0·0001	
No	58 825	45·4	1·00			
Yes	1563	74·9	4·59	4·08, 5·15		
Postmenopausal women					<0·0001	
No	41 005	43·0	1·00			
Yes	19 383	52·6	1·19	1·13, 1·25		

Table 3. *Continued*

	n	Percentage of DS users in each category	Age- and sex-adjusted logistic regression analyses			
			OR	95 % CI	*P*	*P* for trend†
Leisure-time physical activity§					<0·0001	<0·0001
Low	16 212	39·5	1·00			
Moderate	28 350	44·5	1·22	1·17, 1·27		
High	23 209	42·5	1·16	1·11, 1·21		
Self-perceived limitations in daily activities due to a negative emotional state‖					<0·0001	
No	45 083	45·0	1·00			
Yes	19 778	51·0	1·22	1·18, 1·26		
Chronic physical pain‖					<0·0001	
No	18 637	42·3	1·00			
Yes	46 224	48·7	1·24	1·20, 1·29		
Knowledge of official nutritional recommendations¶					<0·0001	<0·0001
Poor (0–2)	22 896	41·1	1·00			
Average (3)	21 750	43·8	1·03	0·99, 1·07		
Good (4–5)	26 651	48·2	1·16	1·12, 1·21		
Organic food consumption**					<0·0001	
Never (avoid organic products)	17 222	37·0	1·00			
Indifferent to organic food	4860	32·0	0·94	0·87, 1·00		
Occasional consumption	25 377	43·7	1·39	1·34, 1·45		
Regular consumption	11 365	60·8	2·61	2·48, 2·74		

* DS users were defined as subjects who used ≥1 DS during the 12 months preceding the DS questionnaire.
† Tests for linear trend were performed using the ordinal score on categories of each variable. DS users were compared with non-users for all the characteristics. The probability of being a DS user is modelled.
‡ Sabbatical leave, preparation for an examination, homemaker, illness.
§ Because of missing values, sample sizes were 28 876 supplement users and 38 895 non-users.
‖ Because of missing values, sample sizes were 30 374 supplement users and 34 487 non-users.
¶ From the French National Nutrition and Health Program. Because of missing values, sample sizes were 31 780 supplement users and 39 517 non-users.
** Determined by multiple correspondence analysis using data from the organic food consumption measure (five clusters defined by the first three discriminant axes). Because of missing values, sample sizes were 25 947 supplement users and 32 877 non-users.

Table 4. Comparison of daily food intake (g/d) in dietary supplement (DS) users* (*n* 24 191) and non-users (*n* 31 378) in the NutriNet-Santé cohort study†

(Mean values with their standard errors)

	Non-users‡		Users‡		
	Mean	SE	Mean	SE	*P* for trend
Vegetables	202·0	0·7	220·7	0·9	<0·0001
Fruits	230·1	1·0	257·1	1·3	<0·0001
Soups and broths	26·8	0·3	28·8	0·4	<0·0001
Potatoes and tubers	47·6	0·3	44·1	0·4	<0·0001
Pasta, rice, semolina, bread, flour, other cereals	178·8	0·5	178·9	0·6	0·8
Whole-grain foods	51·0	0·4	64·1	0·5	<0·0001
Pulses	8·4	0·1	9·5	0·2	<0·0001
Dairy products	203·2	0·9	197·7	1·2	<0·0001
Meat and offal	49·6	0·3	44·2	0·3	<0·0001
Poultry	26·3	0·2	24·9	0·2	<0·0001
Eggs	12·2	0·1	12·5	0·2	0·09
Fish and seafood	37·4	0·3	40·1	0·3	<0·0001
Processed meat	35·3	0·2	32·0	0·3	<0·0001
Fats and sauces	37·9	0·1	38·2	0·2	0·04
Fats (oil, butter, margarine)	21·4	0·1	22·1	0·1	0·1
Breakfast cereals	7·4	0·1	10·0	0·1	<0·0001
Sugar/confectionery/dried fruits/desserts	62·7	0·4	66·9	0·5	<0·0001
Cakes/biscuits/pastries	53·6	0·3	52·4	0·4	0·009
Snacks, pizza, pies	36·2	0·3	33·5	0·4	<0·0001
Unsweetened soft drinks	1040·2	3·4	1170·6	4·2	<0·0001
Sweetened soft drinks	58·2	0·7	52·3	0·8	<0·0001
Alcoholic drinks	124·1	0·9	114·8	1·1	<0·0001
Meal substitutes	0·8	0·1	1·9	0·1	<0·0001

* DS users were defined as subjects who used ≥1 DS during the 12 months preceding the DS questionnaire.
† In subjects with three dietary records at baseline.
‡ Logistic regression analysis comparing DS users and non-users with adjustment for sex, age and energy intake.

Table 5. Comparison of daily dietary energy and nutrient intake in dietary supplement (DS) users* *(n* 24 191) and non-users (*n* 31 378) in the NutriNet-Santé cohort study†

(Mean values with their standard errors)

	Non-users‡		Users‡		
	Mean	SE	Mean	SE	*P* for trend
Energy					<0·0001
kcal	2035·0	2·7	2071·6	3·4	
kJ	8514·4	11·3	8667·6	14·2	
Alcohol (g)	10·6	0·1	9·8	0·1	<0·0001
Total carbohydrates (g)	200·4	0·2	203·4	0·3	<0·0001
Simple carbohydrates (g)	91·3	0·2	94·7	0·2	<0·0001
Starch (g)	108·4	0·2	108·0	0·2	0·1
Fibres (g)	18·6	0·0	20·4	0·0	<0·0001
Proteins (g)	81·0	0·1	80·2	0·1	<0·0001
Total lipids (g)	78·8	0·1	78·4	0·1	0·0003
SFA (g)	32·5	0·0	31·5	0·1	<0·0001
MUFA (g)	28·5	0·0	28·8	0·0	<0·0001
PUFA (g)	11·9	0·0	12·3	0·0	<0·0001
Thiamin (mg)	1·2	0·0	1·3	0·0	<0·0001
Riboflavin (mg)	1·7	0·0	1·8	0·0	<0·0001
Niacin (mg)	18·2	0·0	18·7	0·0	<0·0001
Pantothenic acid (mg)	5·4	0·0	5·5	0·0	<0·0001
Vitamin B_6 (mg)	1·7	0·0	1·8	0·0	<0·0001
Folate (μg)	331·2	0·6	354·3	0·8	<0·0001
Vitamin B_{12} (μg)	5·5	0·0	5·8	0·1	<0·0001
Retinol (μg)	518·8	5·3	512·5	6·6	0·4
β-Carotene (μg)	3677·9	17·4	4063·8	21·8	<0·0001
Total vitamin A (μg)	1197·2	12·5	1251·8	15·7	0·003
Vitamin C (mg)	113·2	0·5	121·8	0·6	<0·0001
Vitamin D (μg)	2·7	0·0	2·9	0·0	<0·0001
Vitamin E (μg)	10·1	0·0	10·8	0·0	<0·0001
Na (mg)	2517·9	3·7	2484·7	4·7	<0·0001
Ca (mg)	889·9	1·6	910·2	2·0	<0·0001
Fe (mg)	12·4	0·0	13·1	0·0	<0·0001
Mg (mg)	311·3	0·5	330·7	0·6	<0·0001
P (mg)	1256·0	1·5	1281·1	1·9	<0·0001
K (mg)	2984·9	3·9	3103·4	4·9	<0·0001
Zn (mg)	10·4	0·0	10·3	0·0	0·05

*DS users were defined as subjects who used ≥1 DS during the 12 months preceding the DS questionnaire.

†In subjects with three dietary records at baseline.

‡Logistic regression analysis (performed to derive the *P* value for the comparison between DS users and non-users) was adjusted for sex, age and energy intake.

Concerning the sociodemographic, lifestyle and behavioural profile of DS users, several studies in other developed countries have also found that supplement users were more often women[8,12], older[35], had a higher level of education[7], belonged to a higher socio-professional category[36] and lived in small-sized households[8]. Lower BMI[8], higher leisure-time physical activity levels[3,10] and healthier lifestyle among users than non-users[37–39] have also been reported. In addition, we observed, for the first time in France, that DS users were more likely to report increased knowledge of nutritional recommendations and increased organic food consumption, adding consistency to the 'healthy DS users' profile.

As reported previously, using another French cohort, we observed that current smokers were less likely to be DS users than were non-smokers[10], which is consistent with a healthier lifestyle. However, DS use in smokers was non-negligible (19 %), despite the fact that the potential health effects of DS use in association with tobacco smoking are not well known. Notably, it has been shown that β-carotene supplements increase cancer risk in smokers[16,40]. β-Carotene DS use was low in the present study, but interestingly, it was not lower among smokers, despite the demonstrated cancer risk in that subgroup. This finding suggests that smokers might not be aware of that risk, or that health care professionals might not be well informed[41]. The most commonly used DS were the same regardless of smoking status, but the reasons for use differed. When compared with never smokers, smokers were more likely to use DS to overcome stress, to lose weight, to compensate for inadequate dietary intake and were more likely to self-medicate, which increases the potential risks associated with DS use in this sub-population.

Considering food and dietary nutrient intake, DS users had a healthier diet than non-users, as observed previously[2,12,38,42]. The prevalence of inadequate dietary nutrient intake was also lower in DS users compared with non-users for most micronutrients, in both men and women, as reported

Table 6. Comparison of the prevalence of dietary nutrient inadequacy stratified by sex and dietary supplement (DS) use in the NutriNet-Santé cohort study*
(Odds ratios and 95 % confidence intervals)

	Men					Women				
	Prevalence of inadequacy† (%)					Prevalence of inadequacy† (%)				
	DS non-users (*n* 9889)	DS users (*n* 3450)‡	OR for inadequacy§	95 % CI	*P*	DS non-users (*n* 21 489)‡	DS users (*n* 20 741)	OR for inadequacy§	95 % CI	*P*
Thiamin	16·3	13·6	0·81	0·73, 0·90	<0·0001	10·9	8·8	0·84	0·79, 0·88	<0·0001
Riboflavin	3·8	3·5	0·95	0·80, 1·12	0·5	14·7	11·2	0·90	0·85, 0·95	0·0002
Niacin	0·1	0·6	0·89	0·69, 1·14	0·3	0·9	0·7	0·99	0·88, 1·11	0·8
Pantothenic acid	3·3	2·1	0·86	0·71, 1·04	0·1	16·4	11·4	0·87	0·83, 0·92	<0·0001
Vitamin B_6	16·4	11·6	0·64	0·57, 0·72	<0·0001	15·5	10·4	0·79	0·75, 0·83	<0·0001
Folate	7·4	4·4	0·71	0·61, 0·83	<0·0001	10·1	4·6	0·62	0·58, 0·66	<0·0001
Vitamin B_{12}	0·1	0·6	1·23	1·00, 1·51	0·06	2·4	2·9	1·14	1·07, 1·22	0·0002
Vitamin A	5·0	4·1	0·84	0·74, 0·95	0·007	1·4	0·6	0·73	0·68, 0·80	<0·0001
Vitamin C	30·6	21·0	0·72	0·66, 0·79	<0·0001	34·8	30·6	0·76	0·73, 0·79	<0·0001
Vitamin E	33·3	23·4	0·70	0·63, 0·76	<0·0001	49·6	38·3	0·72	0·69, 0·76	<0·0001
Ca	18·4	17·3	0·85	0·76, 0·94	0·002	34·3	33·0	0·87	0·83, 0·91	<0·0001
Fe	0·0	0·0	0·75	0·51, 1·12	0·2	54·8	40·7	0·76	0·73, 0·80	<0·0001
Mg	51·3	38·8	0·60	0·55, 0·66	<0·0001	60·4	46·5	0·67	0·64, 0·70	<0·0001
P	0·2	0·1	0·18	0·04, 0·90	0·04	0·0	0·0	0·88	0·69, 1·13	0·3
Zn	13·2	12·8	1·03	0·93, 1·15	0·6	22·9	21·5	1·02	0·97, 1·07	0·5

* In subjects with three dietary records at baseline.
† The probability of dietary nutrient intakes below the estimated average requirements for the French population.
‡ DS users were defined as subjects who used ≥1 DS during the 12 months preceding the DS questionnaire.
§ Logistic regression analysis comparing DS users and non-users, adjusted for age and energy intake. Reference, DS non-users.

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previously[8,37,43], except for vitamin B_{12} in women. In fact, DS users ate less meat than did non-users, meat being a major contributor of vitamin B_{12} intake.

The present study highlighted a risk of insufficient dietary intakes as regards several nutrients in the whole population study. Increased nutrient intake through tablets or pills under medical supervision is justified under certain physiological situations (such as pregnancy). However, several arguments encourage caution regarding supplement use for the general population. They pertain to the quality and safety of DS[44], the absence of clear benefits in chronic disease management in well-nourished populations, the need–use disparity (i.e. increased DS use by those who have the least need for them, as shown in the present study), the behavioural impact (e.g. people might believe that DS use can act as a substitute for a diversified and balanced diet) and the potential deleterious effects of some DS in certain population subgroups (e.g. β-carotene use in smokers[15–17], or DS–drug interactions in individuals taking certain medications[45,46]). Thus, the official recommendation for the general population is to increase dietary variety[47] and improve healthy food choices rather than to use DS in order to achieve adequate nutrient intakes.

Several limitations of the present study should be mentioned. Caution is needed in extrapolating the present results to the general population, as the present study was based on a volunteer sample. Participants were primarily women, mostly belonging to the highest socio-professional categories than the general population. For instance, the proportion of DS users in the present study was slightly higher than the prevalence of DS use assessed in the French INCA2 study (2006) using a nationally representative sample. Similarly, the percentage of organic food consumers in the present study was higher than that in the general population (about 60 % in the NutriNet-Santé study compared with 43 % in a representative French study[48]). This could partly be attributed to sample composition (i.e. the large proportion of women in the present study, who tend to consume more DS[11,13,14] and organic foods[48], than men) and to the self-selection of participants in a nutrition-focused study. However, the present Web-based study allowed the inclusion of subjects from lower socio-professional categories, who are usually difficult to reach. Next, significant associations occurring purely by chance cannot be excluded. However, the present results are hypothesis-driven and supported by available data in the literature. The number of statistically significant results observed in the present study was far above the 5 % error of the first kind and most of them were highly significant ($P<0{\cdot}0001$). Finally, data collection is based on self-administered questionnaires and the DS questionnaire might engender a memory bias because subjects were asked for the motivations and circumstances of their DS purchases over the past 12 months.

In conclusion, the NutriNet-Santé study provided new and detailed information on DS use. Overall, the present results suggest that DS users had an overall healthier profile (in terms of diet, smoking status, physical activity and other parameters) and better knowledge of nutritional recommendations. This is consistent with the findings observed in other developed countries[3,37–39,49,50], which suggests that despite very different behaviours, opinions and culture regarding food, health and nutrition, the profile of DS users is overall stable across such countries. The present study also highlighted the importance of self-medication practices regarding DS use (more than 45 %). The large sample of subjects allowed analysing subgroups of interest (such as smokers), for whom some DS may increase the risk regarding chronic pathologies such as cancer. Current smokers used less DS than did non-smokers, but their DS consumption was substantial (19·0 %) and they were more likely to self-medicate. Finally, the correlates of DS use highlighted in the present study could be useful in properly controlling for potential confounders in future prospective aetiological studies on the relationship between DS use and chronic disease.

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