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Short Communication

Opposites don't attract: high spouse concordance for dietary supplement use in the European Prospective Investigation into Cancer in Norfolk (EPIC-Norfolk) cohort study

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Abstract
Objective: Dietary supplements are commonly consumed but may not be beneficial for everyone. It is known that supplement users have healthy behaviour characteristics but until now concordance between spouses living in the same household has not been investigated and concordance may be an important behavioural determinant.
Design: Prospective cohort study, cross-sectional data analysis.
Setting: European Prospective Investigation into Cancer in Norfolk (EPIC-Norfolk) in the UK, recruitment between 1993 and 1998.
Subjects: Married (or living as married) participants sharing a household, who attended a health examination and completed a 7 d diet diary were included in the analysis (*n* 11 060). The age range was 39–79 years.
Results: Nearly 75 % of the households in EPIC-Norfolk were concordant in their supplement use, with 46·7 % not using supplements and 27·0 % using supplements. Concordance increased with age; the percentage of concordant couples varied less by other sociodemographic characteristics. Participants who had a spouse who used a supplement were nearly nine times more likely to use a supplement (unadjusted). Depending on participants' sex and type of supplement used, odds ratios for 'supplement use by spouse' in the prediction of participants' supplement use varied between 6·2 and 11·7 adjusted for participants' age, smoking status, BMI, social class, education level and physical activity.
Conclusions: 'Supplement use by spouse' is an independent and the strongest predictor of participants' supplement use. This phenomenon can be useful in the design of studies and health interventions; or when assessing risk of excessive intake from dietary supplements.

Keywords
Dietary supplement
Concordance
Spouse
Sociodemographic variables

In the European Prospective Investigation into Cancer in Norfolk (EPIC-Norfolk), dietary supplements were reported by 44·8 % of women and 31·7 % of men in their 7 d diet diary (7dDD)[1], of which cod-liver oil was the most commonly consumed supplement[2]. Studies in the UK have identified the characteristics of supplement users (SU) and found that SU are more likely to have a normal weight, a higher social class and show more health-conscious behaviours[3–5]. They have focused on the SU as an individual; however, people sharing a household could influence each other's behaviour, as has been shown for other types of behaviours such as smoking[6]. Concordance in the choice of using a supplement might partly explain why not all SU consistently show healthy behaviours; their spouse might have influenced them without the SU showing the known characteristics of a SU.

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A UK survey among health-conscious women aged 33–72 years[4] applied the theory of planned behaviour to analyse why women took dietary supplements[7]. The study found that participants rated family and health experts with the same intensity of normative beliefs regarding supplement use, defined as 'perception of whether specific significant others believe you should perform the behaviour or not'[7]. A 'significant other' could be a spouse. A study investigating complementary alternative medicine use among women with a median of 4 years since breast cancer diagnosis reported 15 % more use of complementary alternative medicine (of which dietary supplement use is considered one) among their spouses *v.* women who were not using complementary alternative medicine themselves[8].

There are two reasons why understanding more about spouse concordance is important. First, health interventions encouraging or discouraging supplement use in a specific group could affect the nutritional status or risk of overdosing of people outside the intervention group. Second and conversely, spouse concordance in supplement use could be useful in health interventions to strengthen a message[6].

In EPIC-Norfolk, we found stronger associations for women than for men between supplement use and BMI and season, as well as conflicting results between men and women for sociodemographic variables such as age, education and marital status (MAH Lentjes, AA Welch, AA Mulligan *et al.*, unpublished results). Therefore, we set out to find what level of concordance exists in SU in a large population of men and women. In the present communication we hypothesise that spouses influence each other's choices in using dietary supplements. We studied the existence of concordance and discordance in supplement use and how this relates to other known sociodemographic variables in order to understand the relative importance between spouse concordance, other participants' characteristics and supplement use.

Methods

Study design

EPIC-Norfolk is a prospective cohort study based in East Anglia (UK) that started recruitment in 1993 (up to 1998) to investigate risk factors for chronic diseases such as cancer and CVD[9]. Men and women aged 39–79 years, recruited from thirty-five general practitioners' clinics, completed an informed consent and a health and lifestyle questionnaire. This questionnaire provided information on: (i) marital status ('single', 'married or living as married', 'widowed', 'separated', 'divorced'); (ii) current or past occupation, from which social class was derived according to the Registrar General's occupation-based classification scheme; (iii) highest education level obtained (categorised into 'no qualifications', 'A-level', 'O-level' or 'degree/equivalent'); (iv) smoking status ('current', 'former' or 'never'; derived from two questions: 'Have you ever smoked as much as one cigarette a day for as long as a year?' and 'Do you smoke cigarettes now?'); and (v) self-reported physical activity, from which a validated 4-point score of work-related and leisure-time activity was compiled[10]. A health examination was attended by 25 639 participants at their general practitioner's clinic. A trained nurse measured height (in centimetres) and weight (in kilograms), with participants wearing light clothing and no shoes.

Supplement use

Dietary supplements were defined according to the EU directive 2002/46/EC: '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…'. During the health examination, participants were given a 7dDD that measured dietary supplement use by asking, 'Please name any vitamins, minerals or other food supplements taken on each day of last week'[2]. Participants recording one or more supplements taken on at least one diary day were considered supplement users (SU). Participants who mentioned medication, e.g. ferrous sulfate or prescribed calcium, without further use of dietary supplements, were defined as non-supplement users (NSU). Since cod-liver oil (CLO) is the most commonly consumed supplement in the UK and nearly 25 % in EPIC-Norfolk consumes CLO[2], participants who consumed CLO or fish-oil supplements, with or without other types of supplements, were grouped as a separate category of SU (SU + CLO) to partly account for heterogeneity among SU[11,12].

Household identification

Participants sharing the same address were identified by their surname and postal address at the time of recruitment; the same addresses were given the same household ID, leaving 15 956 participants eligible (7978 households). Participants who (i) both attended a health examination (86·7 % of 15 956), (ii) were living in a household where both EPIC participants were married (or living as married; 98·3 %) and (iii) went on to complete their 7dDD including the supplement question (92·3 %) were included for the current analysis (*n* 11 060). The age range of this sample was 39–79 years; mean age among men was 61·1 (SD 8·4) years and among women, 58·5 (SD 8·3) years.

Statistical analysis

Analyses were sex-stratified for observations to be uncorrelated, unless households rather than participants were the denominator. We use the term 'spouse concordance' to refer to agreement in supplement use, although not all couples were married. The percentages of participants who were concordant in supplement use, i.e. where both members took supplements or both did not take supplements, are given for each stratum of the sociodemographic variables for which we wanted to test the associations with supplement use. For equal presentation purposes, continuous variables, such as age, BMI (kg/m^2) and month of 7dDD completion, were grouped. Differences in sociodemographic variables between SU + CLO, SU − CLO and NSU, as well as spouse concordance, were tested using the χ^2 test. Supplement use, as a categorical variable with three categories (NSU, SU + CLO, SU − CLO), was then used as the dependent variable in multinomial logistic regression with 'supplement use by spouse' as a predictor, including all the sociodemographic variables from Table 1. Participants for whom one or more variables were missing were removed from the regression analysis (2 %). Statistical analysis was performed using the statistical software package IBM SPSS Statistics version 21. *P* values below 0·05 were considered statistically significant.

Results

Of the 11 060 participants, 4445 (40·2 %) were SU; 34·6 % among men and 45·7 % among women. In the 5530 households, nearly 75 % were concordant in their supplement use, with 46·7 % not using supplements (i.e. both NSU) and 27·0 % using supplements (i.e. both SU).

Concordance in supplement use was significantly higher among daily SU *v.* non-daily SU (women only) and for those consuming multiple supplements *v.* single SU (Table 1). Concordance in supplement use increased significantly with age in both sexes. A higher BMI among women was associated with increased concordance in supplement use, but less concordance among men. The column marked 'sole SU' shows the percentage of men/women who used a supplement when their spouse did not. For all participants' characteristics, in all strata, this percentage was higher among women. For age and social class the trends for men and women were opposite. For example, where among women sole supplement use increased with increasing social class, for men this percentage decreased. And where for men physical activity had no association with sole supplement use, for women more physical activity was associated with more sole supplement use.

The odds of the participant being a SU were higher among women than men, irrespective whether the spouse was a SU or NSU (Fig. 1). The odds of using a supplement were higher among participants whose spouses were SU. The OR was 8·86 (95 % CI 7·78, 10·09), indicating that participants with a spouse who used supplements were nearly nine times more likely to be SU than participants whose spouse was a NSU.

All sociodemographic variables from Table 1 were entered one by one into a multinomial logistic regression model (SU + CLO *v.* NSU; SU − CLO *v.* NSU); sex-stratified results are presented in Table 2. The OR for 'supplement use by spouse' attenuated only slightly after inclusion of all other sociodemographic variables. Having a spouse who used supplements was the strongest predictor for both SU + CLO and SU − CLO groups in both sexes, followed at some distance by current smoking. Binary logistic regression, where only SU + CLO and SU − CLO were included, confirmed these differences between the two SU groups and also found 'supplement use by spouse' to be significantly different.

The model without 'supplement use by spouse' (data not shown) showed small differences for age among women (SU + CLO: OR = 1·08; 95 % CI 1·04, 1·13; SU − CLO: OR = 0·94; 95 % CI 0·90, 0·98), a stronger association with social class in men (SU − CLO: OR = 0·66; 95 % CI 0·53, 0·81) and a stronger association for education in women (SU − CLO: OR = 0·76; 95 % CI 0·65, 0·89) compared with Table 2. This indicates that 'supplement use by spouse' was not a strong confounder for these variables that are known to be associated with supplement use.

Discussion

Spouse concordance in supplement use was 73·7 %, with increased age being strongly associated with increased concordance. The strongest predictor for dietary supplement use was supplement use of a spouse. This factor was stronger for participants consuming CLO supplements *v.* non-CLO supplements.

The associations between dietary supplement use and sociodemographic characteristics found in studies in the UK[3,4] and other countries[12–14] were also found in this subcohort of spouses in the EPIC-Norfolk study. EPIC-Norfolk was able to include 'supplement use by spouse' and found it to have the strongest association with dietary supplement use compared with known characteristics of SU, while minimally changing the association between the other sociodemographic variables and supplement use.

The positive association found for increased age and spouse concordance has been described by others as concordance due to cohabitation[6]. In our study, being older independently increased supplement use among men (more strongly for CLO than for non-CLO supplements) and decreased the odds for non-CLO use in women. Assuming that age is correlated with the number of years of marriage, and hence length of cohabitation, we assumed that the correlation between age and supplement use would increase after 'supplement use by spouse' was excluded from the model; however, the OR for age were minimally affected. Positive assortative mating, defined as 'the tendency of individuals to choose a spouse with similar characteristics'[6], could explain the slight attenuation seen for social class and education level with inclusion of 'supplement use by spouse'. Although even in the fully adjusted model 'supplement use by spouse' remained the strongest predictor, we cannot rule out residual confounding.

Table 1 Characteristics of supplement users and spouse concordance among married (or living as married) participants sharing a household, European Prospective Investigation into Cancer in Norfolk (EPIC-Norfolk) cohort study (*n* 11 060)

	Men										Women									
	NSU		SU + CLO		SU − CLO		Sole SU		Concordant SU/NSU		NSU		SU + CLO		SU − CLO		Sole SU		Concordant SU/NSU	
Characteristic	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Frequency supplement																				
Daily	n/a		1250	73·2	458	26·8	370	21·7	1338/0	78·3	n/a		1354	61·4	853	38·6	880	39·9	1327/0	60·1
Non daily	n/a		130	62·5	78	37·5	51	24·5	157/0	75·5	n/a		170	52·8	152	47·2	154	47·8	168/0	52·2
P value					< 0·001*				< 0·348†						< 0·003				< 0·001	
Number of supplements																				
Single (one)	n/a		859	69·4	379	30·6	334	27·0	904/0	73·0	n/a		804	55·4	646	44·6	681	47·0	769/0	53·0
Multiple	n/a		521	76·8	157	23·2	87	12·8	591/0	87·2	n/a		720	66·7	359	33·3	353	32·7	726/0	67·3
P value					< 0·001				< 0·001						< 0·001				< 0·001	
Age																				
≤50 years	561	75·4	105	14·1	78	10·5	44	5·9	139/382	70·0	694	57·5	247	20·5	266	22·0	279	23·1	234/614	70·3
>50–60 years	1210	67·9	400	22·4	172	9·7	135	7·6	437/808	69·9	1048	52·9	559	28·2	374	18·9	414	20·9	519/892	71·2
>60–70 years	1335	61·9	614	28·5	208	9·6	162	7·5	660/995	76·7	1024	53·7	583	30·6	300	15·7	282	14·8	601/872	77·2
>70 years	508	60·0	261	30·8	78	9·2	80	9·4	259/395	77·2	235	54·0	135	31·0	65	14·9	59	13·6	141/202	78·9
P value					< 0·001				< 0·001						< 0·001				< 0·001	
Social class‡																				
Professional	290	67·4	93	21·6	47	10·9	25	5·8	115/196	72·3	210	51·9	104	25·7	91	22·5	86	21·2	109/186	72·8
Managerial	1360	63·7	529	24·8	247	11·6	168	7·9	608/973	74·0	1075	53·9	526	26·4	393	19·7	360	18·1	559/933	74·8
Skilled non-manual	456	63·3	188	26·1	76	10·6	45	6·3	219/306	72·9	465	50·5	294	31·9	162	17·6	179	19·4	277/390	72·4
Skilled manual	912	67·3	343	25·3	101	7·4	114	8·4	330/668	73·6	719	56·1	356	27·8	207	16·1	242	18·9	321/614	72·9
Semi-skilled	464	66·4	181	25·9	54	7·7	53	7·6	182/345	75·4	400	56·7	190	26·9	116	16·4	128	18·1	178/343	73·8
Non-skilled	98	69·0	36	25·4	8	5·6	14	9·9	30/68	69·0	94	60·6	33	21·3	28	18·1	27	17·4	34/80	73·5
P value					< 0·003				< 0·638						< 0·003				< 0·758	
Level of education																				
Degree/equivalent	539	66·9	181	22·5	86	10·7	59	7·3	208/400	75·4	311	58·1	119	22·2	105	19·6	94	17·6	130/275	75·7
A-level	1632	64·2	643	25·3	267	10·5	195	7·7	715/1136	72·8	943	50·0	533	28·3	410	21·7	377	20·0	566/805	72·7
O-level	293	64·8	112	24·8	47	10·4	32	7·1	127/194	71·0	360	55·2	166	25·5	126	19·3	123	18·9	169/307	73·0
No qualifications	1150	66·5	444	25·7	136	7·9	135	7·8	445/850	74·6	1387	56·5	706	28·7	364	14·8	440	17·9	630/1193	74·2
P value					< 0·054				< 0·162						< 0·001				< 0·464	
Smoking‡																				
Never	1170	64·2	456	25·0	197	10·8	133	7·3	520/812	73·1	1782	53·3	941	28·1	620	18·5	617	18·5	944/1537	74·2
Former	2030	64·1	833	26·3	302	9·5	263	8·3	872/1471	74·0	876	52·4	476	28·5	319	19·1	334	20·0	461/743	72·1
Current	395	77·8	82	16·1	31	6·1	23	4·5	90/281	73·0	319	68·0	91	19·4	59	12·6	71	15·1	79/278	76·1
P value					< 0·001				< 0·722						< 0·001				< 0·122	
Physical activity																				
Inactive	1211	69·4	383	21·9	151	8·7	124	7·1	410/882	74·0	924	61·2	374	24·8	213	14·1	223	14·8	364/791	76·4
Moderately inactive	853	62·1	381	27·7	140	10·2	108	7·9	413/593	73·2	969	51·7	557	29·7	348	18·6	364	19·4	541/836	73·5
Moderately active	828	64·2	326	25·3	135	10·5	98	7·6	363/603	74·9	662	51·4	358	27·8	269	20·9	257	19·9	370/567	72·7
Active	722	64·3	290	25·8	110	9·8	91	8·1	309/502	72·2	446	52·1	235	27·5	175	20·4	190	22·2	220/386	70·8
P value					< 0·002				< 0·483						< 0·001				< 0·016	
Start 7dDD																				
Spring (Mar–May)	930	65·7	355	25·1	130	9·2	96	6·8	389/692	76·4	778	54·8	415	29·2	228	16·0	252	17·7	391/671	74·7
Summer (Jun–Aug)	904	65·4	345	25·0	133	9·6	105	7·6	373/648	73·9	793	56·0	365	25·8	257	18·2	240	17·0	382/684	75·3
Autumn (Sep–Nov)	940	66·9	329	23·4	136	9·7	105	7·5	360/657	72·4	742	53·0	382	27·3	277	19·8	289	20·6	370/641	72·2
Winter (Dec–Feb)	840	63·6	351	26·4	137	10·3	115	8·7	373/583	72·0	688	53·2	362	28·0	243	18·8	253	19·6	352/584	72·4
P value					< 0·562				< 0·035						< 0·105				< 0·133	

Table 1 *Continued*

Characteristic	Men										Women									
	NSU		SU + CLO		SU − CLO		Sole SU		Concordant SU/NSU		NSU		SU + CLO		SU − CLO		Sole SU		Concordant SU/NSU	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
BMI‡																				
≤20 kg/m²	34	73·9	6	13·0	6	13·0	2	4·3	10/26	78·3	81	51·6	41	26·1	35	22·3	34	21·7	42/67	69·4
>20–25 kg/m²	1100	63·0	457	26·2	189	10·8	129	7·4	517/782	74·4	1137	51·0	628	28·2	464	20·8	461	20·7	631/978	72·2
>25–30 kg/m²	1954	64·4	788	26·0	294	9·7	243	8·0	839/1387	73·3	1225	54·6	644	28·7	375	16·7	401	17·9	618/1053	74·5
≥30 kg/m²	520	74·8	129	18·6	46	6·6	47	6·8	128/381	73·2	553	62·0	209	23·4	130	14·6	136	15·2	203/477	76·2
P value					<0·001				<0·744						<0·001				<0·052	

NSU, non-supplement user; SU, supplement user; SU + CLO, cod-liver oil supplement user; SU − CLO, supplement user who does not consume-cod liver oil; sole SU, participant is the only SU in the household; concordant SU/NSU, concordance in supplement use (i.e. both spouses NSU or both spouses SU); 7dDD, 7 d diet diary; n/a, not applicable.
*From χ^2 testing of the hypothesis that there is no difference between SU + CLO, SU − CLO and NSU regarding the sociodemographic variables.
†From χ^2 testing of the hypothesis that there is no difference between concordant and discordant spouses regarding the sociodemographic variables.
‡Because of missing values, the numbers do not add up to 11 060.

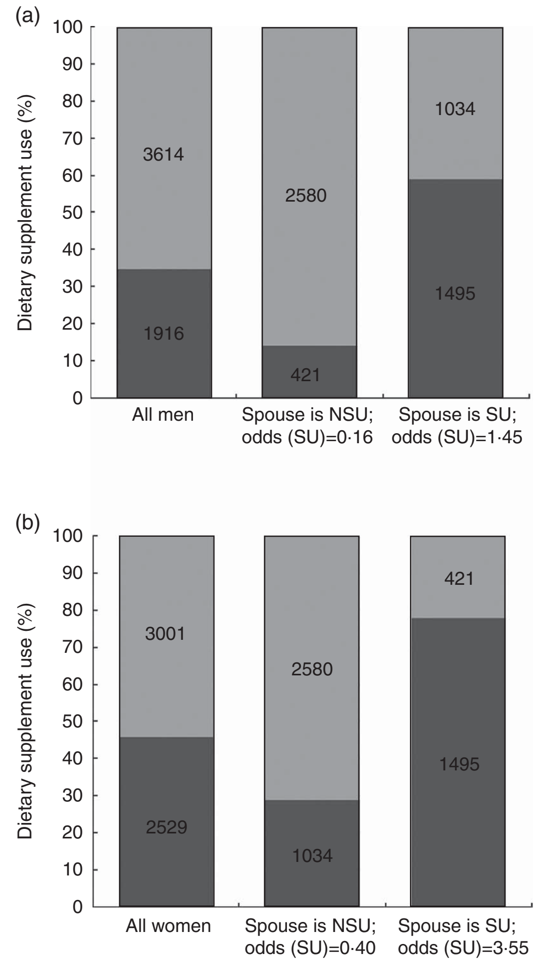

Fig. 1 Dietary supplement use (■, participant NSU; ■, participant SU) of (a) men (*n* 5530) and (b) women (*n* 5530) by spouse's supplement use (NSU, non-supplement user; SU, supplement user) among married (or living as married) participants sharing a household, European Prospective Investigation into Cancer in Norfolk (EPIC-Norfolk) cohort study (*n* 11 060)

Strengths of the current analysis included the detailed recording of supplement use[2], as well as detailed assessment of sociodemographic characteristics[9]. We were able to identify over 5500 households in this free-living UK cohort which, apart from a lower smoking prevalence, represents the UK population aged 40–79 years reasonably well[9]. The analysis described here was, by design, restricted to a sub-cohort – which can be considered a selective group of participants, considering that both participants were willing to participate in a long-term prospective study. Compared with the whole cohort, the mean age among men in this subset increased by 2 years (see online supplementary material, Supplemental Table 1) and might explain the 3 % increase in supplement use. The proportion of SU among women was only 1 % higher compared with the whole cohort. Smoking was approximately 3 % less prevalent in both men and women, and might be indicative of more similar health-related behaviours among these spouses overall and hence could

Table 2 Adjusted odds ratios of using supplements containing cod-liver oil or supplements not containing cod-liver oil compared with not using a supplement at all among married (or living as married) participants sharing a household, European Prospective Investigation into Cancer in Norfolk (EPIC-Norfolk) cohort study (*n* 10 855*)

	Men						Women					
			SU + CLO *v.* NSU		SU – CLO *v.* NSU				SU + CLO *v.* NSU		SU – CLO *v.* NSU	
	n	%	OR	95 % CI	OR	95 % CI	*n*	%	OR	95 % CI	OR	95 % CI
n	5446		1362		526		5409		1486		989	
%			25·0		9·7				27·5		18·3	
Concordance												
Spouse is NSU	2956	54·3	Ref.		Ref.		3528	65·2	Ref.		Ref.	
Spouse is SU	2490	45·7	9·85	8·45, 11·48	7·31	5·92, 9·03	1881	34·8	11·70	10·06, 13·60	6·15	5·21, 7·26
Age (per 5 years)	5446		1·26	1·21, 1·32	1·07	1·01, 1·14	5409		1·00	0·96, 1·05	0·89	0·84, 0·93
BMI (per 4 units)	5446		0·85	0·77, 0·93	0·80	0·71, 0·91	5409		0·89	0·83, 0·95	0·85	0·78, 0·91
Social class†												
Non-manual	3263	59·9	Ref.		Ref.		3290	60·8	Ref.		Ref.	
Manual	2183	40·1	1·14	0·97, 1·33	0·71	0·57, 0·88	2119	39·2	0·95	0·82, 1·11	0·88	0·75, 1·04
Education level												
Some qualification‡	3752	68·9	Ref.		Ref.		3031	56·0	Ref.		Ref.	
No qualification	1694	31·1	0·97	0·82, 1·14	0·88	0·69, 1·11	2378	44·0	1·08	0·93, 1·26	0·80	0·68, 0·94
Smoking												
Never	1810	33·2	Ref.		Ref.		3290	60·8	Ref.		Ref.	
Former	3134	57·5	1·04	0·89, 1·21	0·99	0·80, 1·22	1660	30·7	1·06	0·91, 1·24	1·13	0·96, 1·34
Current	502	9·2	0·52	0·39, 0·70	0·51	0·34, 0·78	459	8·5	0·61	0·46, 0·80	0·59	0·44, 0·81
Physical activity§												
Active	2379	43·7	Ref.		Ref.		2113	39·1	Ref.		Ref.	
Inactive	3067	56·3	0·84	0·72, 0·97	0·83	0·68, 1·01	3296	60·9	0·91	0·78, 1·06	0·81	0·69, 0·95
Season												
Summer (Apr–Sep)	2702	49·6	Ref.		Ref.		2721	50·3	Ref.		Ref.	
Winter (Oct–Mar)	2744	50·4	1·04	0·90, 1·19	1·15	0·94, 1·39	2688	49·7	1·11	0·96, 1·28	1·17	1·01, 1·37

SU + CLO, cod-liver oil supplement user; NSU, non-supplement user; SU – CLO, supplement user who does not consume cod-liver oil, Ref., referent category.
*Participants with complete variable data (list-wise) were included in the analysis (98 %).
†Some qualification takes the summed categories of A-level, O-level and degree/equivalent.
‡Manual takes the summed categories of: skilled manual, semi-skilled and non-skilled. Non-manual takes the summed categories of: professional, managerial and skilled non-manual.
§Active takes the summed categories of active and moderately active. Inactive contains the categories inactive and moderately inactive.

have overestimated the spouse concordance for supplement use found in the present study. Weaknesses of the analysis include that only 'supplement use by spouse' in EPIC-Norfolk could be assessed; however, other relations/resources (such as magazines, health professionals and friends) exist that can influence beliefs relating to supplement use[7]. Alternatively, other motives for using supplements, such as prevalent illness or health concerns, were not taken into account in the analysis, but are known to influence specific types of supplements[15,16].

The sequence of who in the household started with the use of supplements remains unknown. Future studies would benefit from not only requesting supplement information from the participant, but also establishing whether any of the other household members use supplements; as well as asking who first commenced use, since this additional information will help to identify different motivations and characteristics of SU and could aid the development of health interventions and risk assessment.

Conclusion

'Supplement use by spouse' was the strongest predictor of participants' supplement use and hence can be of importance when developing public health messages to encourage or discourage supplement use, since the nutritional status of people beyond the SU could be affected.

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Supplementary material

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