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Research Paper

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Vitamin/mineral and non-vitamin/non-mineral supplement use of breast cancer survivors in Korea

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ABSTRACT

BACKGROUND/OBJECTIVES: Dietary supplement use is common among breast cancer survivors, but studies on Asian populations remain limited. This study investigated dietary supplement use among Korean breast cancer survivors, distinguishing between vitamin/mineral (VM) and non-vitamin/non-mineral (NVNM) supplements.
SUBJECTS/METHODS: This cross-sectional study included 1,136 stage I–III breast cancer survivors from 12 Korean hospitals, who survived more than 6 mon post-surgery. The participants completed a questionnaire on post-diagnostic dietary supplement use. Stepwise logistic regression was applied, calculating odds ratios (ORs) and 95% confidence intervals (CIs) to identify the demographic and clinical factors associated with VM and NVNM use.
RESULTS: Seventy percent of survivors reported supplement use, with 25% using a single product. The most common VM supplements were multivitamins/minerals, vitamin D, and vitamin C, while the most common NVNM supplements included omega-3 fatty acids, probiotics, and ginseng. Survivors with higher education and greater physical activity were more likely to use VM supplements (ORs [95% CIs], 2.74 [1.76–4.25] for college graduates

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Conflict of Interest

The authors declare no potential conflicts of interests.

Author Contributions

Conceptualization: Kang J, Lee JE[1]; Formal analysis: Kang J, Youn J; Investigation: Youn J, Cho HJ, Moon HG, Noh DY, Jung SY, Lee ES, Kim Z, Youn HJ, Cho J, Yoo YB, Lee SK, Lee JE[2], Nam SJ, Min JW, Kim YS, Lee J, Park S, Jeong J, Lee JE[1]; Methodology: Kang J, Lee JE[1]; Supervision: Lee JE[1]; Writing - original draft: Kang J; Writing - review & editing: Youn J, Cho HJ, Moon HG, Noh DY, Jung SY, Lee ES, Kim Z, Youn HJ, Cho J, Yoo YB, Lee SK, Lee JE[2], Nam SJ, Min JW, Kim YS, Lee J, Park S, Jeong J, Lee JE[1].

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or above vs. middle school or below; 1.38 [1.02–1.88] for the most active group vs. the least active group). NVNM use was associated with higher education, greater physical activity levels, and a history of smoking (ORs [95% CIs], 2.29 [1.46–3.58] for college graduates or above vs. middle school or below; 1.52 [1.13–2.06] for the most active group vs. the least active group; 2.00 [1.23–3.25] for ever smokers vs. never smokers). Survivors who had undergone chemotherapy were also more likely to use NVNM supplements than those who had not (OR [95% CI], 1.37 [1.02–1.84]).

CONCLUSION: Seventy percent of Korean breast cancer survivors used dietary supplements in this study. VM use was associated with higher education and physical activity, while higher NVNM use was associated with higher education, greater physical activity, a history of smoking, and chemotherapy.

Keywords: Breast neoplasms; dietary supplements; vitamins; minerals; cancer survivors

INTRODUCTION

Breast cancer is one of the most diagnosed cancers, accounting for 24.5% of cancer incidence in women worldwide [1]. In Korea, the age-standardized incidence rate of breast cancer among women was 59.9 per 100,000 in 2020, with survival rates increasing from 79.3% in 1993–1995 to 93.8% in 2016–2020 [2].

Dietary supplement use is highly prevalent among cancer survivors, particularly breast cancer survivors, ranging from 67% to 87% in the United States and France [3,4], and 55.9% among Korean breast cancer survivors [5]. Previous studies suggest that the decision to use dietary supplements is influenced by various demographic, lifestyle, and clinical factors, including body mass index (BMI), education level, type of treatment, or type of tumor [6-9]. Commonly used supplements include vitamin/mineral (VM) supplements taken to improve overall health, and non-vitamin/non-mineral (NVNM) supplements, such as probiotics, omega-3 fatty acids, and red ginseng, which are often consumed for targeted benefits such as relaxation, sleep, or joint health [5,9-13]. Importantly, the types of NVNM supplements vary across cultures, with red ginseng commonly used in Korea, joint supplements favored by Caucasian and Japanese Americans, and lime and oregano extracts popular among Hispanics [5,14,15].

Despite the widespread use, previous studies have reported that communication gaps between patients and healthcare providers regarding supplements use are common, particularly with NVNM supplements [16-18]. This is concerning for cancer survivors, who often undergo complex treatment regimens, given the potential risks of interactions with medications and the limited evidence on the safety of many NVNM supplements [19-21].

Most existing research either aggregates VM and NVNM supplements or focuses primarily on Western populations [3,5-9,22-24], leaving gaps in understanding culturally specific patterns of use. Therefore, to address these limitations, this study explicitly differentiated between VM and NVNM supplements to investigate their post-diagnostic use among Korean breast cancer survivors. Specifically, we aimed to explore how distinct demographic, lifestyle, and clinical factors were associated with the use of specific supplement types within this culturally distinct population. Understanding these patterns is essential for clinical practitioners to develop tailored nutritional interventions and facilitate proactive, informed patient-provider discussions during survivorship care.

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SUBJECTS AND METHODS

Study population

This cross-sectional study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology Statement [25]. This study recruited 1,149 participants between 2012 and 2023 across 12 hospitals in Korea. The inclusion criteria were as follows: 1) diagnosis with stage I–III breast cancer as a primary cancer; 2) more than 6 mon of survival after surgery; 3) no recurrence or metastasis; and 4) no history of other cancers prior to consent. Among these eligible survivors, those who did not complete the dietary supplement questionnaire (n = 13) were excluded. As a result, 1,136 breast cancer survivors were included in the analysis. The study was approved by the Institutional Review Board of Seoul National University Hospital (H-1111-080-387), National Cancer Center (NCC2014-0101), Soonchunhyang University Bucheon Hospital (SCHBC2014-12-004-001), Jeonbuk National University Hospital (CUH2014-05-002-005, CUH2018-02-004-004), Keimyung University Dongsan Medical Center (DSMC2015-03-026-012, DSMC2015-03-026-017), Konkuk University Hospital (KUH1020068), Samsung Medical Center (SMC2016-07-073-004), Chosun University Hospital (CHOSUN 2016-06-022-001, CHOSUN 2018-06-004-001), Dankook University Hospital (DKUH 2016-07-001-002, DKUH 2020-10-003-008), Soonchunhyang University Seoul Hospital (SCHUH 2020-05-009-002), and Yonsei University Health System, Severance Hospital (4-2020-1239), and Yonsei University Gangnam Severance Hospital (3-2020-0428). All participants provided written informed consent.

Assessment of dietary supplement use

The breast cancer survivors reported their post-diagnosis dietary supplement use via a structured, open-ended questionnaire, which collected the type, name, and brand of each product. Supplements were categorized into 2 groups: VM and NVNM supplements. VM supplements were further classified according to their components. Products containing 2 to 9 vitamins or minerals were categorized into each relevant group, provided that the content of each vitamin or mineral met at least 30% of the Nutrient Reference Value, as specified by the Health Functional Food Code of the Korean Ministry of Food and Drug Safety [26]. Products containing ten or more vitamins or minerals were defined as multivitamins/minerals supplements [27]. Both prescription and over-the-counter medicines intended to provide vitamins or minerals were included.

NVNM supplements included substances derived from natural sources other than vitamins and minerals, such as omega-3 fatty acids, coenzyme Q10, probiotics, and herbs. Pills, powders, extracts, or liquid forms were included, whereas homemade decoctions or juices were excluded. Products with multiple components were categorized into each relevant group. If the product name or brand was missing, it was classified solely according to the type of supplement reported by the participant (n = 416, 36.6%).

Assessment of sociodemographic and clinical factors

The demographic variables were collected via a structured questionnaire, including age at consent, self-reported height and weight, smoking status, marital status, alcohol consumption, physical activity, educational level, and menopausal status at consent. Physical activity was quantified as total metabolic equivalent (MET)-hours per week, based on the type, duration, and frequency of reported activities [28]. BMI was calculated as weight in kilograms divided by height in meters squared. When current weight or height was missing, values at diagnosis from medical records were used (n = 20). Clinical information was

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collected from hospital medical records with consent, including American Joint Committee on Cancer (AJCC) stage at diagnosis, hormone receptor (HR) status (estrogen receptor [ER] and progesterone receptor [PR]), treatments received (chemotherapy, hormone therapy and radiotherapy), menopausal status at diagnosis, and history of chronic diseases (hypertension, diabetes and cardiovascular disease) before diagnosis. HR positivity was defined as ER positivity, PR positivity, or both. Time since surgery was calculated from the date of surgery to the date of informed consent.

Statistical analysis

The number of dietary supplements used concurrently was calculated, and the proportions of specific VM and NVNM supplements used after diagnosis were examined. Logistic regression was applied to assess whether the sociodemographic and clinical factors were independently associated with VM or NVNM use. Model 1 was adjusted for age at consent (< 50, ≥ 50 and < 60, and ≥ 60 yrs) and study center. Model 2 was further developed using factors selected through stepwise logistic regression, with demographic and clinical variables entered into and removed from the model at a *P*-value threshold of 0.1. The final model 2 included education level (middle school or below, high school and college or above), physical activity (< 15, ≥ 15 and < 30, and ≥ 30 MET-hours/week), AJCC stage (I, II and III; VM only), smoking status (never and ever; NVNM only), and chemotherapy (never and ever; NVNM only). Associations of chemotherapy, education, and physical activity with the use of specific supplement types were also examined. Because the proportion of missing values was less than 5%, missing values were assigned to the most frequent category, and missing smoking data were assigned to the 'never smokers' category. All statistical tests were 2-tailed, with *P*-values < 0.05 considered significant. Analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC, USA).

RESULTS

Participant characteristics and the prevalence of dietary supplement use

Table 1 presents the demographic and clinical characteristics of participants. The mean age and BMI were 52.0 yrs and 23.1 kg/m^2, respectively. Overall, 79.5% were married or cohabiting, 34.5% had attained at least a college education, and 36.6% engaged in ≥ 30 MET-hours of exercise per week. In addition, 62.1% were premenopausal, 50.8% were diagnosed with stage I breast cancer, and 79.3% were HR positive. Chemotherapy and hormone therapy were reported by 73.0% and 76.2% of survivors, respectively, whereas 52.1% received radiotherapy and 15.1% had a history of chronic disease before diagnosis. Participant characteristics according to VM and NVNM use are also presented in **Table 1**.

Among 1,136 breast cancer survivors, 69.8% (n = 793) reported dietary supplement use. Specifically, 25.4% (n = 289) used a single product and 44.4% (n = 504) used 2 or more products concurrently (**Table 2**). Among these 793 users, 82.3% (n = 653) used VM supplements, 63.6% (n = 504) used NVNM supplements, and 45.9% (n = 364) used both. The 5 most commonly used VM supplements were multivitamins/minerals (53.3% among VM supplement users), vitamin D (38.6%), vitamin C (38.1%), calcium (20.4%), and vitamin B1 (12.3%) (**Table 3**). The 5 most common NVNM supplements used were omega-3 fatty acids (38.7% among NVNM supplement users), probiotics (27.6%), ginseng (19.8%), propolis (12.9%), and lutein (9.7%).

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Table 1. Demographic and clinical characteristics of the study participants

Characteristics	All	Any VM		Any NVNM	
		User	Non-user	User	Non-user
No.	1,136	653	483	504	632
Age at consent (yrs)	52.0 ± 8.2	52.0 ± 7.7	52.1 ± 8.9	51.7 ± 7.9	52.3 ± 8.5
BMI (kg/m^2)	23.1 ± 3.0	23.0 ± 2.9	23.3 ± 3.0	23.1 ± 3.0	23.1 ± 3.0
Marital status					
Unmarried, divorced, widowed	231 (20.5)	127 (19.6)	104 (21.7)	105 (21.0)	126 (20.1)
Married or cohabiting	896 (79.5)	521 (80.4)	375 (78.3)	395 (79.0)	501 (79.9)
Education level					
Middle school or below	182 (16.1)	72 (11.1)	110 (23.0)	60 (12.0)	122 (19.4)
High school	558 (49.4)	325 (49.9)	233 (48.6)	242 (48.3)	316 (50.2)
College or above	390 (34.5)	254 (39.0)	136 (28.4)	199 (39.7)	191 (30.4)
Physical activity (MET-hours/week)					
< 15	404 (35.6)	208 (31.8)	196 (40.6)	157 (31.2)	247 (39.1)
≥ 15 and < 30	316 (27.8)	194 (29.8)	122 (25.3)	140 (27.8)	176 (27.8)
≥ 30	416 (36.6)	251 (38.4)	165 (34.2)	207 (41.1)	209 (33.1)
Alcohol drinking status					
Non-drinkers	900 (79.7)	523 (80.6)	377 (78.4)	403 (80.3)	497 (79.1)
Current drinkers	230 (20.3)	126 (19.4)	104 (21.6)	99 (19.7)	131 (20.9)
Smoking status					
Never smokers	1,000 (92.3)	565 (91.9)	435 (92.8)	429 (90.1)	571 (93.9)
Ever smokers	84 (7.7)	50 (8.1)	34 (7.2)	47 (9.9)	37 (6.1)
Menopausal status at diagnosis					
Premenopausal	702 (62.1)	402 (61.7)	300 (62.8)	310 (61.7)	392 (62.4)
Postmenopausal	428 (37.9)	250 (38.3)	178 (37.2)	192 (38.3)	236 (37.6)
AJCC stage at diagnosis					
I	577 (50.8)	332 (50.8)	245 (50.8)	269 (53.4)	308 (48.8)
II	444 (39.2)	267 (40.9)	177 (36.7)	187 (37.1)	257 (40.7)
III	114 (10.0)	54 (8.3)	60 (12.4)	48 (9.5)	66 (10.5)
Time since surgery (yrs)					
≥ 0.5 and < 2	407 (35.8)	225 (34.4)	182 (37.7)	178 (35.3)	229 (36.2)
≥ 2 and < 5	365 (32.1)	214 (32.8)	151 (31.3)	156 (31.0)	209 (33.1)
≥ 5	364 (32.1)	214 (32.8)	150 (31.1)	170 (33.7)	194 (30.7)
ER status					
Negative	255 (22.5)	133 (20.4)	122 (25.3)	111 (22.1)	144 (22.8)
Positive	879 (77.5)	519 (79.6)	360 (74.7)	392 (77.9)	487 (77.2)
HR status[1)]					
Negative	235 (20.7)	121 (18.6)	114 (23.7)	108 (21.5)	127 (20.1)
Positive	899 (79.3)	531 (81.4)	368 (76.3)	395 (78.5)	504 (79.9)
Chemotherapy					
Never	307 (27.0)	174 (26.7)	133 (27.5)	131 (26.0)	176 (27.8)
Ever	829 (73.0)	479 (73.3)	350 (72.5)	373 (74.0)	456 (72.2)
Hormone therapy					
Never	270 (23.8)	151 (23.1)	119 (24.6)	134 (26.6)	136 (21.5)
Ever	866 (76.2)	502 (76.9)	364 (75.4)	370 (73.4)	496 (78.5)
Radiotherapy					
Never	544 (47.9)	327 (50.1)	217 (44.9)	250 (49.6)	294 (46.5)
Ever	592 (52.1)	326 (49.9)	266 (55.1)	254 (50.4)	338 (53.5)
History of chronic disease before diagnosis[2)]					
No	964 (84.9)	565 (86.7)	399 (82.6)	439 (87.3)	525 (83.1)
Yes	171 (15.1)	87 (13.3)	84 (17.4)	64 (12.7)	107 (16.9)

Continuous variables are presented as mean ± SD, and categorical variables as number (%).
Missing data: n = 9 for marital status, n = 6 for education level, n = 6 for alcohol drinking status, n = 52 for smoking status, n = 6 for menopausal status, n = 1 for AJCC stage, n = 2 for ER status, n = 2 for HR status, and n = 1 for history of chronic disease before diagnosis.
VM, vitamin/mineral; NVNM, non-vitamin/non-mineral; BMI, body mass index; MET, metabolic equivalent; AJCC, American Joint Committee on Cancer; ER, estrogen receptor; HR, hormone receptor; PR, progesterone receptor.
[1)]HR positivity was defined as having either an ER+ or PR+ subtype.
[2)]Chronic diseases include diabetes, hypertension, or cardiovascular disease.

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Table 2. Number of dietary supplements used among breast cancer survivors (n = 1,136)

Number of dietary supplements used	Values
None	343 (30.2)
1	289 (25.4)
2	196 (17.2)
3	125 (11.0)
4	96 (8.5)
5 or more	87 (7.7)

Values are presented as number (%).

Table 3. Number and proportion of product-specific VM and NVNM supplement use[1)]

Supplement	No.	All participants (%)	VM/NVNM users (%)
VM		(n = 1,136)	(n = 653)
Multivitamins/minerals	348	30.6	53.3
Vitamin D	252	22.2	38.6
Vitamin C	249	21.9	38.1
Calcium	133	11.7	20.4
Vitamin B1	80	7.0	12.3
Vitamin E	75	6.6	11.5
Vitamin B6	72	6.3	11.0
Vitamin B2	69	6.1	10.6
Magnesium	49	4.3	7.5
Zinc	34	3.0	5.2
Selenium	23	2.0	3.5
NVNM		(n = 1,136)	(n = 504)
Omega-3 fatty acids	195	17.2	38.7
Probiotics	139	12.2	27.6
Ginseng	100	8.8	19.8
Propolis	65	5.7	12.9
Lutein	49	4.3	9.7
Spirulina/Chlorella	26	2.3	5.2
Collagen	26	2.3	5.2
Coenzyme Q10	24	2.1	4.8
Onion	17	1.5	3.4
Mushroom	15	1.3	3.0

VM, vitamin/mineral; NVNM, non-vitamin/non-mineral.
[1)]Supplements were counted in each relevant category if they contained 2 or more types of vitamins or minerals. For example, a supplement containing both vitamin D and zinc was counted in both the vitamin D category and the zinc category.

Associations of demographic and clinical factors with VM/NVNM supplement use

This study examined how various demographic and clinical factors were associated with the use of specific supplement categories to identify the key determinants of supplement use among Korean breast cancer survivors (**Table 4**). VM use was associated with higher education and greater physical activity. Compared with survivors with a middle school education or below, the odds of VM use were higher among high school graduates (odds ratio [OR], 2.06; 95% confidence interval [CI], 1.38–3.09) and college graduates or above (OR, 2.74; 95% CI, 1.76–4.25). Survivors engaging in ≥ 30 MET-hours of exercise per week were more likely to use VM supplements than those exercising < 15 MET-hours per week (OR, 1.38; 95% CI, 1.02–1.88). There was also a suggestive inverse association between AJCC stage and VM use, with stage III survivors being less likely to use VM supplements than stage I survivors (OR, 0.67; 95% CI, 0.43–1.04).

NVNM use was more common among survivors with higher education, greater physical activity, a history of smoking, and those who had undergone chemotherapy. Compared with survivors with a middle school education or below, NVNM use was higher among high

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Table 4. ORs and 95% CIs for associations of demographic and clinical factors with any VM or NVNM supplements use

Characteristics	Any VM supplements (n = 653)			Any NVNM supplements (n = 504)		
	No. of VM users/total	Age, center-adjusted model[1]	Multivariate model[2]	No. of NVNM users/total	Age, center-adjusted model[1]	Multivariate model[2]
Age at consent (yrs)						
< 50	248/435	1.00	1.00	192/435	1.00	1.00
≥ 50 and < 60	305/509	1.13 (0.86–1.48)	1.27 (0.95–1.69)	234/509	1.11 (0.85–1.44)	1.26 (0.95–1.67)
≥ 60	100/192	0.87 (0.61–1.25)	1.11 (0.74–1.68)	78/192	0.84 (0.58–1.20)	1.00 (0.67–1.51)
BMI (kg/m^2)						
< 23	363/611	1.00		273/611	1.00	
≥ 23 and < 25	156/269	1.02 (0.75–1.39)		117/269	1.00 (0.74–1.35)	
≥ 25	134/256	0.73 (0.54–1.00)		114/256	0.99 (0.73–1.34)	
Marital status						
Unmarried, divorced, widowed	127/231	1.00		105/231	1.00	
Married or cohabiting	521/896	1.10 (0.81–1.50)		395/896	0.95 (0.70–1.28)	
Education level						
Middle school or below	72/182	1.00	1.00	60/182	1.00	1.00
High school	325/558	2.07 (1.42–3.01)	2.06 (1.38–3.09)	242/558	1.50 (1.03–2.19)	1.67 (1.10–2.52)
College or above	254/390	2.71 (1.80–4.10)	2.74 (1.76–4.25)	199/390	1.88 (1.25–2.83)	2.29 (1.46–3.58)
Physical activity (MET-hours/week)						
< 15	208/404	1.00	1.00	157/404	1.00	1.00
≥ 15 and < 30	194/316	1.53 (1.12–2.09)	1.36 (0.98–1.89)	140/316	1.26 (0.93–1.72)	1.22 (0.88–1.68)
≥ 30	251/416	1.45 (1.08–1.94)	1.38 (1.02–1.88)	207/416	1.59 (1.19–2.11)	1.52 (1.13–2.06)
Alcohol drinking status						
Non-drinkers	523/900	1.00		403/900	1.00	
Current drinkers	126/230	0.88 (0.64–1.19)		99/230	0.99 (0.73–1.34)	
Smoking status						
Never smokers	565/1,000	1.00		429/1,000	1.00	1.00
Ever smokers	50/84	0.89 (0.54–1.44)		47/84	1.75 (1.09–2.81)	2.00 (1.23–3.25)
Menopausal status at diagnosis						
Premenopausal	402/702	1.00		310/702	1.00	
Postmenopausal	250/428	1.09 (0.78–1.52)		192/428	1.01 (0.74–1.40)	
AJCC stage at diagnosis						
I	332/577	1.00	1.00	269/577	1.00	
II	267/444	1.14 (0.88–1.49)	1.19 (0.90–1.57)	187/444	0.88 (0.68–1.14)	
III	54/114	0.66 (0.43–1.01)	0.67 (0.43–1.04)	48/114	0.91 (0.60–1.38)	
Time since surgery (yrs)						
≥ 0.5 and < 2	225/407	1.00		178/407	1.00	
≥ 2 and < 5	214/365	1.07 (0.79–1.46)		156/365	0.91 (0.67–1.24)	
≥ 5 yrs	214/364	1.24 (0.91–1.69)		170/364	1.18 (0.87–1.60)	
ER status						
Negative	133/255	1.00		111/255	1.00	
Positive	519/879	1.25 (0.93–1.67)		392/879	0.99 (0.74–1.32)	
HR status[3]						
Negative	121/235	1.00		108/235	1.00	
Positive	531/899	1.27 (0.94–1.72)		395/899	0.87 (0.65–1.17)	
Chemotherapy						
Never	174/307	1.00		131/307	1.00	1.00
Ever	479/829	1.05 (0.79–1.40)		373/829	1.29 (0.97–1.71)	1.37 (1.02–1.84)
Hormone therapy						
Never	151/270	1.00		134/270	1.00	
Ever	502/866	1.23 (0.91–1.65)		370/866	0.84 (0.63–1.12)	
Radiotherapy						
Never	327/544	1.00		250/544	1.00	
Ever	326/592	1.01 (0.76–1.34)		254/592	1.10 (0.83–1.46)	
History of chronic disease before diagnosis[4]						
No	565/964	1.00		439/964	1.00	
Yes	87/171	0.81 (0.56–1.16)		64/171	0.77 (0.54–1.11)	

Values are presented as odds ratio (95% confidence interval).
VM, vitamin/mineral; NVNM, non-vitamin/non-mineral; BMI, body mass index; MET, metabolic equivalent; AJCC, American Joint Committee on Cancer; ER, estrogen receptor; HR, hormone receptor; PR, progesterone receptor.
[1]Adjusted for age (< 50, ≥ 50 and < 60, and ≥ 60 yrs) and center.
[2]Model 2 was further developed using factors selected through stepwise logistic regression with entry and removal criteria of *P*-value < 0.1.
[3]HR positivity was defined as having either an ER+ or PR+ subtype.
[4]Chronic diseases include diabetes, hypertension, or cardiovascular disease.

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school graduates (OR, 1.67; 95% CI, 1.10–2.52) and college graduates or above (OR, 2.29; 95% CI, 1.46–3.58). Survivors engaging in ≥ 30 MET-hours of exercise per week were more likely to use NVNM products compared with those exercising < 15 MET-hours per week (OR, 1.52; 95% CI, 1.13–2.06). Ever smokers were more likely to use NVNM supplements than never smokers (OR, 2.00; 95% CI, 1.23–3.25). When subdividing according to the smoking status, NVNM use was higher among past smokers but lower among current smokers than never smokers (OR, 2.87; 95% CI, 1.61–5.14 for past smokers; OR, 0.73; 95% CI, 0.27–1.97 for current smokers). Similarly, survivors who had undergone chemotherapy were more likely to use NVNM supplements than those who had not (OR, 1.37; 95% CI, 1.02–1.84).

Associations of demographic and clinical factors with specific supplement types

To provide a more granular understanding of supplement use, we also explored the associations of chemotherapy, education and physical activity with the use of specific supplement types. Ginseng use was more common among survivors who had received chemotherapy than among those who had not, although the association was not statistically significant (OR, 1.46; 95% CI, 0.87–2.45) (**Table 5**). Associations between individual supplements and survivor characteristics, including education level and physical activity, are presented in **Supplementary Tables 1** and **2**.

DISCUSSION

Seventy percent of breast cancer survivors used dietary supplements (82% VM and 64% NVNM supplements among users). Higher education and physical activity were associated with greater use of both types. VM use was suggestively lower among stage III survivors than among stage I survivors, while NVNM use was also common among those with a smoking history. Survivors who had undergone chemotherapy were more likely to

Table 5. ORs and 95% CIs for associations of chemotherapy with specific types of VM or NVNM supplement use

Supplement	No. of supplement users		OR (95% CI)[1]		OR (95% CI)[2]	
	Chemotherapy never	Chemotherapy ever	Chemotherapy never	Chemotherapy ever	Chemotherapy never	Chemotherapy ever
VM						
Multivitamins/minerals	87 (28.3)	261 (31.5)	1.00	1.12 (0.83–1.51)	1.00	1.24 (0.89–1.73)
Vitamin D	73 (23.8)	179 (21.6)	1.00	0.91 (0.64–1.29)	1.00	0.86 (0.58–1.27)
Vitamin C	70 (22.8)	179 (21.6)	1.00	1.02 (0.73–1.42)	1.00	1.09 (0.76–1.57)
Calcium	30 (9.8)	103 (12.4)	1.00	1.19 (0.76–1.86)	1.00	1.46 (0.90–2.38)
Vitamin E	26 (8.5)	49 (5.9)	1.00	0.75 (0.45–1.26)	1.00	0.90 (0.51–1.60)
Vitamin B1	29 (9.5)	51 (6.2)	1.00	0.74 (0.45–1.22)	1.00	0.77 (0.44–1.34)
Vitamin B6	27 (8.8)	45 (5.4)	1.00	0.69 (0.41–1.16)	1.00	0.73 (0.41–1.30)
Vitamin B2	25 (8.1)	44 (5.3)	1.00	0.74 (0.43–1.26)	1.00	0.76 (0.42–1.38)
Magnesium	16 (5.2)	33 (4.0)	1.00	0.97 (0.51–1.83)	1.00	1.13 (0.55–2.29)
NVNM						
Omega-3 fatty acids	51 (16.6)	144 (17.4)	1.00	1.15 (0.80–1.67)	1.00	1.19 (0.83–1.72)
Probiotics	46 (15.0)	93 (11.2)	1.00	1.02 (0.66–1.56)	1.00	1.05 (0.68–1.63)
Ginseng	22 (7.2)	78 (9.4)	1.00	1.43 (0.86–2.38)	1.00	1.46 (0.87–2.45)
Propolis	23 (7.5)	42 (5.1)	1.00	0.73 (0.42–1.26)	1.00	0.73 (0.42–1.28)
Lutein	22 (7.2)	27 (3.3)	1.00	0.55 (0.29–1.02)	1.00	0.56 (0.30–1.06)

Values are presented as number (%).
OR, odds ratio; CI, confidence interval; VM, vitamin/mineral; NVNM, non-vitamin/non-mineral.
[1]Adjusted for age (< 50, ≥ 50 and < 60, and ≥ 60 yrs) and center.
[2]For VM supplements, we additionally adjusted for [1] and education level (middle school or below, high school, college or above), physical activity (< 15, ≥ 15 and < 30, and ≥ 30 MET-hours/week), and AJCC stage (stage I, II, and III). For NVNM supplements, we additionally adjusted for[1] education level (middle school or below, high school, college, or above), physical activity (< 15, ≥ 15 and < 30, and ≥ 30 MET-hours/week), and smoking status (never, ever).

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use NVNM supplements overall, with a non-significant positive trend observed for specific products like ginseng.

The high prevalence of supplement use aligns with previous findings from the US and France, where breast cancer survivors reported rates of 67 to 87% [3,4]. In contrast, the prevalence of supplement use in the general population aged over 50 yrs is lower, at 46.5% to 51% [29], highlighting the higher interest in supplements among breast cancer survivors. The most commonly used VM supplements in this study—multivitamins/minerals (53.3%), vitamin D (38.6%), vitamin C (38.1%), and calcium (20.4%)—were consistent with Western studies, although the prevalence varied. For example, studies from the US and Europe also report that multivitamins and vitamin D are the top choices [3,6,8,30]. In contrast, the use of NVNM supplements showed distinct geographical and cultural variations. Survivors in our study most frequently used omega-3 (38.7%), probiotics (27.6%), ginseng (19.8%), and propolis (12.9%), while survivors in the US frequently used fish oil, turmeric, melatonin, and joint supplements [6,8]. In France, however, the consumption of fiber and polyphenols was more prevalent among breast cancer survivors [3]. In Korea, where ginseng production is high, red ginseng use increased from 2014 to 2018, which may explain its relatively high prevalence among survivors in our study (19.8%), but this was lower than the 33.6%–53.4% reported in previous Korean studies [31-33]. These variations likely reflect cultural differences, national supplement markets, and prevailing health trends.

Importantly, we observed higher NVNM use among survivors who had undergone chemotherapy than among those who had not. A possible explanation for this pattern is that products such as ginseng are perceived to strengthen immunity, boost energy, and alleviate symptoms, including fatigue, insomnia, or anxiety that often follow chemotherapy [13,34,35]. However, this pattern raises concerns because survivors may rely on advice from non-medical sources, including the media or family members, increasing the risk of misuse or overuse [6,16,17,21]. Such concerns are heightened considering the potential pharmacokinetic interactions between NVNM supplements and chemotherapy agents, which may compromise outcomes such as disease-free survival [21,36,37]. These risks are consistent with the guidance from the American Cancer Society and the World Cancer Research Fund, which recommend prioritizing dietary sources for nutritional needs and caution against unregulated supplement use [38,39]. This underscores the need for open, comprehensive communication between healthcare providers and survivors to ensure safe and effective use of supplements, particularly during intensive treatment.

We also observed clear demographic patterns: survivors with higher education were more likely to use multivitamins/minerals, vitamin D, vitamin C, omega-3, and probiotics, while those with higher physical activity were more likely to use vitamin D and magnesium. These findings are consistent with previous studies showing that education and physical activity are positively associated with supplement use [3-5,9]. Furthermore, the higher NVNM use among past smokers than among never smokers is consistent with findings from European studies, which found that past smokers were more likely to use supplements, while no association was observed among current smokers [40-42].

Although the lower VM use among stage III survivors was not statistically significant, this trend is consistent with some studies [24,43] but contrasts with others that reported higher use [33,44,45]. Such variation might be partially explained by family expectations or norms of medical staff regarding supplement use during cancer care [46]. In addition, survivors

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receiving conventional treatments might feel satisfied with their primary care, reducing their perceived need for complementary options [47]. This highlights the need for further investigation into the motivations and contextual factors shaping individual supplement choices among breast cancer survivors.

Our findings underscore the need for evidence-based, individualized survivorship care strategies that address the dietary supplement use patterns of survivors, considering factors such as treatment history and education level. For example, the observed association between chemotherapy and higher NVNM supplement use suggests the importance of targeted nutritional counseling for survivors undergoing treatment. Specifically, clinicians, including dietitians and cancer survivor coordinators, should provide personalized counseling programs to address the perceived benefits and potential risks of NVNM supplements such as ginseng.

Second, cultural factors should also be integrated into survivorship care. The high prevalence of ginseng use in Korea highlights the need for culturally tailored counseling approaches that respect local practices while ensuring patient safety. Third, addressing the communication gaps between healthcare providers and survivors is also crucial for preventing survivors from relying on non-medical sources. Regular counseling sessions and accessible educational resources can empower survivors to make informed decisions.

Finally, these findings highlight the need for future research and clinical guidelines that specifically address supplement-medication interactions. Such efforts are essential for ensuring safe and effective supplement use and improving the long-term outcomes, including disease-free survival, among breast cancer survivors.

This study has several strengths. We provided a detailed, product-specific assessment of VM and NVNM supplement use among Korean breast cancer survivors using open-ended questionnaires to capture diverse products and brands. We also examined the demographic and clinical characteristics associated with supplement use, offering a nuanced understanding of supplement patterns in this population. However, this study also has limitations, including its cross-sectional design, which precluded causal inference. In addition, we did not investigate motivations for supplement use or information sources underlying supplement use, which limited interpretation of product-specific choices. Third, the generalizability of the findings may be limited because the participants were breast cancer survivors recruited from hospitals, which may not fully represent all Korean survivors. Finally, the possibility of residual or unmeasured confounding cannot be entirely ruled out.

In conclusion, 70% of Korean breast cancer survivors in our study reported dietary supplement use after diagnosis. Higher education and greater physical activity were associated with higher use of VM and NVNM supplements. Survivors with stage III cancer showed a tendency toward lower VM use than those with stage I cancer, while NVNM use was more common among those with a history of smoking. Survivors who had undergone chemotherapy also used NVNM supplements more frequently, raising concerns about safety and highlighting the importance of improved provider-patient communication. Further prospective and clinical studies are warranted to explore motivations for supplement use and to evaluate the potential interactions between dietary supplements and cancer treatments. Such evidence will be critical for developing tailored guidance and interventions that ensure safe, effective care for breast cancer survivors.

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SUPPLEMENTARY MATERIALS

Supplementary Table 1

ORs and 95% CIs for associations of education level with specific types of VM or NVNM supplement use

Supplementary Table 2

ORs and 95% CIs for associations of physical activity with specific types of VM or NVNM supplement use

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