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Dietary supplement use among participants of a databank and biorepository at a comprehensive cancer centre

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Abstract

Objective: We assessed the prevalence, patterns and predictors of dietary supplement use among participants of the databank and biorepository (DBBR) at a comprehensive cancer centre in western New York.

Design: Archived epidemiological questionnaire data were obtained from the DBBR at Roswell Park Cancer Institute. Descriptive statistics and logistic regression explored the prevalence, patterns and predictors of lifetime use of four common supplements (multivitamins, vitamin C, vitamin E and calcium) and use of multivitamins, sixteen single vitamins/minerals and eighteen herbal/specialty supplements within the previous 10 years.

Setting: Western New York, USA.

Subjects: DBBR participants (*n* 8096) enrolled between December 2003 and July 2012 were included in these analyses: 66·9 % (*n* 5418) with cancer, 65·6 % (*n* 5309) women, mean age for patients *v.* cancer-free controls 59·9 (SD 12·6) years and 50·7 (SD 15·4) years, respectively.

Results: Overall, 54·4 % of DBBR participants reported lifetime use of one or more supplements and 63·1 % reported use of one or more supplements within the previous 10 years (excluding multivitamins). Multivitamin use was high in this sample (lifetime: 64·1 %; 10 years: 71·3 %; current: 51·8 %). Supplementation was higher among cancer-free controls than cancer patients. Vitamin C, calcium and fish oil were the most common single vitamin, mineral and specialty product, respectively.

Conclusions: A consistently high and increasing proportion of dietary supplement use over time remains clear. Supplementation is prevalent among cancer patients and may even be higher than predicted in cancer-free individuals. Further studies should assess the safety and efficacy of specific supplements in reducing disease risk.

Keywords
Dietary supplements
Vitamins
Minerals
Herbals
Botanicals

Dietary supplement use has become increasingly widespread among the general US population and use may be even more common among individuals living with chronic diseases, such as cancer[1–5]. According to the National Center for Health Statistics, dietary supplement use among US adults aged 20 years and older increased from 42 % to 53 % between the periods 1988–1994 and 2003–2006[6]. Results from the National Health and Nutrition Examination Survey (NHANES) indicated that dietary supplement use among US adults increased from 1971 to 2000 for both men and women[7]. Sales of dietary supplements amounted to approximately $US 18·8 billion in 2003 and surpassed $US 30 billion in 2011, with an expected growth in sales of 7 % annually[8].

More than half of US adults use some type of dietary supplement because they believe that doing so will make them feel better, improve their health, and prevent or treat chronic diseases[9–11]. In addition to use of multivitamins in a perceived effort to maintain general health, there is an increasing use of specific dietary supplements, likely in an effort to prevent chronic disease[11,12]. Compared with non-users, supplement users were more likely to report that taking supplements is an 'insurance policy against possible diet-related ill health'[13].

The rise in dietary supplement use for disease prevention and treatment has been attributed to the increasing evidence suggesting that high intakes of nutrients from fruits and vegetables have protective effects[14]. However, the

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nutritional components of fruits and vegetables have been isolated and used as supplements in an effort to achieve the same effects as dietary intake. This increase in nutrient intake through supplementation, rather than diet, is of great concern because current literature provides insufficient and inconclusive evidence regarding the use of dietary supplements for disease prevention and treatment.

In fact, increasing evidence suggests that dietary supplements may be more harmful than beneficial[5,15–20]. For example, it was previously hypothesized that certain supplements may have preventive properties by acting against oxidative damage and/or inhibiting cell proliferation[21]. However, a recent Cochrane review of seventy-eight randomized trials on the efficacy of antioxidant supplementation (β-carotene, vitamin A, vitamin C, vitamin E and selenium) for disease prevention in the general population did not support this hypothesis[22]. Furthermore, supplementation with β-carotene, vitamin E and high doses of vitamin A was associated with an overall increased mortality risk[22].

There is great interest in complementary and alternative modes of chemoprevention, especially dietary and herbal supplement use[1,15,21]. A survey of 227 newly diagnosed cancer patients on the use of fifty-six dietary supplements revealed that 73 % used some form of dietary supplements within the last 30 d of survey administration[15]. Ferrucci *et al.* reported that 69·3 % of cancer survivors from the American Cancer Society's Longitudinal Study of Cancer Survivors-I initiated supplementation after cancer diagnosis[23]. Among users, the types of supplements used before and after cancer diagnosis also varied. Zirpoli *et al.* reported that use of vitamin C, vitamin E, folic acid and calcium decreased during treatment (possibly due to physicians' recommendations), while the use of vitamin B_6 increased[24].

Despite the prevalent use, it is currently unclear whether dietary supplements are beneficial, or more importantly, harmful for these individuals[5]. While selected dietary supplements may be associated with a decreased risk or complications of certain cancers, others may pose health risks and/or interfere with treatment[5,18–20]. Some vitamins, such as folic acid, may even be involved in cancer progression while herbals, such as St. John's wort, may reduce the effectiveness of certain drugs used during cancer treatment[5]. More research is needed to confirm safety and efficacy before recommendations can be made regarding dietary supplementation in these individuals and characterizing trends in the use of dietary supplements is an important step in evaluating the associated benefits and risks.

The current study presents a cross-sectional analysis of a large cohort on the use of multivitamins, single vitamin, mineral, herbal and specialty supplements, comparing cancer patients with cancer-free controls. Our objective for these analyses was to determine the prevalence, patterns and predictors of dietary supplement use using epidemiological questionnaire data from the Data Bank and BioRepository (DBBR) at Roswell Park Cancer Institute (RPCI) in Buffalo, NY, USA.

Methods

Archived questionnaire data from cancer patients and cancer-free controls were obtained from the DBBR at RPCI. The DBBR, as previously described[25,26], is a Cancer Center Support Grant Shared Resource that prospectively collects and provides de-identified biospecimens, epidemiological and clinical data to investigators with hypothesis-driven, institutional review board-approved studies. Newly diagnosed cancer patients who present for treatment at RPCI are invited to participate in the DBBR during their initial visit prior to any treatment. Cancer-free controls include family and friends of patients, visitors and volunteers recruited from community events throughout the Western New York area. Participants are enrolled into the DBBR after informed consent. The protocol for the DBBR and this present analysis were approved by the RPCI Institutional Review Board.

Data

The DBBR questionnaire collects information on demographics, medical history, family history, medication use history, food habits, physical activity, smoking history and dietary supplement use. The supplement use section, adapted from the VITamins And Lifestyle (VITAL) study[27], queries the lifetime use of four common supplements (multivitamins, vitamin C, vitamin E and calcium) and use of multivitamins, sixteen single vitamins/minerals and eighteen herbal/specialty supplements within the previous 10 years. For lifetime supplement use, participants were asked if they had ever taken the supplement at least once per week for one full year since 18 years of age ('Yes', 'No'). For 10-year use, participants were asked if they had taken the supplement at any time over the previous 10 years from the time of enrolment into the DBBR ('No, never'; 'Yes, occasionally'; 'Yes, at least once a week for one full year'). Single vitamins/minerals included: vitamin A, β-carotene, vitamin C, vitamin D, vitamin E, thiamin, niacin, vitamin B_6, folic acid, vitamin B_{12}, calcium, iron, magnesium, zinc, selenium and chromium. Herbal/specialty supplements included: acidophilus pills, black cohosh, coenzyme Q10 (Co Q10), cranberry pills, fish oil, garlic pills, ginkgo biloba, ginseng, grapeseed, glucosamine, chondroitin, lutein, lycopene, melatonin, methylsulfonylmethane (MSM), soya supplements and St. John's wort.

Statistical analyses

The original data set obtained from the DBBR included 8851 participants enrolled between December 2003 and July 2012. Participants missing all variables of interest were

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Table 1 Descriptive characteristics of cancer patients and cancer-free controls (*n* 8096) participating in the databank and biorepository at a comprehensive cancer centre in western New York, USA, December 2003–July 2012

	Men (*n* 2787)				Women (*n* 5309)			
	Patients (*n* 2145)		Controls (*n* 642)		Patients (*n* 3273)		Controls (*n* 2036)	
	n	%	*n*	%	*n*	%	*n*	%
Age			Men***				Women***	
≤30 years	18	0·8	59	9·2	74	2·3	319	15·7
31–45 years	101	4·7	115	17·9	478	14·6	429	21·1
46–60 years	792	36·9	237	36·9	1295	39·6	786	38·6
61–75 years	963	44·9	188	29·3	1115	34·1	427	21·0
≥76 years	271	12·6	43	6·7	311	9·5	75	3·7
Race/ethnicity			Men				Women	
Non-Hispanic Whites	2054	95·8	602	93·8	3044	93·0	1899	93·3
Non-Hispanic Blacks	64	3·0	24	3·7	128	3·9	69	3·4
Hispanics	11	0·5	4	0·6	37	1·1	28	1·4
Others	16	0·8	12	1·9	64	2·0	40	2·0
Education			Men***				Women***	
<High school	169	7·9	19	3·0	233	7·1	35	1·7
High school/GED	536	25·0	93	14·5	941	28·8	347	17·0
Some college	687	32·0	187	29·1	1147	35·0	684	33·6
College graduate	417	19·4	167	26·0	504	15·4	565	27·8
Advanced degree	336	15·7	176	27·4	448	13·7	405	19·9
BMI category (kg/m^2)			Men				Women***	
Underweight (<18·5)	17	0·8	2	0·3	63	1·9	35	1·7
Normal weight (18·5–24·9)	496	23·1	176	27·4	1054	32·2	766	37·6
Overweight (25·0–29·9)	918	42·8	269	41·9	966	29·5	650	31·9
Obese (≥30·0)	714	33·3	195	30·4	1190	36·4	585	28·7
Fruit and vegetables (servings/d)			Men***				Women***	
1st quartile (<2·05)	632	29·5	148	23·1	847	25·9	389	19·1
2nd quartile (2·05–3·45)	591	27·6	167	22·0	778	23·8	479	23·5
3rd quartile (3·46–5·41)	514	24·0	169	26·3	808	24·7	549	27·0
4th quartile (>5·41)	408	19·0	158	24·6	840	25·7	619	30·4
Physical activity†			Men				Women***	
Much less active	46	2·1	7	1·1	136	4·2	42	2·1
Less active	228	10·6	63	9·8	463	14·2	296	14·5
About the same	532	24·8	151	23·5	1071	32·7	646	31·7
More active	853	39·8	272	42·4	1106	33·8	770	37·8
Much more active	486	22·7	149	23·2	497	15·2	282	13·9
Smoker status			Men***				Women***	
Never	726	33·9	347	54·1	1573	48·1	1189	58·4
Former	1143	53·3	249	38·8	1235	37·7	682	33·5
Current	276	12·9	46	7·2	465	14·2	165	8·1
Family history of cancer			Men				Women***	
No	772	36·0	241	37·5	1153	35·2	816	40·1
Yes	1373	64·0	401	62·5	2120	64·8	1220	59·9

GED, General Educational Development.
P values from χ^2 analyses: ***$P < 0·001$, for differences in categorical variables between cases and controls, by sex.
†Perceived level of physical activity compared with others of similar age.

excluded (*n* 755) and the remaining missing values were imputed using the age- and sex-specific mean, median or mode, resulting in a final sample of 8096. For the purposes of the present analyses, the term 'cancer patient' is used for those participants who reported that they were being seen at RPCI because of a cancer diagnosis at the time of enrolment. The term 'cancer-free control' is used for those participants who were not seeking treatment at RPCI and do not report a cancer diagnosis. Cancer status for patients was later verified through matching with pathology reports and the RPCI Tumor Registry. Additional cancer-related characteristics (cancer type, cancer site, cancer stage) were obtained from the tumour registry. Anatomic cancer sites were combined into broader cancer categories (breast, prostate, gastrointestinal, respiratory, gynaecological, genitourinary, skin and others) to reduce sparse data.

Multivitamin use over the lifetime and the previous 10 years was assessed separately from other lifetime and 10-year supplements. Dietary supplement use was dichotomous ('any use'/'no use'). A 'lifetime supplement user' was defined as having used at least one supplement (vitamin C, vitamin E and/or calcium; excluding multivitamins) at least one full year since 18 years of age. A '10-year supplement user' was defined as having used at least one of the thirty-four single vitamins, minerals, herbals and/or specialty supplements (excluding multivitamins) during the 10 years prior to enrolment into the DBBR.

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Table 2 Clinical characteristics of the cancer patients participating in the databank and biorepository at a comprehensive cancer centre in western New York, USA, December 2003–July 2012

	Overall		Men		Women	
	n	%	*n*	%	*n*	%
Cancer type†						
Benign	924	17·1	255	11·9	669	20·4
New	4113	75·9	1684	78·5	2429	74·2
Recurrent	381	7·0	206	9·6	175	5·4
Cancer site†						
Breast	1439	26·6	15	0·7	1424	43·5
Prostate	837	15·5	837	39·0	N/A	
Gynaecological (cervical, endometrial, ovarian, peritoneal, tubal, vaginal, vulvar)	731	13·5	N/A		731	22·3
Gastrointestinal (oesophagus, stomach, intestine, liver, pancreas, gallbladder, biliary tract, appendix, rectum, anus)	603	11·1	323	15·1	280	8·6
Respiratory (lung, bronchus, larynx, trachea)	526	9·7	258	12·0	268	8·2
Genitourinary (bladder, kidney, testicular, penile)	477	8·8	309	14·4	168	5·1
Skin	246	4·5	126	5·9	120	3·7
Others (head & neck, brain, endocrine, bones, joints & soft tissues, lymphatic, blood & bone marrow)	559	10·3	277	12·9	282	8·6
Cancer stage‡						
In situ	242	5·4	24	1·3	218	8·4
Localized	2020	45·0	860	45·5	1160	44·6
Regional	1141	25·4	481	25·5	660	25·4
Distant	665	14·8	301	15·9	364	14·0
Unknown	426	9·5	224	11·9	202	7·8

N/A, not applicable.
†Cancer patients only (overall = 5418: men = 2145; women = 3273).
‡Cancer patients with malignancies (overall = 4494: men = 1890; women = 2604).

Descriptive statistics were used to describe the characteristics of this sample of DBBR participants. Differences between users and non-users with respect to demographic, lifestyle and cancer-related characteristics were assessed using χ^2 tests. Odds ratios and 95 % confidence intervals were calculated with logistic regression to determine associations between dietary supplement use and demographics (age, sex, race, education and family history of cancer) and lifestyle factors (BMI, physical activity, smoking status, total fruit and vegetable intake). Characteristics significantly associated with supplement use were entered as potential confounders in multivariate logistic regression analysis to determine predictors of supplement use. $P < 0{\cdot}05$ was considered statistically significant for all statistical tests. All data were analysed using the statistical software package SAS version 9·3.

Results

Sample characteristics

Table 1 describes participant characteristics in detail. Women comprise 65·6 % (*n* 5309) of the sample, men 34·4 % (*n* 2787). Cancer patients comprise 66·9 % (*n* 5418) of the sample, cancer-free controls 33·1 % (*n* 2678). Cancer patients were generally older, had less formal education, were more likely to be current or former smokers, consumed fewer fruits and vegetables, were less physically active, and had a higher mean BMI compared with cancer-free controls.

Table 2 provides a more detailed description of cancer patients in this sample of DBBR participants. The following cancer sites were represented in the final sample: breast (26·6 %), prostate (15·5 %), gynaecological (13·5 %), gastrointestinal (11·1 %), respiratory (9·7 %), genitourinary (8·8 %; excluding prostate), skin (4·5 %) and others (10·3 % combined). The 'other cancers' category included: head and neck, brain, blood, bone marrow, endocrine, lymphatic, bones, joints and soft tissues. About 17·1 % of the cases were benign, 75·9 % were new malignancies and 7·0 % were recurrent. Most malignancies were localized (45·0 %) and regional (25·4 %), with some *in situ* (5·4 %), distant (14·8 %) and unstageable (9·5 %) cancers.

Prevalence and patterns of dietary supplement use

The prevalence of use of dietary supplements in DBBR participants is presented in Table 3 . Multivitamin use was high in this sample of DBBR participants (lifetime: 64·1 %; 10 years: 71·3 %; current: 51·8 %). Overall, 54·4 % of participants had used at least one lifetime supplement and 63·1 % had used at least one supplement in the last 10 years (excluding multivitamins). About 59·4 % reported using at least one single vitamin or mineral and 35·6 % reported using at least one herbal or specialty supplement. Vitamin C (34·1 %), calcium (39·1 %) and fish oil (22·4 %) were the most commonly used single vitamin, mineral and specialty supplement within the previous 10 years, respectively.

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Table 3 Overall prevalence of dietary supplement use and the most commonly used supplements among participants (*n* 8096) of the databank and biorepository at a comprehensive cancer centre in western New York, USA, December 2003–July 2012

	n	%
Multivitamin only		
Current use	4196	51·8
10-year use	5773	71·3
Lifetime use	5191	64·1
Lifetime supplements		
Overall	4403	54·4
Vitamin C	2785	34·4
Vitamin E	2205	27·2
Calcium	3177	39·2
10-year supplements		
Overall	5105	63·1
Vitamin/mineral	4811	59·4
Calcium	3164	39·1
Vitamin C	2757	34·1
Vitamin D	2392	29·6
Vitamin E	1992	24·6
Vitamin B_{12}	1300	16·1
Iron	960	11·9
Folic acid	959	11·9
Magnesium	799	9·9
Vitamin B_6	762	9·4
Zinc	698	8·6
Vitamin A	676	8·4
Niacin	560	6·9
Vitamin B_1	548	6·8
Selenium	433	5·4
β-Carotene	346	4·3
Chromium	311	3·8
Herbal/specialty	2879	35·6
Fish oil	1810	22·4
Glucosamine	1141	14·1
Chondroitin	932	11·5
Garlic pills	592	7·3
Co Q10	561	6·9
Acidophilus	459	5·7
Ginkgo biloba	426	5·3
Ginseng	389	4·8
Cranberry pills	286	3·5
Melatonin	284	3·5
MSM	272	3·4
Lutein	250	3·1
St. John's wort	235	2·9
Black cohosh	223	2·8
Soya	190	2·4
Grapeseed	165	2·0
Lycopene	141	1·7
Dong quai	45	0·6

Co Q10, coenzyme Q10; MSM, methylsulfonylmethane.

Characteristics associated with dietary supplement use

Several demographic and lifestyle factors were associated with lifetime and 10-year supplement use (Table 4). Logistic regression revealed older age, female gender, a positive family history of cancer, higher levels of educational attainment, higher fruit and vegetable intake, and smoker status as statistically significant predictors of dietary supplement use. The likelihood of being users increased with increasing age. Non-Hispanic Blacks were less likely to be users compared with non-Hispanic Whites (lifetime: OR = 0·69; 95 % CI 0·54, 0·87; 10 years: OR = 0·77; 95 % CI 0·60, 0·97). Females were almost twice as likely to be users compared with males (lifetime: OR = 1·97; 95 % CI 1·79, 2·16; 10 years: OR = 1·67; 95 % CI 1·52, 1·84). Individuals with higher education, a family history of cancer, and higher fruit and vegetable intake were more likely to be users. Compared with non-smokers, current smokers were less likely to be users (lifetime: OR = 0·60; 95 % CI 0·52, 0·69; 10 years: OR = 0·56; 95 % CI 0·49, 0·65) and former smokers were more likely to be users (lifetime: OR = 1·11; 95 % CI 1·01, 1·22; 10 years: OR = 1·11; 95 % CI 1·01, 1·23) in both lifetime and 10-year analyses. Although not significant, we saw an inverse trend in use with increasing BMI.

Multivitamins

Cancer characteristics associated with multivitamin use are shown in Table 5. Lifetime multivitamin use was significantly associated with being a male cancer patient with an unknown cancer stage (OR = 2·49; 95 % CI 1·04, 5·96), a newly diagnosed female patient (OR = 0·79; 95 % CI 0·64, 0·96) and a female skin cancer patient (OR = 1·62; 95 % CI 1·03, 2·55). Multivitamin use within the past 10 years was significant only among females, with patients less likely to be users compared with controls (OR = 0·85; 95 % CI 0·74, 0·99) and skin cancer patients more likely to be users compared with all other cancer sites (OR = 1·66; 95 % CI 1·02, 2·70). Both male (OR = 0·78; 95 % CI 0·64, 0·95) and female patients (OR = 0·86; 95 % CI 0·76, 0·97) were less likely to be current multivitamin users compared with controls. Among female patients, those with a new diagnosis (OR = 0·79; 95 % CI 0·66, 0·95) and a distant cancer stage (OR = 0·63; 95 % CI 0·44, 0·89) were less likely to be current users compared with other cancer types and stages, respectively. No other associations were significant.

Dietary supplements

Cancer characteristics associated with lifetime and 10-year dietary supplement use are shown in Tables 6 and 7, respectively. No strong associations were observed between cancer variables and lifetime use of vitamin C, vitamin E and/or calcium. Both male (OR = 0·73; 95 % CI 0·60, 0·89) and female (OR = 0·75; 95 % CI 0·65, 0·86) cancer patients were less likely to use one or more of the supplements in the previous 10 years compared with controls. Men with recurrent cancers were almost twice as likely to be 10-year users compared with other cancer types (OR = 1·98; 95 % CI 1·33, 2·96). Women with new (OR = 0·81; 95 % CI 0·67, 0·98) and recurrent diagnoses (OR = 0·64; 95 % CI 0·44, 0·91) were less likely to use one or more supplements in the previous 10 years compared with benign cases. No other associations were significant.

Detailed descriptions of individual supplement use by cancer type and diagnosis are presented in the online supplementary material, Supplementary Tables S1–S13.

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Table 4 Sociodemographic and lifestyle factors associated with dietary supplement use among participants (*n* 8096) of the databank and biorepository at a comprehensive cancer centre in western New York, USA, December 2003–July 2012

	Lifetime		10 years	
	OR	95 % CI	OR	95 % CI
Age				
≤30 years	1·00	Reference	1·00	Reference
31–45 years	1·85	1·47, 2·33	1·71	1·37, 2·12
46–60 years	2·75	2·23, 3·40	2·17	1·78, 2·64
61–75 years	4·19	3·39, 5·19	3·15	2·58, 3·85
≥76 years	3·73	2·91, 4·79	2·59	2·04, 3·30
Race/ethnicity				
Non-Hispanic Whites	1·00	Reference	1·00	Reference
Non-Hispanic Blacks	0·69	0·54, 0·87	0·77	0·60, 0·97
Hispanics	0·64	0·41, 1·00	0·66	0·42, 1·03
Others	0·80	0·57, 1·12	0·69	0·49, 0·98
Gender				
Male	1·00	Reference	1·00	Reference
Female	1·97	1·79, 2·16	1·67	1·52, 1·84
Education				
Less than high school	1·00	Reference	1·00	Reference
High school/GED	1·28	1·04, 1·57	0·98	0·79, 1·20
Some college	1·46	1·19, 1·78	1·33	1·09, 1·63
College degree	1·44	1·17, 1·77	1·26	1·02, 1·55
Advanced degree	1·95	1·58, 2·42	1·82	1·46, 2·27
Family history of cancer				
No	1·00	Reference	1·00	Reference
Yes	1·28	1·17, 1·40	1·31	1·19, 1·44
Smoker status				
Never	1·00	Reference	1·00	Reference
Former	1·11	1·01, 1·22	1·11	1·01, 1·23
Current	0·60	0·52, 0·69	0·56	0·49, 0·65
BMI category (kg/m^2)				
Underweight (<18·5)	1·00	Reference	1·00	Reference
Normal weight (18·5–24·9)	0·94	0·65, 1·37	0·85	0·57, 1·26
Overweight (25·0–29·9)	0·87	0·60, 1·27	0·86	0·54, 1·27
Obese (≥30·0)	0·77	0·53, 1·12	0·81	0·54, 1·20
Fruit and vegetables (servings/d)				
1st quartile (<2·05)	1·00	Reference	1·00	Reference
2nd quartile (2·05–3·45)	1·41	1·25, 1·60	1·38	1·22, 1·57
3rd quartile (3·46–5·41)	2·02	1·78, 2·29	1·83	1·61, 2·08
4th quartile (>5·41)	2·50	2·20, 2·84	2·43	2·13, 2·77
Physical activity†				
Much less active	1·00	Reference	1·00	Reference
Less active	0·74	0·56, 0·98	0·68	0·50, 0·92
About the same	1·08	0·83, 1·42	0·84	0·63, 1·12
More active	1·23	0·94, 1·61	0·96	0·72, 1·27
Much more active	1·13	0·85, 1·49	1·00	0·75, 1·35

GED, General Educational Development.
†Perceived level of physical activity compared with others of similar age.

Discussion

The purpose of the present study was to describe the prevalence, patterns and predictors of dietary supplement use in cancer patients and cancer-free controls participating in the DBBR at RPCI. Overall use was high in our sample of DBBR participants. We found that multivitamin use was reported by more than half of our sample whereas it was previously estimated that multivitamin formulations are used only by about one-third of all US adults[28]. In addition, the prevalence of herbal/specialty supplement use in the present analysis (35·6 %) was twice as much as estimates from the 2007 National Health Interview Survey (NHIS), which indicated that only 17·7 % of US adults used non-vitamin, non-mineral, natural products within the previous 12 months[29].

Differences in the prevalence of dietary supplement use among cancer patients and cancer-free individuals in our study differed from previous reports. In our study, cancer-free controls exhibited higher dietary supplement use compared with cancer patients in both lifetime (controls *v.* patients: 55·7 % *v.* 53·8 %) and 10-year analyses (controls *v.* patients: 66·8 % *v.* 61·2 %). In contrast, dietary supplement use was reported to be higher among the cancer community[1–5] and use among the healthy population was estimated to be only a little more than half

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Table 5 Associations between cancer variables and lifetime, 10-year and current multivitamin use among participants of the databank and biorepository at a comprehensive cancer centre in western New York, USA, December 2003–July 2012

	Lifetime				10 years				Current†			
	Men		Women		Men		Women		Men		Women	
	OR‡	95 % CI	OR‡	95 % CI	OR‡	95 % CI	OR‡	95 % CI	OR‡	95 % CI	OR‡	95 % CI
Cancer status§												
Controls	1·00	Reference	1·00	Reference	1·00	Reference	1·00	Reference	1·00	Reference	1·00	Reference
Patients	0·87	0·71, 1·06	0·91	0·79, 1·04	0·86	0·70, 1·06	0·85	0·74, 0·99	0·78	0·64, 0·95	0·86	0·76, 0·97
Cancer type‖												
Benign	1·00	Reference	1·00	Reference	1·00	Reference	1·00	Reference	1·00	Reference	1·00	Reference
New	0·95	0·72, 1·25	0·79	0·64, 0·96	0·93	0·70, 1·23	0·81	0·65, 1·00	0·85	0·65, 1·12	0·79	0·66, 0·95
Recurrent	1·42	0·96, 2·12	0·80	0·54, 1·17	1·31	0·88, 1·97	0·70	0·47, 1·03	1·07	0·73, 1·56	0·80	0·56, 1·12
Cancer site‖												
Breast¶	1·32	0·44, 3·96	1·05	0·89, 1·23	2·18	0·60, 7·87	1·02	0·86, 1·20	1·30	0·46, 3·68	1·03	0·89, 1·19
Prostate¶	0·99	0·81, 1·19		N/A	1·00	0·82, 1·21		N/A	1·03	0·86, 1·24		N/A
Respiratory¶	1·03	0·78, 1·36	1·01	0·75, 1·35	0·96	0·72, 1·27	0·91	0·68, 1·23	1·08	0·82, 1·42	1·07	0·82, 1·40
Gastrointestinal¶	1·21	0·94, 1·56	0·81	0·61, 1·05	1·19	0·92, 1·54	0·89	0·67, 1·19	1·10	0·86, 1·40	0·78	0·60, 1·00
Gynaecological¶		N/A	0·91	0·76, 1·10		N/A	0·94	0·77, 1·14		N/A	1·07	0·90, 1·27
Genitourinary¶	0·96	0·75, 1·24	0·94	0·67, 1·33	0·96	0·74, 1·24	0·87	0·61, 1·24	0·94	0·73, 1·20	0·84	0·61, 1·15
Skin¶	0·91	0·62, 1·33	1·62	1·03, 2·55	0·99	0·67, 1·45	1·66	1·02, 2·70	0·87	0·60, 1·26	1·11	0·76, 1·62
Others††	0·86	0·66, 1·13	1·13	0·85, 1·50	0·87	0·66, 1·14	1·19	0·88, 1·61	0·90	0·69, 1·17	1·03	0·80, 1·33
Cancer stage‡‡												
In situ	1·00	Reference	1·00	Reference	1·00	Reference	1·00	Reference	1·00	Reference	1·00	Reference
Localized	2·08	0·90, 4·82	0·83	0·59, 1·17	2·00	0·86, 4·61	0·97	0·69, 1·38	2·29	0·82, 5·66	0·87	0·65, 1·18
Regional	1·71	0·73, 4·00	0·70	0·49, 1·01	1·68	0·72, 3·93	0·89	0·62, 1·38	2·08	0·84, 5·20	0·76	0·55, 1·05
Distant	1·92	0·81, 4·55	0·73	0·49, 1·08	1·63	0·69, 3·85	0·94	0·63, 1·40	2·03	0·80, 5·11	0·63	0·44, 0·89
Unknown	2·49	1·04, 5·96	0·77	0·49, 1·20	1·99	0·83, 4·75	1·10	0·69, 1·74	2·36	0·93, 5·99	0·95	0·64, 1·42

N/A, not applicable.
†Use at the time of enrolment into the databank and biorepository.
‡Adjusted for age, race, education, family hx cancer, smoker status, BMI, total fruit and vegetable intake, physical activity.
§Overall *n* 8096 (men = 2787; women = 5309).
‖Cancer patients only (overall = 5418: men = 2145; women = 3273).
¶Odds ratio compared with all other cancer sites or stages.
††Odds ratio compared with all previously reported cancer sites.
‡‡Cancer patients with malignancies (overall = 4494: men = 1890; women = 2604).

Table 6 Associations between cancer variables and any use of vitamin C, vitamin E and/or calcium over the lifetime among participants of the databank and biorepository at a comprehensive cancer centre in western New York, USA, December 2003–July 2012

	Men		Women	
	OR†	95 % CI	OR†	95 % CI
Cancer status‡				
Controls	1·00	Reference	1·00	Reference
Patients	0·86	0·70, 1·05	0·88	0·78, 1·00
Cancer type§				
Benign	1·00	Reference	1·00	Reference
New	0·83	0·63, 1·10	0·87	0·72, 1·05
Recurrent	1·37	0·93, 2·02	0·84	0·59, 1·21
Cancer site§				
Breast‖	0·83	0·28, 2·42	1·04	0·89, 1·21
Prostate‖	1·17	0·97, 1·42	N/A	
Respiratory‖	1·02	0·77, 1·35	0·99	0·75, 1·32
Gastrointestinal‖	0·83	0·65, 1·07	0·83	0·64, 1·07
Gynaecological‖	N/A		0·99	0·82, 1·18
Genitourinary‖	0·86	0·66, 1·11	0·99	0·82, 1·18
Skin‖	0·99	0·67, 1·46	1·36	0·91, 2·03
Others¶	1·05	0·80, 1·38	1·04	0·80, 1·39
Cancer stage††				
In situ	1·00	Reference	1·00	Reference
Localized	1·20	0·52, 2·80	0·81	0·59, 1·11
Regional	0·90	0·38, 2·12	0·73	0·52, 1·02
Distant	0·98	0·41, 2·32	0·75	0·52, 1·08
Unknown	1·15	0·48, 2·75	0·80	0·53, 1·22

N/A, not applicable.
†Adjusted for age, race, education, family history of cancer, smoker status, BMI, total fruit and vegetable intake, physical activity.
‡Overall *n* 8096 (men = 2787; women = 5309).
§Cancer patients only (overall = 5418: men = 2145; women = 3273).
‖Odds ratio compared with all other cancer sites or stages.
¶Odds ratio compared with all previously reported cancer sites.
††Cancer patients with malignancies (overall = 4494: men = 1890; women = 2604).

from NHANES data[6,30]. However, it was also reported that use did not differ between cancer survivors and cancer-free controls in the VITAL study[31].

The variation among reports can be attributed to differences in the study sample and the types and number of supplements assessed. The high prevalence of use in cancer-free controls in our sample may be explained by the potential self-selection bias inherent in recruitment of participants into the DBBR. The cancer-free participants may have been overrepresented by healthier individuals who are more motivated to participate in cancer research, as many were recruited from local health fairs and cancer events and may have higher interest in disease prevention. In addition, at the time of recruitment of cancer patients, participation was also offered to any family members in the room with the patient, which is reflected in the 64 % of cancer-free controls with a family history of cancer. A positive family history of cancer was a significant predictor of supplement use in the present study. A previous report indicated that unaffected men with brothers diagnosed with prostate cancer exhibit similar prevalence of use, with about 30 % reporting use of one or more prostate-related dietary supplements[21].

The prevalence of use among our sample of cancer patients (lifetime: 53·8 %, 10 years: 61·2 %) was comparable to previous reports. Use among cancer patients ranged from 62 % to 78 % in previous studies in similar settings[15,32,33]. Lower use was observed in newly diagnosed cancer patients compared with controls and patients with a benign or recurrent diagnosis, possibly because of physician recommendations to stop supplementation during treatment[24]. Zirpoli *et al.* reported that physicians' recommendations regarding supplementation significantly influenced patients' decisions regarding initiating/terminating supplementation compared with those who did not receive any recommendation[24]. Although we queried lifetime and 10-year use, recall may be affected by current practices, or patients with advanced cancer diagnoses may be hesitant to report prior supplement use.

Multivitamins were the most commonly used lifetime and 10-year supplement whereas vitamin C, calcium and fish oil were the most common single vitamin, mineral and herbal/specialty products used within the previous 10 years, respectively. These findings parallel those previously reported[4,18,29,30,34]. In their analysis of 11 956 adults from the 2007–2010 NHANES, Bailey *et al.* found that multivitamin–mineral products were the most frequently reported supplement taken, followed by calcium and fish oil. Use of calcium supplements is usually common among women and about 36 % of the women in the cohort reported taking calcium

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Table 7 Associations between cancer variables and any use of single vitamins, minerals, herbals and/or specialty supplements in the previous 10 years among participants of the databank and biorepository at a comprehensive cancer centre in western New York, USA, December 2003–July 2012

	Men		Women	
	OR†	95 % CI	OR†	95 % CI
Cancer status‡				
Controls	1·00	Reference	1·00	Reference
Patients	0·73	0·60, 0·89	0·75	0·65, 0·86
Cancer type§				
Benign	1·00	Reference	1·00	Reference
New	1·01	0·77, 1·33	0·81	0·67, 0·98
Recurrent	1·98	1·33, 2·96	0·64	0·44, 0·91
Cancer site§				
Breast‖	0·53	0·18, 1·52	1·05	0·90, 1·22
Prostate‖	1·39	1·15, 1·68		N/A
Respiratory‖	0·92	0·70, 1·22	1·11	0·83, 1·49
Gastrointestinal‖	0·93	0·73, 1·19	0·90	0·69, 1·17
Gynaecological‖		N/A	1·01	0·84, 1·22
Genitourinary‖	0·86	0·67, 1·11	0·99	0·70, 1·39
Skin‖	0·83	0·57, 1·21	0·997	0·66, 1·44
Others¶	0·82	0·63, 1·07	0·88	0·67, 1·15
Cancer stage††				
In situ	1·00	Reference	1·00	Reference
Localized	2·09	0·89, 4·90	0·96	0·69, 1·32
Regional	1·65	0·70, 3·91	0·92	0·65, 1·29
Distant	1·48	0·62, 3·54	0·73	0·50, 1·05
Unknown	1·84	0·76, 4·44	0·94	0·61, 1·43

N/A, not applicable.
†Adjusted for age, race, education, family history cancer, smoker status, BMI, total fruit and vegetable intake, physical activity.
‡Overall *n* 8096 (men = 2787; women = 5309).
§Cancer patients only (overall = 5418: men = 2145; women = 3273).
‖Odds ratio compared with all other cancer sites or stages.
¶Odds ratio compared with all previously reported cancer sites.
††Cancer patients with malignancies (overall = 4494: men = 1890; women = 2604).

products for bone health[34]. High use of vitamin C and fish oil coincides with increasing promotion for the role of antioxidants and *n*-3 fatty acids in cancer prevention. Fish oil was the most commonly used natural product reported by US adults in the 2007 NHIS[29] and consumer use of fish oil increased more quickly than that of all other supplements in 2007[35].

Consistent with previous studies, we found that dietary supplement use was associated with certain demographic and lifestyle factors. Supplement users were more likely to be female, non-Hispanic White, older in age, have higher education, be more physically active, have lower BMI, and tend to have healthier diets[7,8,11,23,29,30,36]. As previously mentioned, individuals with a family history of cancer were more likely to be users than those without[21]. Additionally, supplement use was inversely associated with current smoker status[7,29,30].

There are limitations to the conclusions we can draw from these analyses. This sample may not be descriptive of the general US population because it is a self-selected group of participants in one geographical region. Thus, there are few studies to which we can compare our findings. Comparison among studies is also complicated by the types and number of supplements assessed, including variability in source and dose. However, the current study's strength is in its sample size and diversity in cancer anatomic sites. These analyses suggest that this population of cancer patients may not be taking more supplements, overall, than cancer-free controls.

Conclusion

Despite differences in supplements assessed, assessment tools, as well as study samples, a consistently high and increasing prevalence of supplement use over time remains clear. Dietary supplement use is prevalent among cancer patients and may even be higher than predicted in cancer-free individuals. Health-care professionals should be receptive to questions and be well prepared to initiate conversations with patients about their use of dietary supplements. The American Institute for Cancer Research nutritional guidelines do not recommend dietary supplements for daily use and do not recommend supplements for cancer prevention[37]. Similarly, the American Cancer Society and the National Institutes of Health Office of Dietary Supplements do not recommend routine use of nutritional supplements, especially those in high doses[38,39]. Given the prevalence of use of dietary supplements, and the limited knowledge regarding the risks and benefits of these supplements, further studies should assess the safety and efficacy of the specific cancer-supplement combinations.

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Supplementary material

To view supplementary material for this article, please visit http://dx.doi.org/10.1017/S1368980014001062

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