Public Health Nutrition: 11(12), 1238–1247 doi:10.1017/S136898000800219X

Sociodemographic, health and lifestyle characteristics reported by discrete groups of adult dietary supplement users in Alberta, Canada: findings from The Tomorrow Project

Paula J Robson[1,*], Geraldine Lo Siou[2], Ruth Ullman[2] and Heather E Bryant[2]
[1]Division of Population Health and Information, Alberta Cancer Board, 14th Floor, Sun Life Place, 10123 99th Street, Edmonton, Alberta, Canada, T5J 3H1: [2]Division of Population Health and Information, Alberta Cancer Board, c/o Tom Baker Cancer Centre, 1331 29th Street NW, Calgary, Alberta, Canada, T2N 4N2

Submitted 4 April 2007: Accepted 25 February 2008: First published online 6 May 2008

Abstract

Objective: To determine the extent to which differences in sociodemographic, dietary and lifestyle characteristics exist between users of different types of dietary supplements and supplement non-users.
Design: We analysed cross-sectional data obtained from self-administered questionnaires completed at baseline by participants in The Tomorrow Project; a prospective cohort study in Alberta, Canada. Participants who used at least one type of dietary supplement at least weekly in the year prior to questionnaire completion were defined as supplement users, while the remainder were classified as non-users. Seven discrete user categories were created: multivitamins (+/− minerals) only, specific nutritional supplements only, herbal/other supplements only, and all possible combinations. Differences in sociodemographic, dietary and lifestyle characteristics between different groups of supplement users and non-users were analysed using Rao–Scott χ^2 tests and multinomial logistic regression.
Subjects and setting: Subjects were 5067 men and 7439 women, aged 35–69 years, recruited by random digit dialling throughout Alberta.
Results: Supplement use was extensive in this study population (69·8%). Users of herbal/other supplements only, and women who used multivitamins only, tended to report dietary and lifestyle characteristics that were not significantly different from non-users. In contrast, those who reported using a combination of multivitamins, specific nutritional and herbal/other supplements were more likely than non-users to report behaviours and characteristics consistent with current health guidelines.
Conclusions: Dichotomizing participants as supplement users or non-users is likely to mask further differences in sociodemographic, dietary and lifestyle characteristics among users of different types of supplements. This may have implications for analysis and interpretation of observational studies.

Keywords
Dietary supplements
Cohort study
Health behaviour
Alberta

In the USA and Canada, dietary supplements encompass vitamins and minerals, as well as non-vitamin non-mineral (NVNM) products including herbal preparations, probiotics, amino acids, fatty acids and miscellaneous combinations of these and other ingredients[1,2].

It has been estimated that approximately half of the adult population in the USA are users of dietary supplements[3]. Although no comparable, large population-based studies have reported on supplement intake in Canada, existing prevalence estimates are broadly similar to those observed in the USA[4].

Despite the apparently widespread consumption of dietary supplements in North America, the long-term health effects in the general population are far from clear[5]. For many NVNM supplements in common use, the evidence for health benefits or harms is inconclusive or lacking[6,7]. Similarly, for vitamin and/or mineral supplements, the conflicting and insufficient evidence for health benefits of supplementation in the general population[8–11] has led several recent reviews to conclude that public health policies should continue to recommend consumption of a variety of foods rather than supplements[12–14].

Failure to account fully for the effects of potential confounders when attempting to determine health effects of supplementation may partially explain why hypotheses generated in observational studies and tested in randomized controlled trials have been inconsistent[15–17]. For example, relative to non-users, supplement users tend to report more physical activity[3,18–26], greater intakes of fruits and/or vegetables[19,20,24,27] and lower intake of dietary fat[27].

*Corresponding author: Email paularob@cancerboard.ab.ca

Higher income and education have also been associated positively with supplement use[3,18–20,22,24,25,28].

However it has been observed recently that the dichotomous approach, used by the majority of studies that have examined the characteristics of supplement users *v.* non-users, is likely to mask additional health-related and sociodemographic differences that may exist among users of different types of dietary supplements[15,29]. This observation has prompted some authors to suggest that there is a clear need for more research to investigate similarities and differences among sub-categories of dietary supplement users[15,18].

Thus, the aims of the present study were to estimate the prevalence of dietary supplement use, at baseline, in adults taking part in a longitudinal cancer cohort study in Alberta, Canada (The Tomorrow Project[30]) and to explore the extent to which differences in self-reported sociodemographic, dietary and lifestyle characteristics exist between users of different types of dietary supplements and non-users of supplements.

Subjects and methods

Subject recruitment

Full details describing subject recruitment and enrolment to The Tomorrow Project are described elsewhere[30]. In brief, participants were recruited to the longitudinal cohort study using a two-stage random sampling design. The first stage identified households using a telephone random digit dial (RDD) method, while the second stage identified an eligible individual from within each household.

Eligibility criteria were: age between 35 and 69 years; no personal history of cancer, other than non-melanoma skin cancer; planning to stay in Alberta for one year; and able to complete written questionnaires in English. In households with more than one eligible participant, the person with the most recent birthday was selected[31]. In the first of five recruitment waves, we piloted an approach of recruiting two eligible adults from each household, but this approach was not continued in the latter waves.

The study was described to potentially eligible individuals as a long-term project that would help researchers learn about the causes of cancer. Eligible adults who expressed interest in taking part received a consent form and a Health and Lifestyle Questionnaire (HLQ) by mail. Questionnaires designed to ascertain past year diet and physical activity were sent to participants who returned a completed HLQ and consent form. All questionnaires were self-administered. Data analysed in the present study were obtained between February 2001 and November 2004.

Dietary assessment

Dietary habits were assessed using the US National Cancer Institute's Diet History Questionnaire (DHQ), adapted for use in Canada[32,33].

Dietary supplements

Forty-four different supplements, divided into three separate categories, were queried on the DHQ: multivitamins (with or without minerals); sixteen specific nutritional supplements not consumed as part of a multivitamin/mineral; and twenty-seven herbal/other supplements. Use of multivitamins (with or without minerals) was queried in a single question, and 'One-a-day-, or Centrum-type multivitamins (as pills, liquids, or packets)' were given as examples. For the purposes of the present analysis, we defined specific nutritional supplements as those products that contained at least one component with established nutritional value, but that were not consumed as part of a multivitamin/mineral. The term 'herbal/other' was used to describe supplements of predominantly herbal/botanical origin and those for which no firm nutritional value has yet been established in healthy adults. Products included in the specific nutritional and herbal/other groups of dietary supplements queried on the DHQ are presented in Table 1.

Regular supplement users were defined as participants who reported consumption of at least one type of dietary supplement at least once weekly in the year prior to DHQ completion. For the purposes of the present analysis, the remaining participants, who used supplements less than once weekly or not at all, were combined into one group and referred to as non-users. Following dichotomization, regular users were assigned to one of seven discrete categories: (i) multivitamins (with or without minerals) only (M); (ii) specific nutritional supplements only (N); (iii) herbal/other supplements only (H); (iv) multivitamins and specific nutritional supplements (MN); (v) multivitamins and herbal/other supplements (MH); (vi) specific nutritional and herbal/other supplements (NH); and (vii) multivitamins, specific nutritional and herbal/other supplements (MNH). These categories represented all possible combinations of supplement type queried on the DHQ.

Food and nutrient intakes

Intakes of foods and beverages reported by each person using the DHQ were analysed using the Diet*Calc software version 1·4·2 (National Cancer Institute, Bethesda, MD, USA) to provide information on mean daily nutrient intakes and servings of selected food groups.

Lifestyle and sociodemographic variables

A validated Past Year Total Physical Activity Questionnaire (PYTPAQ)[34] was used to estimate the total number of hours per week spent by each participant performing occupational, transportation, household and recreational activities at vigorous intensity (>6 MET[35,36], where MET=metabolic energy equivalent task). Smoking status, height, body weight, sex, age, marital status, highest level of educational attainment and total household income before tax were assessed using the self-administered HLQ.

https://doi.org/10.1017/S136898000800219X Published online by Cambridge University Press

Table 1 Classification of dietary supplements queried on the Diet History Questionnaire[32,33] completed by participants in The Tomorrow Project

Multivitamins with or without minerals (M)		
Use of multivitamins (with or without minerals) was queried as follows: 'Over the past 12 months, did you take any multivitamins, such as One-a-day-, or Centrum-type multivitamins (as pills, liquids, or packets)?' Supplementary questions queried frequency of use and presence of minerals in the multivitamin.		
Specific nutritional supplements not taken as part of a multivitamin/mineral (N)		
β-Carotene	Vitamin B complex	Iron
Vitamin A	Brewer's yeast	Niacin
Vitamin C	Calcium	Selenium
Vitamin D	Cod-liver oil	Zinc
Vitamin E	Fish oil (omega-3) fatty acids	
Vitamin B_6	Folic acid	
Herbal/other supplements (H)		
Aloe vera	Echinacea	Grapeseed extract
Astragalus	Evening primrose oil	Hydroxytryptophan
Bilberry	Feverfew	Kava kava
Cascara sagrada	Garlic	Milk thistle
Cat's claw	Ginger	Other (not specified)
Cayenne	Ginko biloba	Saw palmetto
Coenzyme Q	Ginseng	Siberian ginseng
Cranberry	Glucosamine	St John's wort
Dong kuai (Tangkwei)	Goldenseal	Valerian

Statistical analyses

In order to account for the complex sampling procedure used in The Tomorrow Project, sample weights were calculated in five steps: adjustments for (i) the probability of household selection, (ii) telephone under-coverage, (iii) household non-response, (iv) person non-response and (v) post-stratification by health region of residence at time of recruitment, sex and age, using population estimates for Alberta[37]. The approach of calculating sample weights was based on the weighting strategy used in the Canadian Community Health Survey[38]. As the first step in the analysis, Rao–Scott design-adjusted χ^2 tests[39–41] were used to explore associations between regular supplement use and sociodemographic, dietary and lifestyle characteristics that had been selected a priori as being consistent with general health guidelines. Multinomial logistic regression models[42] were then used to investigate differences and similarities in these characteristics between non-users and the seven discrete categories of supplement use.

All analyses were performed with weighted data, using the PROC SURVEYFREQ and PROC SURVEYLOGISTIC procedures available in the Statistical Analysis System (SAS) statistical software package version 9·1·3 (SAS Institute Inc., Cary, NC, USA). These procedures used the Taylor expansion method to estimate standard errors of estimates[43,44]. All tests for significance of estimated logit coefficients were two-sided and performed with Wald tests at a 5% significance level. Owing to the complex sampling design, the use of likelihood ratio tests was not appropriate, as these tests assume independence between observations[45,46].

Ethical approval

Ethical approval for The Tomorrow Project was obtained from the Research Ethics Committees of the Alberta Cancer Board and the University of Calgary, Alberta, Canada.

Results

Of the 29 270 individuals recruited on the basis of the eligibility criteria outlined in the RDD protocol, 15 046 (51·4%) enrolled in the cohort by returning a consent form and HLQ. Assuming that the ratio of eligible to ineligible in those for whom a screening interview could not be completed was the same as that in the successfully screened group, it is estimated that the enrolled sample represented about 31% of all potential participants. DHQ and PYTPAQ were not returned by 1859 (12·4%) participants. Using the raw data, no significant differences in education or BMI were found between those who returned DHQ and PYTPAQ and those who did not. However, women, people aged 55–69 years and people living with a partner were over-represented in the group that returned all three baseline questionnaires relative to the group that returned the HLQ only.

Following exclusion of those who did not return DHQ and PYTPAQ, we also excluded the remaining subjects who were recruited as 'second in household' in the first recruitment wave (n 344), people outside the 35–69 year age range at the time of completing the HLQ (n 19), pregnant women (n 24), transgender subjects (n 2), people with BMI $< 18{\cdot}5\,kg/m^2$ (n 85) and those with incomplete data (n 36). In addition we undertook a data linkage with the Alberta Cancer Registry, and subsequently excluded those participants who were flagged as having had a previous diagnosis of cancer before enrolment into the study (n 171). We also considered excluding participants who reported implausible energy intakes (n 504), as defined by Hung *et al.*[47], but as this exclusion had no significant impact on our results (data not shown) these records were retained for analysis, giving a final sample of 12 506 respondents.

https://doi.org/10.1017/S136898000800219X Published online by Cambridge University Press

Just over two-thirds of participants reported using at least one dietary supplement at least once weekly during the 12 months prior to DHQ completion (Table 2). Within the study sample use of multiple supplements was common, with just over a quarter of users reporting that they had consumed five or more different supplements at least once weekly (data not shown). Among women who were regular supplement users, the most commonly reported specific nutritional and herbal/other supplements were calcium, reported by 60·3 %, and glucosamine, reported by 20·3 % of users. In contrast, vitamin C (37·4 %) and garlic (18·9 %) were the specific nutritional and herbal/other supplements reported most commonly by men.

Table 3 presents weighted estimates of percentages with 95 % confidence intervals for the sociodemographic, dietary and lifestyle characteristics reported by all participants

Table 2 Categories of dietary supplement use reported by participants in The Tomorrow Project†

	Raw data†		Weighted‡	
Dietary supplement use	*n*	%	%	95 % CI
Non/irregular supplement use	3456	27·6	30·2	29·2, 31·1
Regular supplement use§	9050	72·4	69·8	68·9, 70·8
Multivitamins only (M)	924	7·4	7·8	7·3, 8·3
Specific nutritional supplements only (N)	1683	13·5	12·9	12·2, 13·5
Herbal/other supplements only (H)	655	5·2	5·5	5·0, 5·9
Multivitamins & specific nutritional supplements (MN)	1729	13·8	13·6	12·9, 14·2
Multivitamins & herbal/other supplements (MH)	333	2·7	2·9	2·5, 3·2
Specific nutritional & herbal/other supplements (NH)	1403	11·2	10·4	9·8, 11·0
Multivitamins, specific nutritional & herbal/other supplements (MNH)	2323	18·6	16·9	16·2, 17·6

†Excludes 'second in household' recruits and those who were <35 years or >69 years, pregnant, transgender, underweight, had had prior cancer or had incomplete data.
‡Weights calculated in five steps: adjustments for the probability of household selection, telephone under-coverage, household non-response, person non-response and post-stratification adjustment by health region of residence at time of recruitment, sex and age.
§Regular users of dietary supplements were defined as those participants who reported consumption of at least one supplement at least once weekly in the year prior to questionnaire completion. All other participants were defined as non-users.

Table 3 Sociodemographic, dietary and lifestyle characteristics reported by adults participating in The Tomorrow Project† and percentage who are regular supplement users

		Weighted estimates‡			
		Percentage of total sample		Percentage who are regular supplement users	
		%	95 % CI	%	95 % CI
Sex	Men	50·7	49·7, 51·7	61·2	59·7, 62·7
	Women	49·3	48·3, 50·3	78·7	77·7, 79·8
Age	35–44 years	41·6	40·6, 42·6	63·7	62·1, 65·3
	45–54 years	32·6	31·7, 33·5	70·2	68·6, 71·7
	55–69 years	25·8	25·0, 26·6	79·4	77·9, 80·9
Marital status	Not cohabiting	22·3	21·5, 23·1	73·5	71·5, 75·4
	Married/living with someone	77·7	76·9, 78·5	68·8	67·8, 69·9
Education	High school or less	27·5	26·6, 28·4	70·3	68·5, 72·0
	Technical school/college	39·0	38·1, 40·0	70·2	68·7, 71·6
	University	33·5	32·5, 34·4	69·1	67·5, 70·8
Fruit & vegetables	<5 servings/d	32·6	31·7, 33·5	64·3	62·6, 66·0
	≥5 servings/d	67·4	66·5, 68·3	72·5	71·4, 73·6
Whole-grain foods	<1 serving/d	46·9	46·0, 47·9	67·6	66·3, 69·0
	≥1 serving/d	53·1	52·1, 54·0	71·8	70·5, 73·1
Saturated fat	<10 % energy intake	41·9	41·0, 42·9	74·5	73·1, 75·9
	≥10 % energy intake	58·1	57·1, 59·0	66·5	65·2, 67·7
Alcohol intake	≤1 drink/d	79·1	78·3, 79·9	70·6	69·6, 71·6
	>1 drink/d	20·9	20·1, 21·7	67·1	64·9, 69·2
Vigorous activity§	<1 h/week	63·2	62·3, 64·2	69·3	68·2, 70·5
	≥1 h/week	36·8	35·8, 37·7	70·7	69·2, 72·3
Smoking status	Current smoker	19·5	18·7, 20·3	63·8	61·7, 66·0
	Non/never smoker	80·5	79·7, 81·3	71·3	70·3, 72·3
BMI	18·5–24·9 kg/m^2	33·9	32·9, 34·8	71·6	70·0, 73·1
	25·0–29·9 kg/m^2	41·3	40·3, 42·3	68·4	66·9, 69·8
	≥30 kg/m^2	24·8	24·0, 25·7	70·0	68·2, 71·8

†Excludes those who did not return all questionnaires, 'second in household' recruits, and those who were <35 years or >69 years, pregnant, transgender, underweight, had had prior cancer or had incomplete data.
‡Weights calculated in five steps: adjustments for the probability of household selection, telephone under-coverage, household non-response, person non-response and post-stratification adjustment by health region of residence at time of recruitment, sex and age.
§Total time (hours per week) performing occupational, transportation, household and recreational activities at intensities greater than 6 MET (MET=metabolic energy equivalent task).

https://doi.org/10.1017/S136898000800219X Published online by Cambridge University Press

included in the current analysis, and also presents the percentages of people in each category who were regular supplement users. Rao–Scott χ^2 tests (data not shown) revealed significant associations between dietary supplement use and most of the characteristics presented in the table, with the exception of educational attainment and participation in vigorous physical activity.

To investigate differences and similarities in dietary and lifestyle characteristics reported by participants in each of the seven discrete categories of regular supplement use, relative to those in the non-use group, we estimated a multinomial logistic model. Preliminary explorations of our data demonstrated that income was significantly positively associated with education and, as we had fewer missing values for the education variable, we chose to use the latter as our indicator of socio-economic status. Thus the final models controlled for sex, age, marital status and education. As our preliminary analyses indicated significant interaction effects for supplement use between age and sex, and between marital status and sex (data not shown), the final models presented in Table 4 were estimated separately for men and women. The odds ratios presented in Table 4 can be interpreted as follows: men aged 55–69 years, relative to men aged 35–44 years, were three times more likely to be in the MNH group than in the non-users group. Similarly, men who were married/living with someone, relative to men who were not cohabiting, were 0·4 (i.e. 1·0 minus 0·6) times less likely to be in the MNH group than in the non-user group.

Men and women in the N, MN, NH and MNH groups were more likely than non-users to be in the older age group (Table 4). However, men and women who used multivitamins only (M) and multivitamins with herbal/other supplements (MH), and women who used herbal/other supplements only (H), were not significantly different from non-users with respect to age. Furthermore, the majority of dietary and lifestyle characteristics reported by men and women who used herbal/other supplements only (H) were not significantly different from those of non-users. Similarly, women who reported use of multivitamins only (M) did not differ significantly from non-users with respect to most sociodemographic characteristics or dietary and lifestyle behaviours.

Men and women in the MN, NH and MNH groups were more likely than non-users to report consumption of at least five servings of fruit and vegetables per day. In addition, women in the MNH and MN groups were less likely than non-users to be smokers, and more likely to report at least one daily serving of whole-grain foods, less than 10% energy from saturated fat and more participation in vigorous physical activity. A broadly similar pattern was observed for men in the MNH group. With respect to marital status, men and women in the MNH group were less likely than non-users to be married or living with someone. In addition, men in the MN and NH groups were less likely than non-users to report cohabitation.

Discussion

Approximately 70% of participants in The Tomorrow Project were classified as regular users of dietary supplements. This estimate is somewhat higher than the 45–50% reported in two smaller Canadian surveys[4,48] and the two most recent large US population-based studies[3,18]. One possible reason for the apparent disparity in prevalence estimates could be the fact that we assessed supplement use in adults aged 35–69 years, whereas other North American surveys have included people from the age of 18 years[3,4,18,48]. As supplement use tends to increase with increasing age[3,18,28,49,50], this could account, at least in part, for the observation that our estimate of regular use was higher than has been reported by others.

However, a more likely explanation is the fact that our subjects were participants in a long-term cohort being established for the study of cancer aetiology. Compared with the two most recent US population-based surveys, which reported response rates of 72·1% (National Health Interview Survey; NHIS[18]) and 82% (National Health and Nutrition Examination Survey[3]), our estimated response rate was relatively low (31%). Furthermore, it is likely that our participants may be more health-conscious than the general population, suggesting that our estimate of the prevalence of supplement use is likely to be somewhat biased.

The lower response rate obtained in The Tomorrow Project is not particularly surprising, given that the participants were invited to enrol in a longitudinal cohort study, rather than a one-off cross-sectional survey. Previous comparisons of the sample with the Albertan population have demonstrated no significant differences with respect to marital status and income. In contrast, however, our participants reported greater educational attainment, but they also reported higher BMI, suggesting that there is likely to be more than a simple 'healthy user' bias operating within our sample[30]. Furthermore, we attempted to account for selection bias by calculating sample weights and by using statistical approaches appropriate for surveys with complex sampling procedures.

Although our prevalence of use estimates may be somewhat biased, we did observe sociodemographic, dietary and lifestyle differences among discrete groups of supplement users in our study population. These results are difficult to compare directly with previous work because the methods used to group subjects on the basis of use of different types of supplements have varied widely between studies[4,15,18,23,29]. The lack of consistency in the published literature means that there is no strong theoretical framework to guide the methods that should be used in this type of work. Therefore, the approach used in the current study was driven by our need to try to understand the extent to which users of different types of supplements may differ from non-users and from each other. Thus the decision to create

Table 4 Sociodemographic, dietary and lifestyle characteristics reported by adults in each of seven discrete categories of dietary supplement use compared with those reported by supplement non-users†,‡

		M		N		H		MN		MH		NH		MNH	
		OR§	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95% CI	OR	95% CI
Men															
Age***	35–44 years	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	45–54 years	1·1	0·8, 1·4	1·0	0·8, 1·3	1·0	0·8, 1·4	1·2	0·9, 1·6	1·3	0·9, 2·0	1·8***	1·3, 2·5	1·4*	1·1, 1·8
	55–69 years	1·3	1·0, 1·7	1·7***	1·3, 2·1	1·8***	1·3, 2·5	1·7***	1·3, 2·2	1·5	1·0, 2·5	3·2***	2·3, 4·4	3·0***	2·3, 3·8
Marital status***	Not cohabiting	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	Married/living with someone	0·8	0·6, 1·1	1·0	0·7, 1·3	1·0	0·7, 1·4	0·6**	0·5, 0·8	0·7	0·5, 1·1	0·6***	0·4, 0·8	0·6***	0·5, 0·8
Education***	High school or less	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	Technical school/college	1·2	0·9, 1·6	0·9	0·7, 1·2	1·2	0·9, 1·6	1·6**	1.1, 2·1	1·4	0·9, 2·1	1·1	0·8, 1·5	1·1	0·8, 1·4
	University	1·2	0·9, 1·6	0·8	0·6, 1·0	0·7*	0·5, 1·0	1·6**	1·2, 2·2	1·1	0·7, 1·7	0·7	0·5, 1·0	1·2	0·9, 1·6
Fruit & vegetables***	<5 servings/d	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	≥5 servings/d	0·8*	0·6, 1·0	1·2	0·9, 1·5	1·1	0·8, 1·4	1·3*	1·0, 1·7	1·3	0·9, 2·0	1·7***	1·3, 2·3	2·0***	1·5, 2·5
Whole-grain foods**	<1 serving/d	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	≥1 serving/d	1·6***	1·3, 2·0	1·3*	1·0, 1·6	1·1	0·8, 1·4	1·3*	1·0, 1·6	1·3	0·9, 1·9	1·3	1·0, 1·7	1·4**	1·1, 1·8
Saturated fat	≥10 % energy	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	<10 % energy	1·2	0·9, 1·5	1·2	0·9, 1·5	1·3	1·0, 1·6	1·3	1·0, 1·6	1·1	0·8, 1·6	1·1	0·9, 1·4	1·2	1·0, 1·5
Alcohol intake	>1 drink/d	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	≤1 drink/d	1·0	0·8, 1·3	0·9	0·7, 1·1	0·7**	0·5, 0·9	1·1	0·9, 1·5	1·1	0·8, 1·7	1·0	0·7, 1·3	0·9	0·7, 1·1
Vigorous activity*	<1 h/week	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	≥1 h/week	1·3*	1·0, 1·7	1·0	0·8, 1·2	1·1	0·8, 1·5	1·1	0·8, 1·4	1·8**	1·2, 2·6	1·2	0·9, 1·5	1·0	0·8, 1·3
Smoking status	Current smoker	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	Non/never smoker	0·9	0·7, 1·2	1·2	0·9, 1·6	1·2	0·8, 1·6	1·2	0·9, 1·7	1·3	0·9, 2·1	1·3	0·9, 1·8	1·4*	1·1, 1·9
BMI	≥30 kg/m^2	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	18·5–24·9 kg/m^2	0·8	0·6, 1·1	0·7*	0·6, 1·0	0·7	0·5, 1·0	1·2	0·9, 1·7	0·8	0·5, 1·3	0·8	0·5, 1·2	1·0	0·8, 1·4
	25·0–29·9 kg/m^2	0·7*	0·5, 0·9	0·8	0·6, 1·0	0·9	0·7, 1·2	1·2	0·9, 1·6	0·8	0·5, 1·2	1·1	0·8, 1·4	1·1	0·9, 1·4
Women															
Age***	35–44 years	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	45–54 years	1·0	0·7, 1·3	1·8***	1·4, 2·2	1·0	0·7, 1·4	1·5***	1·2, 1·8	1·1	0·7, 1·6	2.4***	1·9, 3·0	2·2***	1·8, 2·7
	55–69 years	1·0	0·8, 1·4	2·9***	2·3, 3·6	1·2	0·8, 1·7	2·9***	2·3, 3·6	1·4	0·9, 2·3	3·7***	2·9, 4·7	3·7***	3·0, 4·6
Marital status**	Not cohabiting	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	Married/living with someone	1·1	0·8, 1·5	1·1	0·9, 1·3	1·3	0·9, 1·8	1·0	0·8, 1·2	0·7	0·5, 1·1	0·9	0·7, 1·1	0·8**	0·6, 0·9
Education	High school or less	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	Technical school/college	1·2	0·9, 1·6	1·1	0·9, 1·3	0·9	0·6, 1·2	1·1	0·9, 1·3	1·2	0·8, 1·9	0·9	0·7, 1·1	0·9	0·8, 1·1
	University	1·2	0·9, 1·6	0·9	0·7, 1·1	0·7	0·5, 1·0	0·9	0·7, 1·1	1·0	0·6, 1·6	0·8*	0·6, 1·0	0·8	0·7, 1·0
Fruit & vegetables***	<5 servings/d	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	≥5 servings/d	1·2	0·9, 1·6	1·2*	1·0, 1·5	1·3	1·0, 1·8	1·3*	1·1, 1·5	1·1	0·8, 1·6	1·5***	1·2, 1·9	1·6***	1·3, 1·9
Whole-grain foods***	<1 serving/d	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	≥1 serving/d	1·2	0·9, 1·5	1·2	1·0, 1·4	0·8	0·6, 1·1	1·2*	1·0, 1·5	1·2	0·8, 1·7	1·1	0·9, 1·4	1·4***	1·2, 1·7
Saturated fat**	≥10 % energy	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	<10 % energy	1·0	0·8, 1·2	1·2	1·0, 1·4	1·1	0·8, 1·4	1·3**	1·1, 1·6	1·4	0·9, 2·0	1·2	1·0, 1·4	1·4***	1·1, 1·6
Alcohol intake	>1 drink/d	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	≤1 drink/d	1·8**	1·2, 2·8	1·0	0·8, 1·3	0·7	0·5, 1·1	1·0	0·8, 1·3	0·9	0·5, 1·4	1·0	0·8, 1·4	0·9	0·7, 1·1

Table 4 *Continued*

		M		N		H		MN		MH		NH		MNH	
		OR§	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Vigorous activity**	<1 h/week	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	≥1 h/week	1·3	1·0, 1·7	1·1	0·9, 1·3	1·0	0·7, 1·3	1·3*	1·1, 1·5	2·1***	1·4, 3·0	1·1	0·9, 1·3	1·2*	1·0, 1·5
Smoking status**	Current smoker	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	Non/never smoker	0·9	0·7, 1·2	1·5***	1·2, 1·8	1·5*	1·1, 2·2	1·3*	1·1, 1·6	1·1	0·7, 1·7	1·3*	1·0, 1·7	1·4***	1·2, 1·7
BMI	≥30 kg/m²	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–	1·0	–
	18·5–24·9 kg/m²	1·0	0·8, 1·4	1·3*	1·0, 1·6	0·9	0·6, 1·3	1·4**	1·1, 1·8	0·8	0·5, 1·3	1·1	0·9, 1·4	1·2	1·0, 1·5
	25·0–29·9 kg/m²	0·9	0·7, 1·3	1·1	0·9, 1·4	0·9	0·6, 1·3	1·2	0·9, 1·5	1·0	0·6, 1·5	1·1	0·9, 1·4	1·1	0·9, 1·4

M, multivitamins only; N, specific nutritional supplements only; H, herbal/other supplements only; MN, multivitamins and specific nutritional supplements; MH, multivitamins and herbal/other supplements; NH, specific nutritional and herbal/other supplements; MNH, multivitamins, specific nutritional and herbal/other supplements.

*$P<0·05$, **$P<0·01$ and ***$P<0·001$, assessed using Wald tests. In the first column, asterisks beside the description of the characteristic indicate the range for the *P* value resulting from Wald tests for the null hypothesis that there is no relationship between the characteristic and the outcome (i.e. supplement use). Asterisks that follow odds ratios in the body of the table represent the range for the *P* values resulting from the Wald tests for the null hypothesis that a particular estimated logit coefficient is zero.

†Analyses were based on weighted data from baseline questionnaires completed by participants in The Tomorrow Project, a longitudinal cohort for the study of cancer aetiology.

‡Comparisons were undertaken by estimating multinomial logistic regression models. Full models were estimated separately for men and women, using non-users as the comparison group. All variables presented in the table were included in the final model estimated for each sex. The first row within each category of the sociodemographic, dietary and lifestyle characteristics is the reference category.

§The odds ratios can be interpreted as follows: men aged 35–44 years, relative to men aged 55–69 years, were three times more likely to be in the MNH group than in the non-user group. Similarly, men who were married/living with someone, relative to men who were not cohabiting, were 0·4 (i.e. 1·0 minus 0·6) times less likely to be in the MNH group than in the non-user group.

seven discrete groups was a pragmatic one; it represented all possible combinations of the groups of supplements and did not rely on the creation of arbitrary groupings.

However, despite the difficulties encountered in making direct comparisons between studies, our finding that men and women who used multiple types of supplements tended to report characteristics that are more consistent with established health guidelines supports the results of previous studies[15,29]. Similarly, our finding that women who used multivitamins only tended to report characteristics that were not significantly different from those reported by non-users is a theme that has emerged in the few previous studies that have investigated this issue[4,15,28,29]. It is possible that the lack of statistically significant differences observed in the current study could be a function of the relatively small size of the multivitamin only group. However, previous studies that have reported similar findings have speculated that users in this category may be taking a multivitamin/mineral as 'nutrient insurance', without considering the need to participate in other healthy lifestyle behaviours[15,20]. None the less, this hypothesis is unlikely to explain our observation that users of herbal/other supplements only reported characteristics that were little different from those reported by non-users. Clearly, this is an area that requires further research.

One other intriguing finding was the association between marital status and supplement use. Users of all types of dietary supplements (MNH) were less likely than supplement non-users to be married or living with someone. Of the few other studies that have examined associations between marital status and supplement use, results have been conflicting. For example, the Multiethnic Cohort Study reported that marital status was weakly and inconsistently associated with supplement use. Specifically, those participants who were divorced, separated or widowed were slightly more likely to report supplement use than people who were married. However, this relationship was apparent only in some ethnic groups[20]. Another study of US female physicians reported that women who had never married were least likely to use supplements, whereas widowed women were most likely to be supplement users[27]. Analysis of NHIS 2000 data reported that unmarried people were more likely to use herbal supplements than married people, but no such associations were observed for vitamins and minerals[18]. Others have reported no association between marital status and supplement use[22,51].

In the absence of data concerning motivations for use of dietary supplements in the present study, the reasons for the apparent differences in health-related and sociodemographic characteristics reported by discrete groups of supplement users can only be speculated upon. It has been suggested that people use dietary supplements for health maintenance, to reduce risk of developing chronic

diseases or to treat existing conditions[5,49,52]. Although participants in The Tomorrow Project were asked about previous diagnoses of chronic conditions, we could not ascertain whether those who indicated that they had ever received such a diagnosis still had that condition. Therefore, while we observed that those who took all types of dietary supplements were more likely than non-users to report behaviours associated with healthier lifestyles, we cannot determine the extent to which this phenomenon was associated with health maintenance, disease prevention or treatment of pre-existing disease. This is an area that needs further examination, and it is anticipated that future follow-up surveys undertaken with The Tomorrow Project cohort will attempt to explore motivations for supplement use, in addition to capturing more in-depth data concerning types, doses, frequency and duration of use of different types of supplements.

The present study does have several other limitations that should be borne in mind when attempting to compare its findings with previous and future studies. First, dietary habits and supplement use were assessed using the National Cancer Institute's DHQ that had been modified to account for Canadian food fortification practices[32]. The supplement section was not modified, owing to a paucity of up-to-date, national population-based data concerning the types of supplements used by Canadian adults at that time. Thus we cannot be certain that the DHQ list adequately reflects the types of supplements likely to have been consumed in our population. However, the supplements reported most commonly in the study were broadly in line with those described in the Food Habits of Canadians Study[4] and the British Columbia Nutrition Survey[48], both of which used open-ended questions to assess types of supplements consumed by their participants.

Despite these limitations, the results of the present study support previous observations that the relationships between use of different types of dietary supplements and sociodemographic, dietary and lifestyle characteristics are complex and cannot be accounted for by simply dichotomizing subjects as users or non-users of dietary supplements[15,29]. If this issue is to be investigated further, there is a clear need for the implementation of standardized methods designed specifically to assess supplement use, in order to better describe and assess the prevalence, types, doses, frequencies and motivations for use of different types of supplements. Standardized methods of assessing these aspects of supplement use, as well as categorizing study participants, will help researchers to compare results more easily between studies, thereby moving this area of research forward. In the long run, such information will also be useful when trying to disentangle the effects of use of different types of supplements, as well as dietary and lifestyle habits, on chronic disease risk.

Acknowledgements

Funding: The Tomorrow Project receives support from the Alberta Cancer Board and the Alberta Cancer Foundation.

Contributions: P.J.R. conceptualized the study and P.J.R. and G.L.S. developed the analysis plan. G.L.S. undertook the analysis and P.J.R. and G.L.S. interpreted the data. H.E.B. was responsible for obtaining funding for The Tomorrow Project, as well as overseeing the choice of data acquisition methods. R.U. oversaw subject enrolment and data acquisition and was responsible for the day-to-day operations of the cohort study. H.E.B. contributed substantial intellectual content and critically reviewed the manuscript.

Conflicts of interest: None of the authors has any conflict of interest to declare.

Thanks: The authors would like to thank the participants of The Tomorrow Project for their participation in the study. In addition, we acknowledge the contributions made by study staff in data entry and processing. Finally, we wish to thank Drs Elizabeth McGregor, Christine Friedenreich, Ilona Csizmadi and Karen Kopciuk of the Alberta Cancer Board for their helpful comments on the manuscript. The latter four people have given permission to be acknowledged.

References

1. Center for Food Safety and Applied Nutrition (1995) Dietary Supplement Health and Education Act of 1994. http://www.cfsan.fda.gov/ ~ dms/dietsupp.html (accessed October 2007).
2. Health Canada (2004) About Natural Health Product Regulation in Canada. http://www.hc-sc.gc.ca/dhp-mps/prodnatur/about-apropos/index_e.html (accessed October 2007).
3. Radimer K, Bindewald B, Hughes J, Ervin B, Swanson C & Picciano MF (2004) Dietary supplement use by US adults: data from the National Health and Nutrition Examination Survey, 1999–2000. *Am J Epidemiol* **160**, 339–349.
4. Troppmann L, Johns T & Gray-Donald K (2002) Natural health product use in Canada. *Can J Public Health* **93**, 426–430.
5. Neuhouser ML (2003) Dietary supplement use by American women: challenges in assessing patterns of use, motives and costs. *J Nutr* **133**, 1992S–1996S.
6. Ernst E (2002) The risk–benefit profile of commonly used herbal therapies: Ginkgo, St. John's Wort, Ginseng, Echinacea, Saw Palmetto, and Kava. *Ann Intern Med* **136**, 42–53.
7. Tesch BJ (2003) Herbs commonly used by women: an evidence-based review. *Am J Obstet Gynecol* **188**, S44–S55.
8. US Preventive Services Task Force (2003) Routine vitamin supplementation to prevent cancer and cardiovascular disease: recommendations and rationale. *Ann Intern Med* **139**, 51–55.
9. El-Kadiki A & Sutton AJ (2005) Role of multivitamins and mineral supplements in preventing infections in elderly people: systematic review and meta-analysis of randomised controlled trials. *BMJ* **330**, 871.

10. National Institutes of Health State-of-the-Science Conference Statement (2006) Multivitamin/mineral supplements and chronic disease prevention. *Ann Intern Med* **145**, 364–371.
11. Huang H-Y, Caballero B, Chang S *et al.* (2006) The efficacy and safety of multivitamin and mineral supplement use to prevent cancer and chronic disease in adults: a systematic review for a National Institutes of Health State-of-the-Science Conference. *Ann Intern Med* **145**, 372–385.
12. Bender DA (2002) Daily doses of multivitamin tablets. *BMJ* **325**, 173–174.
13. Lichtenstein AH & Russell RM (2005) Essential nutrients: food or supplements? Where should the emphasis be? *JAMA* **294**, 351–358.
14. American Dietetic Association (2001) Position of the American Dietetic Association: food fortification and dietary supplements. *J Am Diet Assoc* **101**, 115–125.
15. Reedy J, Haines PS & Campbell MK (2005) Differences in fruit and vegetable intake among categories of dietary supplement users. *J Am Diet Assoc* **105**, 1749–1756.
16. Hoggatt KJ (2003) Commentary: Vitamin supplement use and confounding by lifestyle. *Int J Epidemiol* **32**, 553–555.
17. Lawlor DA, Davey Smith G, Bruckdorfer KR, Kundu D & Ebrahim S (2004) Those confounded vitamins: what can we learn from the differences between observational versus randomised trial evidence? *Lancet* **363**, 1724–1727.
18. Fennell D (2004) Determinants of supplement usage. *Prev Med* **39**, 932–939.
19. Lyle BJ, Mares-Perlman JA, Klein BEK, Klein R & Greger JL (1998) Supplement users differ from nonusers in demographic, lifestyle, dietary and health characteristics. *J Nutr* **128**, 2355–2362.
20. Foote JA, Murphy SP, Wilkens LR, Hankin JH, Henderson BE & Kolonel LN (2003) Factors associated with dietary supplement use among healthy adults of five ethnicities: the Multiethnic Cohort Study. *Am J Epidemiol* **157**, 888–897.
21. McNaughton SA, Mishra GD, Paul AA, Prynne CJ & Wadsworth MEJ (2005) Supplement use is associated with health status and health-related behaviors in the 1946 British Birth Cohort. *J Nutr* **135**, 1782–1789.
22. Marques-Vidal P, Arveiler D, Evans A *et al.* (2000) Characteristics of male vitamin supplement users aged 50–59 years in France and Northern Ireland: the PRIME Study. Prospective Epidemiological Study of Myocardial Infarction. *Int J Vitam Nutr Res* **70**, 102–109.
23. Messerer M, Johansson SE & Wolk A (2001) Sociodemographic and health behaviour factors among dietary supplement and natural remedy users. *Eur J Clin Nutr* **55**, 1104–1110.
24. Patterson RE, Neuhouser ML, White E, Hunt JR & Kristal AR (1998) Cancer-related behavior of vitamin supplement users. *Cancer Epidemiol Biomarkers Prev* **7**, 79–81.
25. Shikany JM, Patterson RE, Agurs-Collins T & Anderson G (2003) Antioxidant supplement use in Women's Health Initiative participants. *Prev Med* **36**, 379–387.
26. Ishihara J, Sobue T, Yamamoto S, Sasaki S & Tsugane S (2003) Demographics, lifestyles, health characteristics, and dietary intake among dietary supplement users in Japan. *Int J Epidemiol* **32**, 546–553.
27. Frank E, Bendich A & Denniston M (2000) Use of vitamin–mineral supplements by female physicians in the United States. *Am J Clin Nutr* **72**, 969–975.
28. Block G, Cox C, Madans J, Schreiber GB, Licitra L & Melia N (1988) Vitamin supplement use, by demographic characteristics. *Am J Epidemiol* **127**, 297–309.
29. Hoggatt KJ, Bernstein L, Reynolds P *et al.* (2002) Correlates of vitamin supplement use in the United States: data from the California Teachers Study cohort. *Cancer Causes Control* **13**, 735–740.
30. Bryant H, Robson PJ, Ullman R, Friedenreich CM & Dawe U (2006) Population-based cohort development in Alberta, Canada: a feasibility study. *Chronic Dis Can* **27**, 55–63.
31. Lavrakas PJ (1993) *Telephone Survey Methods Sampling, Selection, and Supervision.* Newbury Park, CA: Sage Publications, Inc.
32. Csizmadi I, Kahle L, Ullman R, Dawe U, Zimmerman TP, Friedenreich CM, Bryant H & Subar AF (2007) Adaptation and evaluation of the National Cancer Institute's Diet History Questionnaire and nutrient database for Canadian populations. *Public Health Nutr* **10**, 88–96.
33. National Cancer Institute (2007) Diet History Questionnaire: Canadian Version. http://riskfactor.cancer.gov/DHQ/forms/canadian/index.html (accessed October 2007).
34. Friedenreich CM, Courneya KS, Neilson HK, Matthews CE, Willis G, Irwin M, Troiano R & Ballard-Barbash R (2006) Reliability and validity of the Past Year Total Physical Activity Questionnaire. *Am J Epidemiol* **163**, 959–970.
35. Ainsworth BE, Haskell WL, Leon AS, Jacobs DR Jr, Montoye HJ, Sallis JF & Paffenbarger RS Jr (1993) Compendium of physical activities: classification of energy costs of human physical activities. *Med Sci Sports Exerc* **25**, 71–80.
36. Ainsworth BE, Haskell WL, Whitt MC *et al.* (2000) Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc* **32**, S498–S504.
37. Statistics Canada (2001) *Canadian Community Health Survey Cycle 1.1.* Ottawa: Canadian Federal Government.
38. Brisebois F & Thivierge S (2001) The weighting strategy of the Canadian Community Health Survey. Proceedings of the Annual Meeting of the American Statistical Association, August 5–9, 2001. http://www.amstat.org/sections/srms/Proceedings/y2001/Proceed/00643.pdf (accessed October 2007).
39. Rao JNK & Scott AJ (1981) The analysis of categorical data from complex sample surveys – chi-squared tests for goodness of fit and independence in 2-way tables. *J Am Stat Assoc* **76**, 221–230.
40. Rao JNK & Scott AJ (1984) On chi-squared tests for multiway contingency tables with cell proportions estimated from survey data. *Ann Stat* **12**, 46–60.
41. Rao JNK & Scott AJ (1987) On simple adjustments to chi-square tests with sample survey data. *Ann Stat* **15**, 385–397.
42. Hosmer DW & Lemeshow S (2000) *Applied Logistic Regression.* New York: John Wiley & Sons, Inc.
43. Binder DA (1983) On the variances of asymptotically normal estimators from complex surveys. *Int Stat Rev* **51**, 279–292.
44. Woodruff RS (1971) A simple method for approximating the variance of a complicated estimate. *J Am Stat Assoc* **66**, 411–414.
45. Roberts G, Rao JNK & Kumar S (1987) Logistic regression analysis of sample survey data. *Biometrika* **74**, 1–12.
46. Sribney B (2005) Why should I not do a likelihood-ratio test after an ML estimation (e.g., logit, probit) with clustering or pweights? http://www.stata.com/support/faqs/stat/lrtest.html (accessed October 2007).
47. Hung H-C, Joshipura KJ, Jiang R, Hu FB, Hunter D, Smith-Warner SA, Colditz GA, Rosner B, Spiegelman D & Willett WC (2004) Fruit and vegetable intake and risk of major chronic disease. *J Natl Cancer Inst* **96**, 1577–1584.
48. Barr SI (2004) British Columbia Nutrition Survey: Report on Supplements. Prepared for Prevention and Wellness Planning, BC Ministry of Health Services. http://www.healthservices.gov.bc.ca/prevent/nutrition/pdf/nutrition_supp.pdf (accessed October 2007).

49. Satia-Abouta J, Kristal AR, Patterson RE, Littman AJ, Stratton KL & White E (2003) Dietary supplement use and medical conditions: the VITAL study. *Am J Prev Med* **24**, 43–51.
50. Yu SM, Kogan MD & Huang ZJ (2003) Vitamin-mineral supplement use among US women, 2000. *J Am Med Womens Assoc* **58**, 157–164.
51. Wallström P, Elmståhl S, Hanson BS, Östergren P-O, Johansson U, Janzon L & Larsson SA (1996) Demographic and psychosocial characteristics of middle-aged women and men who use dietary supplements: results from the Malmö Diet and Cancer Study. *Eur J Public Health* **6**, 188–195.
52. Conner M, Kirk SF, Cade JE & Barrett JH (2003) Environmental influences: factors influencing a woman's decision to use dietary supplements. *J Nutr* **133**, 1978S–1982S.

https://doi.org/10.1017/S136898000800219X Published online by Cambridge University Press