Research Article

Cancer Epidemiology, Biomarkers & Prevention

Suicide Rates and Risk Factors among Korean Cancer Patients, 1993-2005

Eunmi Ahn[1], Dong Wook Shin[1], Sung-Il Cho[2], Sohee Park[1], Young-Joo Won[1], and Young Ho Yun[1]

Abstract

Background: As the number of cancer survivors increases, suicide risk approaches that of the general population. We therefore investigated suicide rates and risk factors among Korean cancer patients.

Methods: We observed 816,295 cancer patients for 3,007,294 person-years from 1993 to 2005 through a nationwide cancer registry. We calculated their sex- and age-standardized mortality ratios (SMR) and studied suicide risk factors using rate ratios (RR) based on a log-linear Poisson regression model.

Results: Compared with the Korean general population, the suicide rate among cancer patients was high [SMR, 2.00; 95% confidence interval (95% CI), 1.91-2.08]. The rates were highest in the year following the cancer diagnosis (SMR, 3.45; 95% CI, 3.19-3.73) and were still elevated 5 years later (SMR, 1.23; 95% CI, 1.12-1.36). The clinical groups at highest risk were male pancreas cancer patients (SMR, 6.01; 95% CI, 4.33-8.33) and female lung cancer patients (SMR, 3.55; 95% CI, 2.55-4.94). The sociodemographic groups at highest risk were those who had no spouse versus those who were married (RR, 1.50; 95% CI, 1.35-1.68), those who were not employed versus those who were (RR, 1.39; 95% CI, 1.26-1.54), and those who did not have high school education versus those who had (RR, 1.52; 95% CI, 1.30-1.79).

Conclusions: Korean cancer patients are at increased risk of suicide. Both clinical and sociodemographic factors play a role.

Impact: There is a need for social support and suicide prevention strategies for cancer survivors in Korea.
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Introduction

For several years after a cancer diagnosis, the suicide rate is higher for patients than for the general population, and evidence that cancer increases suicide risk has been accumulating in the United States (1, 2), Norway (2, 3), Sweden (2, 4), Austria (2, 5), Finland (2), and Denmark (1-6). The number of people who live with the after-effects of cancer and its treatment—disability, fear of recurrence, and economic burden—is growing (7-20). Factors related to suicide include mainly clinical characteristics such as age at diagnosis (6, 21), prognosis (5), psychiatric status (21, 22), stage (1, 3, 6), time since diagnosis (1, 6, 21), and period of diagnosis (1, 4-6), and sociodemographic characteristics such as sex (1, 3), race (1, 21), and marital status (1, 3, 21).

Cancer is one of several illnesses that increase the risk of suicide in Asian countries (22-28). In Korea, cancer has been named as a suicide risk factor when coupled with comorbidities such as psychiatric diseases (22). Here we investigated whether the suicide rate is higher among Korean cancer patients than it is in the general Korean population or in other countries. We then investigated risk factors that could explain the differences.

Materials and Methods

Data sources and study population

We identified cancer patients from the Korea Central Cancer Registry (KCCR), a nationwide registry that covers approximately 90% of the nation's new cancer cases (29). The study subjects were registered in the KCCR from 1993 to 2002 and followed up until 2005. We excluded multiple primary cancer cases and obtained suicide mortality data for both cancer patients and the general Korean population from the National Statistical Office (NSO) "Cause of Mortality" database.

Study variables

Available data in the KCCR included sex, age, and cancer diagnosis made according to International Classification of Diseases for Oncology (ICD)-10 criteria (30, 31).

Authors' Affiliations: [1]National Cancer Control Institute and Hospital, Goyang, Gyeonggi, Korea and [2]School of Public Health and Institute of Health and Environment, Seoul National University, Seoul, Korea

Corresponding Author: Young Ho Yun, Research Institute and Hospital, National Cancer Center, 111 Jungbalsan-ro, Ilsandong-gu, Goyang-si, Gyeonggi-do, 410-769, Korea. Phone: 82-31-920-1705; Fax: 82-31-920-2586. E-mail: lawyun08@ncc.re.kr

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Table 1. Characteristics and suicide rates among Korean cancer survivors

Characteristics	Patients, *n* (%)	Person-years of follow-up	Deaths by suicide, *n* (%)	Suicide rate*	SMR† (95% CI)
Total	816,295 (100)	3,007,294	2,065 (100)	68.7	2.00 (1.91-2.08)
Sex					
Male	446,778 (54.7)	1,311,008	1,521 (73.7)	116.0	2.05 (1.95-2.15)
Female	369,517 (45.3)	1,696,286	544 (26.3)	32.1	1.87 (1.72-2.03)
Age at diagnosis, y					
0-19	15,174 (1.9)	79,177	7 (0.3)	8.8	1.91 (0.91-4.01)
20-39	95,335 (11.7)	537,022	191 (9.2)	35.6	2.30 (1.99-2.64)
40-59	319,914 (39.2)	1,358,089	819 (39.7)	60.3	2.26 (2.11-2.42)
60-79	353,828 (43.3)	984,846	981 (47.5)	99.6	1.82 (1.71-1.94)
≥80	32,044 (3.9)	48,160	67 (3.2)	139.1	1.46 (1.15-1.85)
Years of follow-up					
<1	278,980 (34.2)	107,729	626 (30.3)	581.1	3.45 (3.19-3.73)
1-4	302,470 (37.0)	903,569	1,025 (49.6)	113.4	1.98 (1.86-2.10)
≥5	234,845 (28.8)	1,995,996	414 (20.5)	20.7	1.23 (1.12-1.36)
Year of diagnosis					
1993-1997	329,165 (40.3)	1,563,560	737 (35.7)	47.1	1.58 (1.47-1.70)
<1 year	116,717 (35.5)	45,208	178 (24.2)	393.7	3.38 (2.91-3.91)
1-4 years	74,555 (22.7)	163,432	254 (34.5)	155.4	1.64 (1.45-1.85)
≥5 years	137,893 (41.9)	1,354,920	305 (41.4)	22.5	1.18 (1.06-1.33)
1998-2002	487,130 (59.7)	1,443,737	1,328 (64.3)	92.0	2.33 (2.21-2.46)
<1 year	162,263 (33.3)	62,521	448 (33.7)	716.6	3.48 (3.18-3.82)
1-4 years	227,915 (46.8)	740,137	771 (58.1)	104.2	2.12 (1.98-2.28)
≥5 years	96,952 (19.9)	641,076	109 (8.2)	17.0	1.40 (1.16-1.69)

*Suicide rates per 100,000 person-years.
†Sex- and age-adjusted standardized mortality ratio.

We identified the 12 most common cancer sites, which included the 10 most common among men and the 10 most common among women, and we grouped the rest as "other" (7). We identified as suicides those deaths coded as "Suicide and Self-inflicted Injury (ICD-10 code X60-X84)" in the NSO Cause of Mortality database. The other variables we collected from that database were age, educational status, job status, and marital status, all at the time of death.

Statistical analysis

We calculated sex- and age-standardized mortality ratios (SMR) and used them to compare the suicide rate of cancer patients with that of the general Korean population. We calculated person-years at risk for each year from 1993 through 2005. We calculated the expected number of suicides by an indirect standardization method, multiplying person-years at risk by the Korean population suicide rate in each year of follow-up. We calculated SMRs by dividing the observed number of suicides by the expected number of suicides and derived 95% confidence intervals (95% CI) using a Poisson regression model (32).

To investigate the sociodemographic characteristics associated with suicide risk, we estimated rate ratios (RR) using a log-linear Poisson regression model. We built the regression model reflecting variables that correlated significantly with risk in univariate analysis (sex, age at diagnosis, year of diagnosis, time to suicide or cancer death, site of cancer, marital status, and educational status) and known suicide risk factors, namely, sex (1, 3), age at diagnosis (6, 21), marital status (1, 3), site of cancer (1, 3-5), and residential area (22, 33). Because we obtained the sociodemographic data from a mortality database, the study was necessarily limited to deceased patients. We did all analyses with STATA 10.1 (StataCorp LP), and all statistical tests were two-sided.

Results

Among the 838,594 cancer patients registered, we excluded those who had multiple primary cancers (n = 19,392); those whose date of death (n = 746), age at diagnosis (n = 450), or sex (n = 1) was missing; and those whose cancer diagnosis was recorded on or after the date of death (because those survival times were not reliable; n = 1,710).

Finally, 816,295 cancer patients (54.7% male) with a mean survival time of 3.5 years (2.8 for men and 4.3 for women) were included in the study, which covered

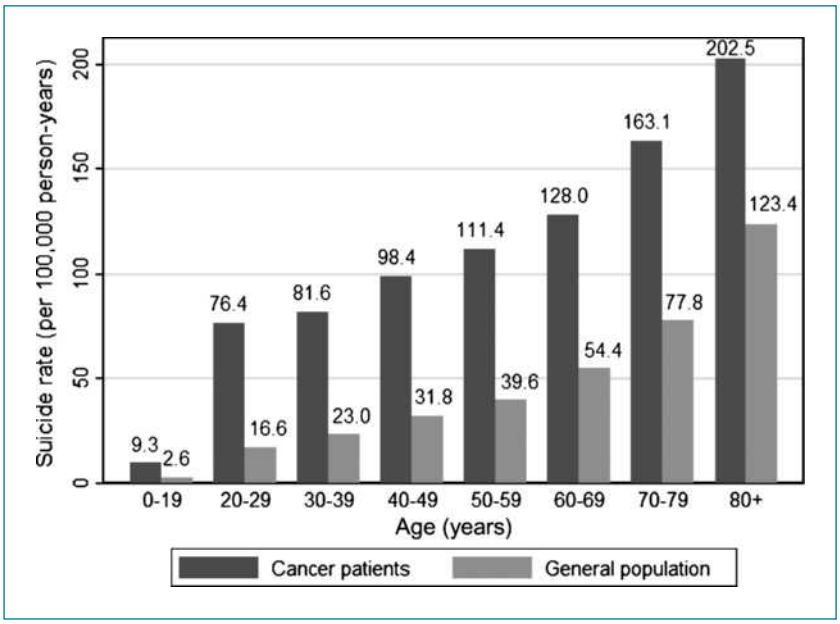

Figure 1. Male suicide rate by age group for cancer patients and the general Korean population (per 100,000 person-years).

3,007,294 person-years. We observed 446,778 men for 1,311,008 person-years and 369,517 women for 1,696,286 person-years. Among them, 2,065 patients committed suicide, yielding an overall suicide rate of 68.7/100,000 person-years (Table 1).

Suicide rates

Suicide rates were higher for men (116/100,000 person-years) than for women (32/100,000 person-years). They were twice as high for cancer patients than for the general population, and the differences were larger among men (Table 1).

The suicide rate for patients of both sexes increased with age (Figs. 1 and 2). The suicide SMR, however, was highest among 20- to 39-year-olds and then decreased with age (Table 1). The sex- and age-adjusted suicide rates were the highest in the year following the cancer diagnosis than at any later

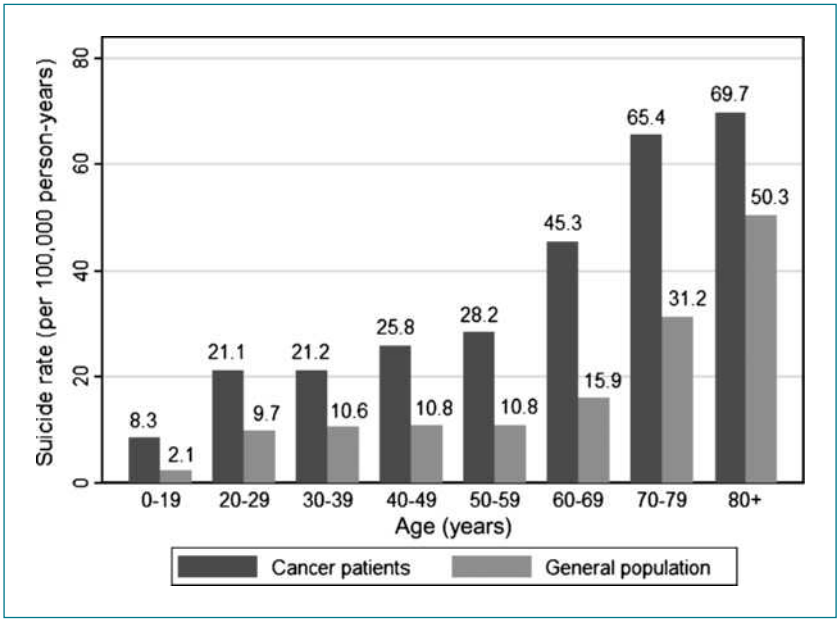

Figure 2. Female suicide rate by age group for cancer patients and the general Korean population (per 100,000 person-years).

Table 2. Suicide rates among male cancer survivors by cancer diagnosis (ICD-10)

Diagnosis	Patients, *n* (%)	Person-years of follow-up	Deaths by suicide, *n* (%)	Suicide rates*	SMR† (95% CI)
Male total	446,778 (100)	1,311,008	1,521 (100)	116.0	2.05 (1.95-2.15)
Bladder					
Total	13,989 (3.1)	70,800	100 (6.6)	141.2	2.09 (1.72-2.55)
<1 year	1,907 (0.4)	975	19 (1.2)	1,949.7	3.00 (1.91-4.70)
1-4 years	6,135 (1.4)	20,246	48 (3.2)	237.1	1.96 (1.48-2.60)
≥5 years	5,947 (1.3)	49,579	33 (2.2)	66.6	1.95 (1.38-2.74)
Colon					
Total	41,524 (9.3)	176,281	204 (13.4)	115.7	1.84 (1.61-2.12)
<1 year	7,892 (1.8)	3,634	43 (2.8)	1,183.2	2.51 (1.86-3.38)
1-4 years	20,346 (4.6)	64,452	119 (7.8)	184.6	1.98 (1.66-2.38)
≥5 years	13,286 (3.0)	108,194	42 (2.8)	38.8	1.25 (0.93-1.70)
Prostate					
Total	10,227 (2.3)	42,000	56 (3.7)	133.3	1.47 (1.14-1.92)
<1 year	1,298 (0.3)	685	6 (0.4)	876.3	0.98 (0.44-2.18)
1-4 years	5,969 (1.3)	18,964	36 (2.4)	189.8	1.61 (1.16-2.23)
≥5 years	2,960 (0.7)	22,352	14 (0.9)	62.6	1.48 (0.88-2.50)
Stomach					
Total	110,915 (24.8)	407,252	442 (29.1)	108.5	1.89 (1.72-2.07)
<1 year	36,855 (8.2)	15,410	119 (7.8)	772.2	3.15 (2.64-3.78)
1-4 years	42,649 (9.5)	125,726	220 (14.5)	175.0	1.89 (1.66-2.16)
≥5 years	31,411 (7.0)	266,117	103 (6.8)	38.7	1.28 (1.06-1.55)
Oropharyngeal					
Total	10,664 (2.4)	37,364	57 (3.7)	152.6	2.93 (2.26-3.80)
<1 year	3,100 (0.7)	1,692	15 (1.0)	886.8	4.12 (2.48-6.83)
1-4 years	4,812 (1.1)	12,858	36 (2.4)	280.0	3.71 (2.67-5.14)
≥5 years	2,752 (0.6)	22,815	6 (0.4)	26.3	0.98 (0.44-2.19)
Biliary					
Total	11,974 (2.7)	23,707	46 (3.0)	194.0	3.19 (2.39-4.26)
<1 year	6,694 (1.5)	2,438	19 (1.2)	779.3	5.32 (3.40-8.35)
1-4 years	3,832 (0.9)	9,303	25 (1.6)	268.7	3.59 (2.43-5.31)
≥5 years	1,448 (0.3)	11,965	2 (0.1)	16.7	0.52 (0.13-2.06)
Liver					
Total	73,829 (16.5)	115,644	118 (7.8)	102.0	2.82 (2.44-3.26)
<1 year	45,911 (10.3)	14,141	53 (3.5)	374.8	3.19 (2.44-4.18)
1-4 years	21,978 (4.9)	54,835	54 (3.6)	98.5	1.80 (1.38-2.35)
≥5 years	5,940 (1.3)	46,669	11 (0.7)	23.6	0.96 (0.53-1.73)
Esophagus					
Total	13,147 (3.0)	22,401	34 (2.2)	151.8	2.62 (1.87-3.67)
<1 year	7,473 (1.7)	3,367	13 (0.9)	386.1	3.22 (1.87-5.55)
1-4 years	4,527 (1.0)	9,875	16 (1.1)	162.0	2.62 (1.60-4.27)
≥5 years	1,147 (0.3)	9,160	5 (0.3)	54.6	1.77 (0.74-4.25)

(*Continued on the following page*)

time, but they remained somewhat elevated even after 5 years (Table 1).

A notable finding was that the 1993-1997 suicide rate jumped in 1998-2002. The suicide SMR was also higher for the 1998-2002 group than for the 1993-1997 group. The differences were still observed, although lessened, after we stratified the data by length of follow-up (Table 1).

Suicide mortality by cancer diagnosis

Among men, the suicide SMR was especially high for pancreas, biliary, and oropharyngeal cancer, and low for stomach, colon, and prostate cancer (Table 2). Among women, the suicide SMR was highest for lung, ovarian, and pancreatic cancer, and lowest for breast, cervical, and thyroid cancer (Table 3). For both men and women, the

Table 2. Suicide rates among male cancer survivors by cancer diagnosis (ICD-10) (Cont'd)

Diagnosis	Patients, *n* (%)	Person-years of follow-up	Deaths by suicide, *n* (%)	Suicide rates*	SMR† (95% CI)
Lung					
Total	72,898 (16.3)	108,105	181 (11.9)	167.4	2.79 (2.40-3.23)
<1 year	44,897 (10.0)	17,683	113 (7.4)	639.0	5.42 (4.51-6.52)
1-4 years	22,843 (5.1)	47,887	59 (3.9)	123.2	2.03 (1.58-2.62)
≥5 years	5,158 (1.2)	42,535	9 (0.6)	21.2	0.63 (0.33-1.20)
Pancreas					
Total	10,842 (2.4)	11,197	36 (2.4)	321.5	6.01 (4.33-8.33)
<1 year	8,340 (1.9)	2,759.31	15 (1.0)	543.6	6.56 (3.96-10.89)
1-4 years	1,958 (0.4)	3,894	19 (1.2)	488.0	8.10 (5.17-12.70)
≥5 years	544 (0.1)	4,544	2 (0.1)	44.0	1.47 (0.37-5.87)
Others‡	76,769 (17.2)	296,257	247 (16.2)	83.4	N/A

Abbreviation: N/A, not available.

*Suicide rates per 100,000 person years.

†Sex- and age-adjusted standardized mortality ratio.

‡Cancers other than the 10 most common cancers among men.

suicide SMR was highest for pancreas, lung, and biliary cancer the first year after diagnosis (Tables 2 and 3).

Suicide risk factors among Korean cancer patients

In a case-only study among those who died (n = 483,572), the risk of suicide was significantly higher for men than for women (Table 4). Patients ages 20 to 39 years were the most likely to die of suicide (Table 4). The risk of suicide was significantly higher for people who were divorced, separated, or widowed versus married people, for those who did not have a high school education versus those who did, for the unemployed versus the employed, and for those who lived in large cities versus those who lived in small cities or rural areas, with all variables pertaining to the time of death (Table 4).

Discussion

In this first population-based Asian study that used a nationwide cancer registry to investigate the risk of suicide among cancer patients, we found that the suicide rate among Korean cancer patients was approximately twice that of the general Korean population. Additionally, although direct comparisons must be made with care, suicide rates in the general population were notably higher in Korea than in western countries, where they range from 39.5 to 72.1 for men and from 7.5 to 20.4 for women (1-5). Suicide SMRs among cancer patients also tended to be higher in Korea (2.05 for men, 1.87 for women; Table 1) than in western countries (1.55-2.09 for men, 1.35-1.48 for women; refs. 1, 3-5).

That suicide SMRs were highest in those 29 to 39 years old may be due to younger patients feeling more discouraged than older patients, and the finding that suicide SMRs were still somewhat elevated 5 years later raises concerns about the long-term consequences of a cancer diagnosis and its treatment.

Our finding that both the suicide rate and the suicide SMR increased during the second 5-year follow-up period was unexpected. The differences were still observed after we stratified the data for length of follow-up. The increase cannot be explained by the cancer itself because national cancer survival rates improved over the study period (34). Suicide rates also increased in the general Korean population during the same period, but it did so more rapidly in cancer patients. Because lower socioeconomic status is a risk factor for suicide in the general population (1, 3, 22, 35-37), the increment in cancer patients may be attributable to the increasing socioeconomic inequality observed in South Korea (38-40). That suicide risk was higher among those with less education and those who were unemployed at the time of death supports that speculation. In fact, the Gini coefficient, which estimates the inequality of income or wealth distribution, increased in Korea from 0.269 in 1993 to 0.304 in 2005.

Our finding that suicide risk among cancer survivors was higher in large cities than in small cities or rural areas conflicts with previous reports about the general Korean population (22, 33). Studies are needed to determine how type of residential area is related to suicide risk.

That suicide rates in Korea were especially high for patients with pancreatic, lung, biliary, and oropharyngeal cancer is concordant with reports in western countries (1, 3-5). This could be partially explained by the patients' prognosis. Suicide risk was higher among patients with cancers that confer a poor prognosis, especially within the first year of diagnosis. It may also be related to the quality of life specific to the type of cancer. For example,

Table 3. Suicide rates among female cancer survivors by cancer diagnosis (ICD-10)

Diagnosis	Patients, *n* (%)	Person-years of follow-up	Deaths by suicide, *n* (%)	Suicides/100,000 person-years	SMR* (95% CI)
Total	369,517 (100)	1,696,286	544 (100)	32.1	1.87 (1.72-2.03)
Thyroid					
Total	23,141 (6.3)	149,421	18 (3.3)	12.1	0.81 (0.51-1.28)
<1 year	724 (0.2)	257	2 (0.4)	779.5	0.78 (0.19-3.12)
1-4 years	9,427 (2.6)	37,758	9 (1.7)	23.8	0.79 (0.41-1.52)
≥5 years	12,990 (3.5)	111,407	7 (1.3)	6.3	0.84 (0.40-1.76)
Breast					
Total	47,854 (13.0)	286,926	65 (12.0)	22.7	1.54 (1.21-1.96)
<1 year	1,698 (0.5)	974	7 (1.3)	718.6	1.33 (0.63-2.79)
1-4 years	21,849 (5.9)	80,421	37 (6.8)	46.0	1.70 (1.23-2.34)
≥5 years	24,307 (6.6)	205,531	21 (3.9)	10.2	1.38 (0.90-2.12)
Cervix					
Total	43,066 (11.7)	277,680	60 (11.0)	21.6	1.36 (1.06-1.75)
<1 year	3,099 (0.8)	1,721	11 (2.0)	639.3	2.32 (1.28-4.19)
1-4 years	14,960 (4.0)	50,916	28 (5.1)	55.0	1.44 (0.99-2.08)
≥5 years	25,007 (6.8)	225,043	21 (3.9)	9.3	1.06 (0.69-1.62)
Ovary					
Total	10,390 (2.8)	50,553	21 (3.9)	41.5	2.84 (1.85-4.35)
<1 year	1,791 (0.5)	801	4 (0.7)	499.7	3.74 (1.41-9.98)
1-4 years	4,425 (1.2)	14,027	14 (2.6)	99.8	3.83 (2.27-6.47)
≥5 years	4,174 (1.1)	35,725	3 (0.6)	8.4	1.12 (0.36-3.48)
Colon					
Total	33,708 (9.1)	146,588	81 (14.9)	55.3	2.40 (1.93-2.98)
<1 year	6,809 (1.8)	3,125	21 (3.9)	672.0	4.26 (2.78-6.53)
1-4 years	15,498 (4.2)	48,701	46 (8.5)	94.5	2.65 (1.99-3.54)
≥5 years	11,401 (3.1)	94,763	14 (2.6)	14.8	1.22 (0.72-2.05)
Stomach					
Total	56,049 (15.2)	210,698	103 (18.9)	48.9	2.38 (1.96-2.89)
<1 year	18,720 (5.1)	7,851	31 (5.7)	394.8	4.60 (3.23-6.53)
1-4 years	20,894 (5.7)	61,694	50 (9.2)	81.1	2.41 (1.83-3.18)
≥5 years	16,435 (4.4)	141,153	22 (4.0)	15.6	1.39 (0.92-2.11)
Biliary					
Total	11,695 (3.2)	22,820	13 (2.4)	57.0	2.44 (1.41-4.20)
<1 year	6,827 (1.8)	2,518	7 (1.3)	278.0	5.39 (2.57-11.31)
1-4 years	3,451 (0.9)	8,308	5 (0.9)	60.2	2.06 (0.86-4.94)
≥5 years	1,417 (0.4)	11,994	1 (0.2)	8.3	0.62 (0.09-4.41)
Liver					
Total	22,558 (6.1)	38,780	14 (2.6)	36.1	1.94 (1.15-3.28)
<1 year	13,573 (3.7)	4,363	9 (1.7)	206.3	4.60 (2.39-8.84)
1-4 years	6,855 (1.9)	17,109	4 (0.7)	23.4	1.12 (0.42-2.99)
≥5 years	2,130 (0.6)	17,309	1 (0.2)	5.8	0.59 (0.08-4.22)

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change of appearance, speech, and swallowing ability could lead to suicidal ideation among patients with oropharyngeal cancer.

We observed unexpected patterns of suicide among patients with stomach or liver cancer, which are common cancers in Korea. The suicide SMR for stomach cancer was not as high as it is in western countries (1, 3, 4), which might follow from the better prognosis for stomach cancer in Korea (5, 6, 41). That the suicide rate for liver cancer was lower than in Sweden (4) could follow from differing etiologies: chronic hepatitis B (from vertical infection) in South Korea and chronic hepatitis C (often related to i.v. substance abuse) in Sweden (42, 43).

Our study should be interpreted in the light of its limitations. First, we could not determine which patients completed treatment and which were midtreatment, and

Table 3. Suicide rates among female cancer survivors by cancer diagnosis (ICD-10) (Cont'd)

Diagnosis	Patients, *n* (%)	Person-years of follow-up	Deaths by suicide, *n* (%)	Suicides/100,000 person-years	SMR* (95% CI)
Lung					
Total	23,234 (6.3)	42,008	35 (6.4)	83.3	3.55 (2.55-4.94)
<1 year	13,128 (3.6)	5,122	19 (3.5)	371.0	7.31 (4.66-11.47)
1-4 years	7,794 (2.1)	17,949	15 (2.8)	83.6	3.17 (1.91-5.25)
≥5 years	2,312 (0.6)	18,937	1 (0.2)	5.3	0.40 (0.06-2.81)
Pancreas					
Total	7,790 (2.1)	8,680	5 (0.9)	57.6	2.76 (1.15-6.63)
<1 year	5,971 (1.6)	2,067	5 (0.9)	241.9	7.61 (3.17-18.29)
1-4 years	1,379 (0.4)	2,723	0 (0.0)	0.0	N/A
≥5 years	440 (0.1)	3,891	0 (0.0)	0.0	N/A
Other†	90,032 (24.4)	462,130	129 (23.7)	27.9	N/A

*Sex- and age-adjusted standardized mortality ratio.
†Cancers other than 10 most common cancers among women.

those groups could differ in suicide propensity. For those who completed treatment, for example, socioeconomic status might be a more important risk factor than clinical characteristics. Second, our limited data did not allow for consideration of the influence of stage at diagnosis in the analysis of suicide risk. However, the correlation between those variables is inconsistent. A study in the United States showed that suicide rates were higher among

Table 4. Sociodemographic characteristics of cancer survivors who died from suicide compared with those who died from the cancer itself

Characteristic	Deaths by suicide, *n* (%)	Person-years of follow-up	RR* (95% CI)	*P*
Sex				
Female	544 (26.3)	1,311,008	1 (reference)	
Male	1,521 (73.7)	1,696,286	2.40 (2.12-2.71)	<0.0001
Age at diagnosis, y				
Mean (SD)	58.29 (13.26)			
≤19	7 (0.3)	79,177	0.13 (0.06-0.28)	<0.0001
20-39	191 (9.3)	537,022	1 (reference)	
40-59	819 (39.7)	1,358,089	0.78 (0.66-0.92)	0.004
60-79	981 (47.5)	984,846	0.53 (0.45- 0.63)	<0.0001
≥80	67 (3.2)	48,160	0.33 (0.25-0.45)	<0.0001
Marital status				
Married	1,413 (69.0)	465,948	1 (reference)	
Divorced/separated/widowed	544 (26.6)	172,800	1.44 (1.29-1.61)	<0.0001
Single	91 (4.4)	25,382	1.33 (1.05-1.69)	0.020
Education				
>12 years	178 (8.7)	69,825	1 (reference)	
≤12 years	1,878 (91.3)	598,148	1.50 (1.28-1.76)	<0.0001
Employed at time of death				
Yes	677 (33.2)	233,182	1 (reference)	
No	1,363 (66.8)	424,139	1.38 (1.25-1.53)	<0.0001
Residential area				
Small city or rural area	1,048 (50.8)	1,502,346	1 (reference)	
Large city	1,017 (49.3)	1,502,429	1.15 (1.05-1.25)	0.003

*Adjusted for sex, age, marriage, education, region, cancer diagnosis, year of diagnosis, and time to suicide or cancer death.

cancer patients with advanced disease at diagnosis (1), whereas an international study of breast cancer patients showed the trend of increased suicide risk with increasing stage to be nonsignificant (P for heterogeneity = 0.08; ref. 2) and a Norwegian study reported the relative suicide risk to be higher for patients with nonlocalized cancers than for patients with localized cancers ($P < 0.001$) only in men (3).

Third, patients who were registered in 2001-2002 were followed up for <5 years. Therefore, for patients who survived >5 years, the difference in suicide between those who were diagnosed in 1993-1997 and those who were diagnosed in 1998-2002 could be underestimated because the suicide rate increased during the latter period.

Fourth, in the analysis of risk factors, our sample was limited to deceased patients, and it therefore may have been biased. Our observations, however, are consistent with reports that suicide risk in the general population is higher when social status is lower. Furthermore, suicide risk could be underestimated in lower socioeconomic groups because a higher cancer death rate could operate as a competing mortality. There is ample evidence that lower socioeconomic status is associated with poorer cancer outcomes and survival (44-47). Nevertheless, further investigation to confirm our observation is warranted.

Fifth, KCCR records may underestimate suicide rates because the KCCR depends on the reports of bereaved families. Thus, many suicides may be misclassified as traffic accident fatalities, and the deaths of homeless or unidentified persons are not counted (48). In addition, we did not consider race as a significant variable because Korea is racially homogeneous and neither the KCCR nor the NSO database collects racial data.

In spite of those limitations, our study showed that Korean cancer patients were at increased risk of suicide, and the risk was greater for the less educated and the unemployed. Further research into the suicide risk of cancer patients should extend the range of concerns from clinical factors to socioeconomic factors, and our findings suggest the need for social support and prevention efforts.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

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