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ORIGINAL PAPER

A comparison of cancer screening practices in cancer survivors and in the general population: the Korean national health and nutrition examination survey (KNHANES) 2001–2007

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Abstract
Objective This study aimed to describe cancer screening rates for second primary cancer among cancer survivors in Korea, and to compare these rates with those of two control groups: individuals without a history of cancer but with other chronic diseases, and individuals without a history of cancer and without other chronic diseases.
Methods The study is a cross-sectional analysis of 15,556 adults ≥30 years old who participated in the 2001, 2005, and 2007 Korean National Health and Nutrition Examination Surveys (KNHANES). The prevalence of breast, cervical, gastric, and colorectal cancer screening examinations according to national guidelines was assessed and compared to two control groups.
Results Screening rates among cancer survivors were 48.5, 54.7, 34.7, and 28.6% for breast, cervical, gastric, and colorectal cancer screening, respectively. Cancer survivors showed higher screening rates for all four cancer sites compared with both control groups, but breast cancer screening was only statistically significant after adjusting gender, age, marital status, education, income, working status, health insurance, smoking and drinking status, and self-reported health status.
Conclusions Cancer survivors were more likely than individuals without a cancer history to obtain screening examinations according to recommended guidelines. Still, screening rates even among survivors were suboptimal, emphasizing the need for a more systematic approach to second primary cancer screening and prevention.

Keywords Second cancers · Cancer screening · Prevention · Control · Survivorship

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Introduction

Due to improvements in early detection, supportive care and treatment, the number of cancer survivors in the United States has tripled since 1971 [1]. In 2005, there were nearly 11.1 million cancer survivors in the United States [2]. The 5-year relative survival rate among all cancer patients is around 68% [2]. As survival improves, identification and quantification of the late effects of cancer have become critical [3]. One of the most serious events by cancer survivors is the diagnosis of a new cancer [4]. In the United

States, around 8% of cancer survivors develop a second primary cancer (SPC), and 10% of all new cancers are diagnosed in cancer survivors [1, 3, 4].

Similarly in Korea, the overall incidence rate for cancer increased by 2.6% annually from 1999 to 2005 [5]. The overall 5-year relative survival rates for all cancers increased from 41.2 in 1993–1995 to 57.1% in 2003–2007 [5]. Between 2003 and 2005, the five most common cancers in males were stomach, lung, liver, colon and rectum, and prostate cancers. For females, breast cancer was the most common primary cancer, followed by thyroid, stomach, colon and rectum, and lung cancers [5]. In terms of SPC, about 2% of all new cancer cases were diagnosed in cancer survivors in 1999–2001, but the number of SPC is expected to increase due to improved survivorship and a growing number of cancer survivors [6, 7].

Cancer survivors are at greater risk for developing cancer than the general population [8–10]. In the Swedish Family Cancer study, there was a 30% and a 60% increase in the standardized incidence of new cancers in male and female cancer survivors, respectively, when compared with participants without previous cancers [8]. In the US SEER cancer registry, cancer survivors had a 14% higher risk of cancer compared with subjects without a previous cancer, although it was suspected that the rates of SPC were underestimated due to selective migration [9]. While screening for SPC is recommended to facilitate early identification and to reduce the frequency of severe complications and morbidity among cancer survivors [11], it is unclear whether a cancer history is associated with increased or decreased utilization of screenings for other cancers. Furthermore, cancer survivors may have different cancer screening patterns compared with subjects without cancer [12–17]. The few studies that have examined cancer screening practices in cancer survivors have been largely based on the analysis of secondary data, such as Medicare claims, with limited ability to examine cancer survivors' cancer screening patterns compared with people without cancer history. Furthermore, it is unclear whether the screening practices of cancer survivors are similar to those of patients with other comorbid chronic conditions, which may also increase the frequency of medical encounters and of cancer screening.

In Korea, screening for stomach, breast, colorectal, and cervical cancer is provided at no or minimal cost by the National Cancer Screening Program since 2001 (Table 1) [18]. These cancers were selected because of their high incidence and 5-year survival rates in Korea (Appendix Table 5) [5]. This study aimed to describe cancer screening rates for SPC among cancer survivors in Korea and to compare these rates with those of two non-cancer control groups: individuals without a personal history of cancer but with other chronic diseases, and individual without a personal history of cancer and without other chronic diseases.

Materials and methods

Study population

The data were derived from the 2001, 2005, and 2007 Korean National Health and Nutrition Examination Surveys (KNHANES). KNHANES is a series of population-based cross-sectional surveys that used a stratified multistage sampling design according to geographic area, age, and gender group to select a representative sample of the civilian, noninstitutionalized Korean population. Stratification was conducted based on the 13 areas of Korea (seven metropolitan cities and six provinces), the administrative unit (*dong* or *eup-myeon*; Korean units), and the dwelling type (apartment house or others) [19].

We combined data for the 2001, 2005, and 2007 surveys into a large cross-sectional dataset. Each KNHANES survey is composed of three parts: Health Interview Survey, Health Examination, and Nutrition Survey. We used data from the Health Interview Survey component that asked questions pertaining to socio-demographic characteristics, health status, medical history, healthcare utilization, quality of life, and behavior including cancer screening practices.

The Health Interview Survey was completed by 10,252, 8,338, and 5,083 adults aged 18 years and older in 2001, 2005, and 2007, respectively. The response rates were 88.5,

Table 1 National Cancer Screening Program in Korea (2001 ~ 2010)

Cancer	Target population	Frequency	Test or procedure
Breast	40 and over (women)	Every 2 years	Mammography and clinical breast examination
Cervix	30 and over (women)	Every 2 years	Pap smear
Stomach	40 and over (men and women)	Every 2 years	Endoscopy or upper gastrointestinal series
Colorectal	50 and over (men and women)	Every 1 to 5 years	Fecal occult blood testing (every 1 year) and colonoscopy or barium enema (every 5 year)

The Korean National Cancer Screening Program also includes screening of high-risk groups for liver cancer every 6 months using sonography and α-fetoprotein levels

93.6, and 80.6% in 2001, 2005, and 2007, respectively. Since the National Cancer Screening Program in Korea is targeted to women 30 years of age or older and men 40 years of age or older (Table 1), we restricted our analyses to the 15,556 KNHANES participants who were 30 years of age or older (6,446, 6,466, and 2,644 participants in 2001, 2005, and 2007, respectively), with analyses by cancer site restricted to the appropriate gender and age group to match the guidelines. KNHANES was approved by the Korea Centers for Disease Control and Prevention (KCDC) Institutional Review Board, and all participants signed a written informed consent.

Data collection

Participation in the survey was voluntary and confidentiality was assured. Trained interviewers conducted the face-to-face interview at the participants' households using a structured questionnaire [19]. Each interview took 45 min to an hour. As part of the interview, participants were asked whether they had ever told by a physician that they had cancer as well as a variety of chronic conditions that are not curable and that usually result in life-time increase of medical encounters [19]. They were operationally defined a self-reported history of arthritis, hypertension, diabetes mellitus, heart disease, stroke, asthma, or chronic obstructive pulmonary disease.

Participants were classified as cancer survivors if they reported having ever been told by a doctor that they had cancer or a malignancy of any kind. Cancer survivors were also asked about the site and the age of diagnosis. Since frequent contacts with health professionals are associated with higher screening rates [20], we separated the rest of participants into two non-cancer control groups: participants without cancer but with chronic diseases, and participants without cancer and without chronic diseases. Participants without a history of cancer but who had been told by a physician that they had arthritis, hypertension, diabetes mellitus, heart disease, stroke, asthma, or chronic obstructive pulmonary disease comprised the non-cancer chronic disease control group.

Screening questions included whether individuals had ever had a mammogram and clinical breast examination, a stomach cancer screening examination (endoscopy or upper gastrointestinal series), or a Papanicolaou test. Since 2005, the Health Interview Survey also included a question about colorectal cancer screening examinations (fecal occult blood test and colonoscopy or barium enema). Screening questions were appropriate for the respondents' gender (e.g., males were not asked about Papanicolaou tests) and age. An answer of "yes" to any screening question was followed by questions about the timing of the most recent examination.

The Health Interview Survey data were also used to obtain socio-demographic factors that have been associated with screening practice in the previous studies: age [21, 22], marital status [21, 23, 24], education [20–22], income [23–25], working status [24], insurance status [20–22], smoking [22], alcohol consumption [25], and self-reported health status [21, 22, 26]. For working status, we considered as economically active participants those who were working at the time of survey, and as economically inactive participants those who were retired, unemployed, or on long-term medical leave.

Statistical analysis

The National Cancer Screening Program [18] was used to define age- and sex-appropriate cancer screening behaviors: breast cancer screening every 2 years in women 40 years of age or older, cervical cancer screening every 2 years in women 30 years of age or older, stomach cancer screening every 2 years in men and women 40 years of age or older, and colorectal cancer screening with colonoscopy or barium enema every 5 years in men and women 50 years of age or older. Cancer survivors who had had the specific cancer that the screening aimed to detect were excluded from each calculation [13].

We used multivariable logistic regression to model the probability of receiving screening as a function of study group (cancer survivors, non-cancer controls with chronic disease, and non-cancer controls without chronic disease) and other covariates. Adjusted proportions of receiving cancer screening were computed using marginal standardization [27]. All statistical analyses were performed using *svy* commands in Stata 11.0 to incorporate sampling weights and the complex survey design [28].

Results

The overall study sample was comprised by 264 cancer survivors, 4,851 non-cancer chronic disease controls, and 10,441 non-cancer non-chronic disease controls. Of the 264 cancer survivors, 68.9% reported having one of four types of cancer: stomach ($n = 57$), cervical ($n = 49$), breast ($n = 47$), and colorectal cancer ($n = 30$). In addition, 4.6% ($n = 9$) of survivors reported having more than one type of cancer, and they were included in the study sample.

Overall, the socio-demographic characteristics of cancer survivors and non-cancer chronic disease controls were similar, although cancer survivors were less likely to be economically active, less likely to smoke and drink alcohol, and more likely to report a poor or very poor health status. On the other hand, cancer survivors and non-cancer chronic disease controls had very different ($p < 0.001$)

socio-demographic characteristics compared with non-cancer non-chronic disease controls. Cancer survivors were more likely to be older, female, to have a lower level of education, to get a lower monthly income, to be economically inactive, and to have a poorer self-reported health status. In addition, cancer survivors were less likely to be current smokers or drinkers (Table 2).

Table 3 presents the prevalence of cancer screening practices by study group. Cancer survivors were mostly like to do breast, stomach, and colorectal cancer screenings compared with both non-cancer chronic disease controls and non-cancer non-chronic disease controls, but non-cancer non-chronic disease controls showed higher prevalence of cervical cancer screening than the two other groups. The overall proportions of screening according to guideline recommendations for breast, cervical, stomach, and colorectal cancer were 50.0, 43.1, 37.1, and 28.0%, respectively. Half of the female cancer survivors had had breast cancer screening in the last 2 years, a proportion that was significantly higher than those of both control groups (30.9 and 34.6%, respectively, p value <0.05; Table 3). Cancer survivors also showed higher prevalence of stomach (37.1 vs. 31.3 and 28.9%), and it was statistically significant. They also reported higher screening rate for colorectal cancer (28.0%) compared with non-cancer chronic disease control (21.4%), and it was statistically significant.

Table 4 reports the adjusted prevalence of breast, cervical, stomach, and colorectal cancer screenings. After adjusting for socio-demographic factors including gender, age, marital status, education, income, working status, health insurance, smoking and drinking status, self-reported health status, and survey year, the proportions of screening for breast, cervical, stomach, and colorectal cancer were 46.4, 54.8, 31.5, and 28.5%, respectively. Cancer survivors showed higher screening rates for all four cancer sites compared with both control groups, but only the differences for breast cancer screening were statistically significant (p value <0.05; Table 4 and Appendix Table 6). About 47% cancer survivors had breast cancer screening, while 36 and 30% of non-cancer chronic and non-cancer non-chronic controls had screening, respectively (Table 4 and Appendix Table 6). Although they were lower than those of cancer survivors, people with other chronic diseases showed significantly higher screening rates for breast (36.0 vs. 30.0%, $p = 0.001$) and stomach (32.7 vs. 28.4%, $p < 0.001$) cancers compared with non-cancer non-chronic disease control group.

Monthly income had positive relationship with all four cancer screening practices, and people who had higher income were more likely to follow the screening guideline compared with people who had lower income (Appendix Table 6). People who were married were more likely to do cervical and stomach cancer screening ($p < 0.001$) compared with people who were single, widowed, or separated. The prevalence of breast, stomach, and colorectal cancer screening rates was improved by survey year, and survivors were about three times more likely to receive breast and stomach cancer screening in 2007 compared to in 2001 ($p < 0.001$).

In sum, survivors followed breast cancer screening guideline better compared with non-cancer chronic controls, and non-cancer chronic controls did better screening practice than non-cancer non-chronic controls controlling all other factors (Table 4 and Appendix Table 6). In addition, age, marital status, monthly income, smoking status, and survey year were significantly associated with breast cancer screening practice.

Discussion

To our knowledge, this is the first study to investigate cancer screening practices of cancer survivors in a general population setting outside the United States. After multivariate adjustment, cancer survivors were more likely to receive breast cancer screening compared with people without a previous cancer. This is similar to the results of the previous studies. Increased contact with health care system and perceived vulnerability have been suggested as possible reasons of higher breast cancer screening rates among cancer survivors compared with people without a history of cancer [13–15]. In addition, breast cancer screening may be more accessible and acceptable to survivors compared with other screening procedures, since it is non-invasive, well-known, and widely offered in Korea. Although it was varied by different cancer screenings, higher rates of screening among cancer survivors have also been observed in other studies in the United States [12, 13, 15]. Some researchers pointed that frequent medical encounter that cancer survivors experienced would be associated with higher rates of screening [15–17]. However, the results of our study showed that cancer survivors had even higher rates of screening compared with people with other chronic diseases who would have similar medical encounter. Cancer survivors would have different health beliefs, including perceived risk, self-efficacy, and risk perceptions related to cancer screenings, all of which may influence screening behaviors [14]. They felt that they were at higher risk of developing another cancer compared to the general population, and they acknowledged the benefits of screening [29]. However, even for participants with a previous cancer, screening rates in our study were only 30–50%, much lower than in the United States where 70–95% of survivors had breast and cervical cancer

Table 2 Characteristics of cancer survivors and controls among Korean National Health and Nutrition Examination Survey 2001, 2005, and 2007 participants 30 years of age and older ($n = 15,556$)

Characteristics	Cancer survivors ($n = 264$)		Non-cancer chronic disease controls ($n = 4,851$)[a,b]		Non-cancer non-chronic disease controls[c] ($n = 10,441$)	
	%	(95% CI)	%	(95% CI)	%	(95% CI)
Gender						
Male	33.1.2	(26.4, 40.6)	42.0	(40.2, 43.8)	50.5	(49.3, 51.8)
Female	66.9	(59.4, 73.6)	58.0	(56.2, 59.8)	49.5	(48.2, 50.7)
Age (Mean, years)	58.7	(56.9, 60.5)	58.9	(58.4, 59.3)	44.3	(44.1, 44.6)
30–39	5.6	(2.7, 11.0)	6.5	(5.7, 7.5)	40.3	(39.1, 41.5)
40–49	22.3	(16.4, 29.6)	18.5	(17.0, 20.1)	33.8	(32.7, 35.0)
50–59	19.6	(13.8, 27.0)	26.1	(24.5, 27.8)	15.3	(14.5, 16.2)
60–69	31.4	(24.6, 39.0)	27.0	(25.5, 28.5)	6.7	(6.2, 7.3)
≥70	21.2	(16.4, 27.0)	21.9	(20.5, 23.3)	3.8	(3.4, 4.3)
Marital status						
Married	71.2	(63.4, 77.9)	71.9	(70.3, 73.4)	84.1	(83.1, 84.9)
Others (single, separated) widowed, or divorced)	28.8	(22.1, 36.6)	28.1	(26.6, 29.7)	15.9	(15.1, 16.9)
Education						
Less than high school	55.8	(47.9, 63.4)	65.4	(63.6, 67.2)	26.4	(25.4, 27.5)
High school	28.6	(22.0, 36.2)	22.6	(21.1, 24.2)	42.1	(40.9, 43.4)
College and above	15.7	(10.3, 23.1)	12.0	(10.8, 13.3)	31.4	(30.3, 32.6)
Monthly income						
Less than $1,000	44.2	(36.7, 52.0)	44.8	(43.0, 46.6)	19.7	(18.8, 20.6)
$1,000 ~ $2,000	24.0	(17.9, 31.3)	26.2	(24.6, 27.8)	35.3	(34.1, 36.5)
$2.000 ~ $4,000	22.1	(15.7, 30.0)	23.0	(21.3, 24.7)	35.6	(34.4, 36.9)
More than $4,000	9.7	(5.6, 16.4)	6.0	(5.1, 7.1)	9.4	(8.6, 10.3)
Working						
Economically active	26.3	(20.4, 33.2)	48.2	(46.4, 50.0)	67.7	(66.6, 68.9)
Economically inactive	73.7	(66.8, 79.6)	51.8	(50.0, 53.6)	32.3	(31.1, 33.4)
Insurance						
National health insurance	91.8	(86.5, 95.1)	92.1	(91.1, 93.0)	97.6	(95.4, 96.2)
Medical aid	8.2	(4.9, 13.5)	7.9	(7.0, 8.9)	2.4	(2.1, 2.8)
Smoker						
Never smoker	66.8	(59.4, 73.4)	57.5	(55.7, 59.3)	53.6	(52.4, 54.9)
Former smoker	22.1	(16.8, 28.4)	20.3	(18.8, 21.9)	15.9	(15.0, 16.9)
Current smoker	11.1	(6.9, 17.4)	22.1	(20.6, 23.7)	30.4	(29.3, 31.6)
Alcohol drinker						
Not at all	56.1	(48.2, 63.6)	42.2	(40.5, 44.0)	27.8	(26.8, 28.8)
Some or more	43.9	(36.4, 51.8)	57.8	(56.0, 59.5)	72.2	(71.2, 73.2)
Self-reported health status						
Very good	2.8	(0.9, 8.2)	1.5	(1.1, 2.0)	4.8	(4.3, 5.4)
Good	14.3	(9.2, 21.5)	17.0	(15.7, 18.4)	41.4	(40.3, 42.7)
Normal	28.8	(22.2, 36.5)	38.4	(36.6, 40.2)	42.6	(41.3, 43.8)
Poor	38.3	(31.4, 45.7)	34.4	(32.8, 36.1)	10.2	(9.4, 10.9)
Very poor	15.8	(11.0, 22.2)	8.7	(7.8, 9.8)	1.0	(0.8, 1.2)

[a] Gender ($p = 0.024$), working status ($p < 0.001$), smoking status ($p = 0.004$), alcohol drinking status ($p = 0.001$), and self-reported health status (0.011) were significantly different between cancer survivors and non-cancer chronic controls

[b] All characteristic were significantly different between non-cancer chronic disease controls and non-cancer non-chronic controls ($p < 0.001$)

[c] All characteristic were significantly different between cancer survivors and non-cancer non-chronic controls ($p < 0.001$)

Table 3 Prevalence of cancer screening among Korean National Health and Nutrition Examination Survey 2001, 2005, and 2007 participants

	Cancer survivors		Non-cancer chronic disease controls		Non-cancer non-chronic disease controls	
	%	(95% CI)	%	(95% CI)	%	(95% CI)
Breast cancer screening in 2 years[a,b]	50.0	(38.8, 61.2)	30.9	(28.7, 33.3)*	34.6	(32.4, 36.8)*
Cervical cancer screening in 2 years[b,c]	43.1	(32.0, 54.8)	36.4	(34.2, 38.7)*	49.3	(47.6, 51.0)
Stomach cancer screening in 2 years[b,d]	37.1	(28.7, 46.4)	31.3	(29.5, 33.2)*	28.9	(27.5, 30.5)*
Colorectal cancer screening in 5 years[e,b,f]	28.0	(19.6, 38.2)	21.4	(19.4, 23.7)*	26.0	(23.3, 28.9)*

[a] Females 40 years of age or older ($n = 6{,}192$)

[b] Only patients not having the specific type of cancer were included for the cancer screening

[c] Females 30 years of age or older ($n = 8{,}564$)

[d] Males and females 40 years of age or older ($n = 11{,}181$)

[e] Males and females 50 years of age or older ($n = 6{,}866$)

[f] Only 2005 and 2007 data were included for analysis

* p value <0.05 when compared for cancer survivors

Table 4 Adjusted prevalence of cancer screening among Korean National Health and Nutrition Examination Survey 2001, 2005, and 2007 participants

	Cancer survivors		Non-cancer chronic disease controls		Non-cancer non-chronic disease controls	
	%	(95% CI)	%	(95% CI)	%	(95% CI)
Breast cancer screening in 2 years[a,b]	46.4	(36.2, 56.7)	36.0	(33.2, 38.9)*∫	30.0	(27.8, 32.2)*
Cervical cancer screening in 2 years[b,c]	54.8	(43.6, 65.9)	47.5	(44.6, 50.4)	44.4	(42.7, 46.2)
Stomach cancer screening in 2 years[b,d]	31.5	(22.7, 40.4)	32.7	(30.6, 34.9)∫	28.4	(26.8, 29.9)
Colorectal cancer screening in 5 years[b,e,f]	28.5	(18.4, 38.5)	22.9	(20.3, 25.5)	24.4	(21.5, 27.4)

Adjusted for gender, age (continuous), marital status (married, other), education (less than high school, high school, college and above), income (less than $1,000, $1,000–$2,000, $2,000–$4,000, more than $4,000), working status (economically active, economically inactive), insurance status (National Health insurance, Medical aid), smoking status (never, former, current), drinking status (never, some or more), self-reported health status (very good, good, normal, poor, very poor), and survey year (2001, 2005, 2007)

[a] Females 40 years of age or older ($n = 6{,}192$)

[b] Only patients not having the specific type of cancer were included for the cancer screening

[c] Females 30 years of age or older ($n = 8{,}564$)

[d] Males and females 40 years of age or older ($n = 11{,}181$)

[e] Males and females 50 years of age or older ($n = 6{,}866$)

[f] Only 2005 and 2007 data were included for analysis

* p value <0.05 when compared for cancer survivors

∫ p value <0.001 when compared for non-cancer non-chronic controls

screening and 40–85% of them had colorectal cancer screening [13, 14]. In Korea, cancer screening rates in the general public were also lower compared with other developed countries [30], which may also influence lower screening rates for SPC among cancer survivors.

Our findings need to be interpreted in the context of the Korean healthcare system. Firstly, Korea has a universal health care system. All Koreans are covered by National Health Insurance (NHI) except the lowest income category group (3–5% of the population), which is covered by Medical Aid [18]. In terms of access to cancer screening, Koreans can get screening for the five most common cancers (breast, cervical, stomach, liver, and colorectal cancers) with no or minimum cost through the National Cancer Screening Program. Specifically, cancer screening is free for people with Medical Aid, while people with NHI have a 10–20% copayment. Even this copayment is relatively low compared to US health care costs, even after considering differences in per capita income between Korea and the United States ($15,840 vs. $43,560 in 2005) [31]. Copayment for mammography in Korea is about 3.5 US dollars, for gastric cancer screening (UGIS or

endoscopy) is about 7 US dollars, and for colorectal cancer (fecal occult blood test) is about 0.5 US dollar. Cervical cancer screening is free for all women in Korea [18]. Therefore, although there is almost no economic barrier to cancer screening in Korea, there may be other socio-economic factors that affect cancer screening behavior, such as lack of time or access to care. In our study, low monthly income was associated with lower cancer screening rate. People with low socio-economic status may not have enough time to receive cancer screening because of competing demands to make their living. Actually, 'lack of time' was the most commonly cited reason for non-participation not only in cancer screening programs, but also in other health screening programs. There might also be disparities due to access to care (rural vs. urban). However, in Korea, there is a 'Mobile Screening System' in rural areas, in which a bus with health screening facilities visits rural towns and provides health screening services. In addition, people receive invitation letters and reminding post-cards from local health departments for National Cancer Screening Program every year.

Secondly, there is no family doctor or referral system in Korea, and people can get care from any clinic or medical center in the nation without seeing designated physicians (family doctors). Therefore, there is no organized primary care provided to cancer survivors after treatment. In the previous studies, survivors followed up by both primary care providers and oncology specialists were more likely to receive SPC screening and other appropriate care [15–17, 32], and lack of physicians' recommendation contributes to underuse of cancer screening [14, 33–35]. We could not confirm whether this is also the case with our study as we did not have information on which healthcare providers (oncologist or primary care physician) the survivors had seen. In Korea, there is not a system of family doctor registration, and people are free to visit any doctors or hospitals depending on their needs. As a consequence, there is no primary care physician or coordination mechanism for cancer survivors in Korea, and oncologists could be the best providers who would deliver information about SPC and screenings to cancer survivors.

Recently, more attention is being paid to the follow-up care for cancer survivors [36]. Like previous studies, we used the cancer screening guidelines recommended for those people at average risk for cancer to analyze the screening practice of cancer survivors [12–17, 23]. However, researchers have claimed that more tailored and rigorous screening should be recommended to cancer survivors considering their high risk of developing secondary cancer. Indeed, earlier and more intensive cancer screening is recommended for childhood cancer survivors [37–39]. For adult cancer survivors, the optimal level of screening is unclear, but it seems reasonable to recommend for cancer survivors at least the same screening guidelines as for the general public.

The limitations of this study are mainly related to conducting secondary data analysis. KNHANES was not designed to evaluate survivorship issues, and the number of survivors was relatively small. Self-reported cancer history and screening practices are subject to recall bias, and no verification of self-reports was conducted. KNHANES is a lengthy, time intensive survey, and cancer survivors in poor health might not be able to participate. It could be possible that survivors who responded to the survey might be healthier and more likely to take advantage of cancer screening than non-respondents. We also lacked information on clinical data, such as cancer stage and post-disease care. The non-cancer chronic control is a heterogeneous group, and the composition of this group may influence screening practices. However, we were not able to examine health impact of different chronic diseases because the number of patients with each individual chronic condition was not high enough to result a stable control group. Furthermore, no single disease can be defined as an optimal control group for second primary cancer patients.

Despite these limitations, our nationally representative sample of survivors and controls provided a unique opportunity to explore cancer screening practice among Korean cancer survivors and general population controls.

In summary, our findings indicate that cancer survivors were more likely than individuals without a cancer history to obtain screening examinations within the recommended guidelines. Higher cancer screening rates in cancer survivors, even after adjustment for socio-demographic factors, warrant future studies to explore different health beliefs and risk perceptions in this population related to cancer prevention. Nevertheless, less than half of the survivors were screened for cancer according to guidelines, and there was wide variation in the proportion of cancer survivors who obtained particular screenings. Future research needs to examine the differences in screening rates between gender-specific cancers and other cancers. Importantly, the suboptimal screening rate of cancer survivors emphasizes the need for a systematic approach to SPC prevention. Survivors should be closely followed, and cancer screening guidelines for SPC should be included in long-term care plans for cancer survivors.

Conflict of interest None.

Appendix

See Tables 5 and 6.

Table 5 Incidence and 5-year relative survival rates of stomach, colorectal, breast and cervical cancers in Korea

	Incidence (crude)[a]		Prevalence (crude)[a]		5 year relative survival[b]	
	Male	Female	Male	Female	Male	Female
Stomach	65.5	26.3	224.1	111	57	55.1
Colorectal	39.6	22.2	158.1	109.3	66.7	62.4
Breast	0.2	31	0.8	189.3	87.1	87.3
Cervix	NA	15.4	NA	68.7	NA	81.1

[a] Per 100,000 persons per year

[b] Percent

Table 6 Factors related to cancer screening

	Breast cancer screening in 2 years[a,b]			Cervical cancer screening in 2 years[b,c]			Stomach cancer screening in 2 years[b,d]			Colorectal cancer screening in 5 years[b,e,f]		
	OR	(95% CI)	*p* value	OR	(95% CI)	*p* value	OR	(95% CI)	*p* value	OR	(95% CI)	*p* value
Chronic conditions												
Cancer survivors	1.00			1.00			1.00			1.00		
Non-cancer chronic disease controls	0.61	(0.38, 0.99)	0.046	0.72	(0.44, 1.21)	0.215	1.06	(0.68, 1.66)	0.797	0.74	(0.43, 1.25)	0.260
Non-cancer non-chronic disease controls	0.45	(0.28, 0.73)	0.001	0.63	(0.38, 1.05)	0.078	0.85	(0.54, 1.34)	0.482	0.81	(0.46, 1.40)	0.444
Gender												
Male							1.00			1.00		
Female							0.91	(0.75, 1.11)	0.358	0.96	(0.68, 1.35)	0.803
Age	0.97	(0.96, 0.98)	<0.001	0.98	(0.97, 0.98)	<0.001	0.99	(0.99, 1.00)	0.064	0.99	(0.98, 1.00)	0.143
Marital status												
Married	1.00			1.00			1.00			1.00		
Others	0.84	(0.68, 1.02)	0.077	0.62	(0.53, 0.73)	0.000	0.71	(0.61, 0.84)	<0.001	0.85	(0.65, 1.10)	0.209
Education												
Less than high school	1.00			1.00			1.00			1.00		
High school	1.01	(0.83, 1.24)	0.901	1.09	(0.92, 1.29)	0.334	0.88	(0.75, 1.03)	0.121	1.01	(0.76, 1.34)	0.943
College and above	1.09	(0.80, 1.48)	0.578	0.92	(0.74, 1.14)	0.428	1.22	(1.01, 1.49)	0.042	1.24	(0.85, 1.79)	0.262
Monthly income												
Less than $1,000	1.00			1.00			1.00			1.00		
$1,000 ~ $2,000	1.05	(0.86, 1.28)	0.661	1.30	(1.11, 1.52)	0.001	1.18	(1.01, 1.38)	0.040	1.62	(1.24, 2.12)	<0.001
$2.000 ~ $4,000	1.41	(1.13, 1.75)	0.002	1.69	(1.41, 2.01)	<0.001	1.25	(1.05, 1.49)	0.013	1.37	(1.03, 1.82)	0.029
More than $4,000	1.79	(1.27, 2.53)	0.001	2.26	(1.73, 2.96)	<0.001	1.87	(1.45, 2.43)	<0.001	1.69	(1.11, 2.57)	0.015
Working												
Economically active	1.00			1.00			1.00			1.00		
Economically inactive	1.09	(0.93, 1.29)	0.297	1.07	(0.94, 1.21)	0.307	1.03	(0.89, 1.18)	0.729	0.85	(0.67, 1.08)	0.192
Insurance												
National health insurance	1.00			1.00			1.00			1.00		
Medical aid	0.96	(0.66, 1.38)	0.813	1.00	(0.73, 1.36)	0.985	1.27	(0.95, 1.68)	0.106	1.06	(0.63, 1.77)	0.836
Smoker												
Non-smoker	1.00			1.00			1.00			1.00		
Former smoker	0.58	(0.36, 0.91)	0.019	0.95	(0.68, 1.32)	0.767	0.97	(0.79, 1.20)	0.778	1.07	(0.76, 1.53)	0.690
Current smoker	0.46	(0.30, 0.72)	0.001	0.54	(0.40, 0.73)	<0.001	0.76	(0.62, 0.93)	0.007	0.84	(0.58, 1.21)	0.342

Table 6 continued

	Breast cancer screening in 2 years[a,b]			Cervical cancer screening in 2 years[b,c]			Stomach cancer screening in 2 years[b,d]			Colorectal cancer screening in 5 years[b,e,f]		
	OR	(95% CI)	*p* value	OR	(95% CI)	*p* value	OR	(95% CI)	*p* value	OR	(95% CI)	*p* value
Alcohol drinker												
Not at all	1.00			1.00			1.00			1.00		
Some or more	0.98	(0.82, 1.17)	0.824	1.22	(1.07, 1.39)	0.004	1.05	(0.92, 1.20)	0.499	1.15	(0.92, 1.45)	0.216
Self-reported health status												
Very bad	1.00			1.00			1.00			1.00		
Bad	1.11	(0.67, 1.84)	0.685	1.08	(0.77, 1.52)	0.660	0.87	(0.62, 1.23)	0.438	1.59	(0.81, 3.14)	0.181
Normal	1.17	(0.71, 1.94)	0.534	1.13	(0.80, 1.59)	0.500	0.97	(0.69, 1.36)	0.842	1.65	(0.84, 3.24)	0.147
Good	0.96	(0.57, 1.61)	0.878	0.95	(0.66, 1.37)	0.784	0.91	(0.64, 1.30)	0.619	2.01	(1.01, 4.00)	0.048
Very good	1.00	(0.54, 1.84)	1.000	0.86	(0.53, 1.38)	0.532	0.83	(0.54, 1.27)	0.390	1.60	(0.74, 3.47)	0.237
Survey year												
2001	1.00			1.00			1.00					
2005	1.48	(1.25, 1.75)	<0.001	0.91	(0.80, 1.03)	0.140	2.28	(2.02, 2.58)	<0.001	1.00		
2007	2.97	(2.34, 3.77)	<0.001	1.19	(0.99, 1.43)	0.070	3.15	(2.66, 3.73)	<0.001	1.88	(1.53, 2.31)	<0.001

[a] Females 40 years of age or older ($n = 6{,}192$)

[b] Only patients not having the specific type of cancer were included for the cancer screening

[c] Females 30 years of age or older ($n = 8{,}564$)

[d] Males and females 40 years of age or older ($n = 11{,}181$)

[e] Males and females 50 years of age or older ($n = 6{,}866$)

[f] Only 2005 and 2007 data were included for analysis

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