Diet and lifestyle characteristics associated with dietary supplement use in women

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Abstract

Objectives: To describe the characteristics of dietary supplement users in a large cohort of women and test the hypothesis that supplement users would be more likely to have a healthier lifestyle than non-users.
Design: Comparison of nutrient intakes from food frequency questionnaire (FFQ) data for 8409 supplement users and 5413 non-users. Use of logistic regression modelling to determine predictors of supplement use in this cohort.
Subjects: 13,822 subjects from the UK Women's Cohort Study (UKWCS) for whom data on supplement use was available.
Results: Significant differences in nutrient intakes from FFQ were seen between the two groups, with supplement users having higher intakes of all nutrients, except for fat and vitamin B_{12}. Use of dietary supplements was associated with being vegetarian, vegan or fish-eating, consuming more fruit and vegetables, being more physically active and having a lower alcohol intake. Supplement use was less likely in those with a body mass index above 25 and those who reported smoking regularly.
Conclusions: The findings are consistent with the hypothesis that supplement use is associated with a healthier lifestyle profile and an adequate nutritional intake, suggesting that supplement users do not need to take supplements to meet a nutrient deficiency.

Keywords
Dietary supplements
Women
Lifestyle characteristics
Nutrient intakes

The National Diet and Nutrition Survey of British Adults reported that dietary supplements were used by 17% of the female population[1]. In this survey, those who took dietary supplements paradoxically had higher recorded nutrient intakes from food sources alone than those who did not take supplements. We have previously called this paradox the 'inverse supplement hypothesis', in that the people most likely to use dietary supplements may be those who least need them[2]. Supplement use may be a marker for a range of health-related behaviours, with supplement users being less likely to drink heavily, smoke and be obese, and more likely to engage in physical activity[3].

The most commonly used supplements in the National Diet and Nutrition Survey of British Adults[1] were multivitamins, cod liver oil, vitamin C and vitamin B complex. Yet evidence concerning the effectiveness of dietary supplements for various conditions remains controversial and conflicting. For example, vitamin C is widely viewed by the lay population as preventing the common cold, but a recent systematic review of 30 studies found that vitamin C taken prophylactically, even at doses of 1 g day^{-1} for several winter months, had no consistent beneficial effect on incidence of the common cold[4], although a modest beneficial effect on symptom duration was found from these studies. Cod liver oil and evening primrose oil have both been implicated in the management of rheumatoid arthritis and are widely promoted by the health food industry as containing 'ingredients that help to keep your joints supple and flexible'[5]. Yet the levels of the active ingredient in fish oil capsules, eicosapentanoic acid (EPA), that may be required to produce a subjective improvement in disease activity[6] have been estimated to be five times higher than those contained in an average capsule of cod liver oil. At this dose vitamin A toxicity may be a potential problem. Based on such evidence, the use of some supplements may at best be unnecessary and at worst potentially harmful. Discouraging potentially unnecessary supplement use is thus an important consideration in promoting good health.

The UK Women's Cohort Study (UKWCS) is a national study being conducted on 30,000 women[7]. So far, data on nutrient intakes and lifestyle factors are available on over 15,000 women, 60% of whom have reported taking dietary supplements, three to four times higher than the figure reported by Gregory *et al.*[1]

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This study provides a unique opportunity to examine dietary supplement use in relation to other health behaviours in a large group of women. The aim of this study is therefore to compare the characteristics of supplement users and non-users within this cohort and to test the hypothesis that supplement users are more likely to have higher nutrient intakes and healthier lifestyles.

Subjects and methods

The sample used for this study consisted of the first 15,191 participants in the UKWCS, a national sample of women aged 33–72 years with differing self-reported dietary habits ranging from meat-eating to vegan[7]. For the cohort study, subjects were recruited via a World Cancer Research Fund mailshot and therefore were likely to be more health conscious and aware of the role of diet in the development and prevention of cancer and other diseases. Thus, they do not represent the general population.

Subjects completed a questionnaire on aspects of diet and lifestyle. Dietary intake was assessed by a food frequency questionnaire (FFQ), adapted for use with vegetarians as well as meat-eaters. Data collection is ongoing. Data on supplement use was not available on 1369 subjects or 9% of the cohort, so for the purposes of the analysis reported here, subjects for whom no information on dietary supplement use was available were excluded. Consequently, analysis has been carried out on 13,822 subjects. The mean age of supplement users was 51.4 years (SD 9.0) and of non-users 50.1 years (SD 8.9). This difference was small but statistically significant (95% CI for difference, 0.9, 1.5). Subjects classified themselves as either meat-eating, fish-eating (i.e. avoid meat, but eat fish), vegetarian and vegan (i.e. no animal products consumed) and supplement use was defined by responses to the question 'Do you take any vitamins, minerals, fish oils, fibre or other food supplements?' Although subjects had reported the type of supplements they were using, this has not been coded for the whole cohort and so was not available for this analysis.

Two analyses were carried out on these data, one to determine nutrient intake in supplement users and non-users, and the second employing a logistic regression model to determine predictors of supplement use. Nutrient data from food frequency questionnaires were available on 8409 supplement users and 5413 non-users in the cohort and were compared between users and non-users. Lifestyle factors for inclusion in the logistic regression model were selected on the basis of the hypothesis to be tested, that supplement users would have a healthier lifestyle profile than non-users. The following variables were included in the logistic regression analysis.

Age
Subjects were categorized broadly into age bands spanning ten years, i.e. up to age 44 years, which was used as the baseline category, 45–54 years, 55–64 years and over 64 years.

Body mass index (BMI)
These categories were based on the accepted definitions for BMI, i.e. normal weight, BMI 20–25 kg m^{-2}, which was used as the baseline, underweight, BMI below 20 kg m^{-2}, overweight, BMI 25-30 kg m^{-2} and obese, BMI over 30 kg m^{-2}.

Diet category
This variable was based on self-reported eating habits, i.e. meat-eating (baseline), fish-eating, vegetarian or vegan.

Fruit and vegetable intake
Based on FFQ data on reported consumption of fruit and vegetables, subjects were categorized as eating less than 2 helpings day^{-1} (baseline), 2–4 helpings day^{-1} or more than 4 helpings day^{-1}, as an indicator of a healthy diet.

Smoking status
Reported smoking habits were used to categorize subjects as never having smoked (baseline), ex- or occasional smoker or regular smoker.

Alcohol intake
This was categorized on the basis of self-report as less than 1 unit $week^{-1}$ (baseline), 2–6 units $week^{-1}$ and 7 or more units $week^{-1}$.

Physical activity level
This variable was based on reported activity sufficiently vigorous to cause sweating or an increased heartbeat; categories were low activity (baseline, indicating no vigorous activity), moderate activity and high activity.

Educational status
Based on reported educational qualifications, women were categorized as having no formal qualifications (baseline), O levels as highest qualification, A levels or a degree.

Statistical analysis of the data was carried out using SPSS for Windows, version 7 (SPSS Inc). Between-group analysis was by Student's independent *t*-test (two-tailed). Values of $P < 0.05$ were accepted as statistically significant.

Results

Nutrient analysis
The results of the nutrient analysis are given in Table 1. This showed that there were significant differences

Table 1 Nutrient analysis from food frequency questionnaire – comparison of supplement users and non-users (mean SD)

Nutrient	Supplement users $n = 8409$	Supplement non-users $n = 5413$	Significance (P)	95% CI for difference (users minus non-users)
Energy (kcal)	2373 (786.3)	2339 (786.3)	<0.05	7.3, 61.4
Protein (g)	85.6 (28.2)	84.9 (28.6)	0.190	–0.3, 1.6
Fat (g)	84.1 (34.5)	85.5 (36.5)	<0.05	2.6, –0.2
Carbohydrate (g)	325.0 (116.8)	310.7 (113.2)	<0.001	10.1, 18.0
Sugar (g)	141.8 (81.6)	133.3 (76.7)	<0.001	5.8, 11.2
Starch (g)	156.4 (63.9)	153.7 (61.6)	<0.05	0.6, 4.7
Fibre (g)	27.7 (11.8)	25.6 (11.2)	<0.001	1.7, 2.5
Calcium (mg)	1137.7 (412.5)	1126.7 (404.7)	0.12	–3.0, 25.0
Iron (mg)	18.9 (8.2)	17.8 (7.7)	<0.001	0.9, 1.4
Zinc (mg)	10.9 (3.8)	10.7 (3.8)	<0.05	0.0, 0.3
Vitamin A (μg)	1185.3 (600.9)	1177.8 (577.0)	0.466	–12.7, 27.7
Thiamin (mg)	5.7 (8.3)	4.7 (7.4)	<0.001	0.8, 1.3
Riboflavin (mg)	2.5 (0.9)	2.4 (0.9)	<0.001	0.0, 0.1
Vitamin B_6 (mg)	2.8 (1.0)	2.6 (0.9)	<0.001	0.1, 0.2
Vitamin B_{12} (μg)	5.1 (3.3)	5.4 (3.5)	<0.001	–0.4, –0.2
Folate (μg)	390.7 (149.0)	371.4 (140.6)	<0.001	14.5, 24.3
Vitamin C (mg)	197.5 (111.1)	181.0 (99.8)	<0.001	12.9, 20.0
Vitamin D (μg)	2.9 (1.8)	2.8 (1.8)	<0.001	0.0, 0.2
Vitamin E (μg)	8.7 (3.8)	8.1 (3.5)	<0.001	0.5, 0.7

between the two groups for all nutrients analysed, except for protein, calcium and vitamin A. Further, supplement users had higher intakes of all nutrients, except for fat and vitamin B_{12}. However, these results should be interpreted bearing in mind that, because of the large numbers in each group, even relatively small differences are statistically significant. The findings do appear to support the hypothesis that supplement users are eating at least as nutritious a diet as non-users, before the effects of supplementation are taken into account, and may therefore be unnecessarily consuming supplements to meet a deficiency in nutrients.

Logistic regression analysis

For the logistic regression, univariate analysis showed that all the variables studied, except for educational status, were significantly associated with supplement taking. This lack of effect of educational status may be explained by the nature of the recruitment of the sample group, as subjects were not randomly selected and generally comprised highly educated subjects. For the next step, all variables except educational status were entered into a multivariate model. The results are shown in Table 2. The quoted odds ratios and P values refer to the effect of each variable after accounting for the other variables in the model.

These results showed that, after controlling for the other factors, all the variables included in the analysis had a significant effect on whether subjects took dietary supplements. Subjects with a low body mass index (BMI $<20\,\text{kg m}^{-2}$) were more likely to take dietary supplements than those in the normal range, whereas those with a high BMI (i.e. BMI $>25\,\text{kg m}^{-2}$) were progressively less likely to do so. Age was associated with supplement use, with older subjects progressively more likely to use dietary supplement compared to the younger age group. Those subjects who classified themselves as vegetarian, vegan or fish-eating as opposed to eating meat were also more likely to take supplements, with fish-eaters and vegans more likely to use supplements than vegetarians. High consumption of fruit and vegetables, higher levels of physical activity and a lower alcohol intake were also characteristics associated with supplement use, while subjects who reported smoking regularly were less likely to take supplements and ex- or occasional smokers were more likely to take supplements. These findings are consistent with our hypothesis, that supplement users are more likely to have a healthier lifestyle.

Discussion

The findings from this study further support the inverse supplement hypothesis, that those most likely to use dietary supplements are those least likely to need them. Supplement users in this large cohort had higher intakes from FFQ data of all nutrients, except fat and vitamin B_{12}, than non-users. In addition, the use of supplements was associated with other health behaviours, with supplement users being less likely to smoke regularly or drink alcohol, and more likely to have adopted a more vegetarian eating pattern and to consume more fruits and vegetables. Supplement use was associated with having a BMI below 20, which is of some concern, since this is classified as underweight, although mean energy intake from FFQ data was higher in the supplement users. Previous research has also found that vegetarians are often leaner than their meat-eating counterparts[8,9]. Our findings do fit in with the results of a recent Mintel survey[10], which found that supplement users tended to be female, in their forties and fifties, of higher

Table 2 Results from the logistic regression model describing the relative probabilities of taking dietary supplements

Variable	*P* value	Odds ratio (95% CI)
Age up to 44 years ($n = 3653$)	< 0.001	1.00
45–54 years ($n = 5091$)		1.38 (1.27, 1.51)
55–64 years ($n = 2445$)		1.44 (1.30, 1.61)
> 64 years ($n = 1240$)		1.46 (1.27, 1.68)
BMI 20–25 ($n = 7357$)	< 0.001	1.00
< 20 ($n = 1460$)		1.18 (1.05, 1.33)
25–30 ($n = 2688$)		0.83 (0.76, 0.92)
> 30 ($n = 924$)		0.77 (0.67, 0.89)
Meat-eating diet ($n = 4069$)	< 0.001	1.00
Fish-eating diet ($n = 4805$)		1.63 (1.49, 1.78)
Vegetarian diet ($n = 3341$)		1.28 (1.17, 1.41)
Vegan diet ($n = 214$)		1.75 (1.29, 2.37)
< 2 helpings fruit/veg day^{-1} ($n = 4407$)	< 0.001	1.00
2–4 helpings day^{-1} ($n = 5723$)		1.14 (1.05, 1.23)
> 4 helpings day^{-1} ($n = 2299$)		1.48 (1.33, 1.65)
Non–smoker ($n = 7224$)	< 0.001	1.00
Ex- or occasional smoker ($n = 4243$)		1.14 (1.05, 1.24)
Regular smoker ($n = 962$)		0.83 (0.73, 0.96)
Alcohol < 1 unit wk^{-1} ($n = 4294$)	0.008	1.00
2–6 units wk^{-1} ($n = 3989$)		0.96 (0.88, 1.05)
> 7 units wk^{-1} ($n = 4146$)		0.87 (0.79, 0.95)
Low activity ($n = 4924$)	< 0.001	1.00
Moderate activity ($n = 3065$)		1.16 (1.06, 1.28)
High activity ($n = 4440$)		1.29 (1.18, 1.41)
Number of cases in the model	12,429	

socioeconomic status and with higher disposable incomes, although the latter cannot be verified within the scope of this analysis.

Limitations of this analysis are that the population from which the sample was drawn are not representative of the general female population, since, as previously outlined, the subjects taking part in the UKWCS are likely to be women with an interest in diet and health, particularly in relation to cancer. This explains the lack of significance in education status from the univariate analysis, since there was relatively little variation in the women's education levels. Despite these limitations, our findings are of interest as a comparison of supplement users and non-users within a cohort of women. For example, there are fewer obese subjects within this sample than in the general population, yet we can still compare the rate of supplement use in obese subjects and those of normal weight.

In this cohort, the average intakes in both supplement users and non-users are more than adequate to meet the reference nutrient intake (RNI) for all nutrients studied. It would be expected that consumption of fruits and vegetables would be higher in vegetarians and vegans, by the very nature of their dietary choices. Yet even taking into account the type of diet, fruit and vegetable intake was still an independent predictor of supplement use. It is interesting that supplement use was even more likely in fish-eaters and vegans than in vegetarians, which could be interpreted in one of two ways. The adoption of some degree of dietary restriction in the form of vegetarianism might be expected to increase the likelihood of using dietary supplements, because of concerns about dietary adequacy. Or it may also be that people adopting a vegetarian diet are more health conscious. Further research is required to investigate the motivations behind the use of dietary supplements. The lower intake of vitamin B_{12} in supplement users could be accounted for by the adoption of a vegetarian diet as this vitamin is difficult to obtain from a vegetarian diet.

In conclusion, supplement users were more likely to perform other health behaviours, such as taking more physical activity or not smoking, providing further evidence in support of our 'inverse supplement hypothesis'. As some supplements may be harmful at high intakes[11], the potential to self-medicate with a range of dietary supplements is an important public health issue. Until sufficient evidence is available to support the use of supplements to provide optimal nutrient intakes for disease prevention, the need for dietary supplements to meet nutrient deficiency should be questioned for the majority of women who are most likely to take them.

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References

1 Gregory J, Foster K, Tyler H, Wiseman M. *The Dietary and Nutritional Survey of British Adults*. London, HMSO, 1990.
2 Kirk S, Woodhouse A, Conner M and the UKWCS Steering Group. Beliefs, attitudes and behaviour in relation to supplement use in the UK Women's Cohort Study. *Proc. Nutr. Soc.* 1998; **57**: 1: 54A.
3 Block G, Sinha R, Gridley G. Collection of dietary supplement data and implications for analysis. *Am. J Clin. Nutr.* 1994; **59** (suppl): 232S–239S.
4 Douglas RM, Chalker EB, Treacy B. Vitamin C for the common cold. In: Douglas R, Bridges-Webb C, Glasziou P, Lozano J, Steinhoff M, Wang E (eds) *Acute Respiratory Infections Module of the Cochrane Database of Systematic Reviews* (updated 01 December 1997). Available in the Cochrane Library (database on disk or CD-ROM). The Cochrane Collaboration; issue 1. Oxford, Update Software, 1998.
5 Promotional leaflet for Seven Seas Extra High Strength Cod Liver Oil capsules.
6 Belch JJF, Ansell D, Madhok R, O'Dowd A, Sturrock RD. Effects of altering dietary essential fatty acids on requirements for non-steroidal anti-inflammatory drugs in patients with rheumatoid arthritis: a double blind placebo controlled study. *Ann. Rheum. Dis.* 1988; **47**: 96–104.
7 Woodhouse A, Calvert C, Cade J. The UK Women's Cohort Study. Background and obtaining local ethical approval. *Proc. Nutr. Soc.* 1997; **56**: 64A.
8 Burr M.L, Bates C.J, Fehily A.M, St Leger A.S. Plasma cholesterol and blood pressure in vegetarians. *J. Hum. Nutr.* 1981; **35**: 437–41.
9 Pixley F, Wilson D, McPherson K, Mann JI. Effect of vegetarianism on development of gallstones in women. *Br. Med. J.* 1985; **291**: 11–12.
10 Mintel. *Vitamins and Dietary Supplements*. London, Mintel International Group, 1997.
11 Hathcock JN. Vitamins and minerals: efficacy and safety. *Am J Clin. Nutr.* 1997; **66**: 427–37.

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