

Cancer Statistics in Korea: Incidence, Mortality, Survival, and Prevalence in 2016

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Purpose

This study presents the 2016 nationwide cancer statistics in Korea, including cancer incidence, survival, prevalence, and mortality.

Materials and Methods

Cancer incidence data from 1999 to 2016 were obtained from the Korea National Cancer Incidence Database and followed until December 31, 2017. Mortality data from 1983 to 2016 were obtained from Statistics Korea. The prevalence was defined as the number of cancer patients alive on January 1, 2017 among all cancer patients diagnosed since 1999. Crude and age-standardized rates (ASRs) for incidence, mortality, and prevalence and 5-year relative survivals were also calculated.

Results

Overall, 229,180 and 78,194 Koreans were newly diagnosed and died from cancer in 2016, respectively. The ASRs for cancer incidence and mortality in 2016 were 269.0 and 79.8 per 100,000 individuals, respectively. The all-cancer incidence rate increased significantly by 3.6% annually from 1999 to 2011 and started to decrease after 2011 (2011-2016; annual percent change, -3.1%). However, overall cancer mortality has decreased 2.7% annually since 2002. The 5-year relative survival rate for patients diagnosed with cancer between 2012 and 2016 was 70.6%, an improvement from the 41.2% for patients diagnosed between 1993 and 1995.

Conclusion

The cancer prevalence in Korea has increased very fast as survival has improved remarkably. The high prevalence of cancer emphasizes the need for comprehensive cancer control efforts in Korea.

Key words

Incidence, Survival, Prevalence, Mortality, Neoplasms, Korea

Introduction

The global cancer burden has risen to 18.1 million cases and 9.6 million cancer deaths in 2018 [1]. Cancer incidence and mortality are rapidly growing worldwide. The reasons are complex but reflect both aging and growth of the population, as well as changes in the prevalence and distribution of the main risk factors for cancer [2].

In Korea, cancer accounts for one in four deaths and more

than 200,000 new cancer cases were diagnosed in 2015 [3]. The number of cancer incidences and deaths are expected to increase with an aging population and westernized lifestyles [4].

In this context, cancer statistics are the most important indicator to assess the national cancer burden, which can be used to establish cancer control strategies. This article aimed to provide nationwide cancer statistics including incidence, survival, prevalence, and mortality in 2016.

Materials and Methods

1. Data sources

The Korea Central Cancer Registry (KCCR) was established by the Ministry of Health and Welfare in 1980 as a nationwide hospital-based cancer registry. Since 1999, the KCCR has collected cancer incidence data nationwide by integrating a nationwide hospital-based KCCR database with data from regional cancer registries. The KCCR currently provides the nationwide cancer incidence, survival, and prevalence statistics annually [5].

The KCCR built the Korea National Cancer Incidence Database (KNCI DB) from hospitals, 11 population-based registries, and additional medical record reviews. The KNCI DB contains information regarding age, sex, region, date of diagnosis, primary cancer site, histological type, most valid diagnostic method, summary stage of surveillance, epidemiology and end results program (SEER) and first course of treatment within four months after diagnosis. The completeness of cancer incidence data for 2016 was estimated to be 98.2% based on the method proposed by Ajiki et al. [6]. The mid-year population and cancer mortality data from 1983 to 2016 were obtained from Statistics Korea [7]. To ascertain vital status and to calculate survival and prevalence, the KNCI DB was linked to mortality data and population registration data from the Ministry of the Interior.

2. Classification

All incidence cases were registered according to the International Classification of Diseases for Oncology, third edition [8] and converted to the International Classification of Diseases, 10th edition (ICD-10) [9]. The mortality cases were registered according to ICD-10. All cancer cases were reported based on the 24 cancer types.

3. Statistical analyses

Rates were expressed as crude and age-standardized rates (CR and ASR, respectively) per 100,000 individuals. The CR was calculated as the total number of incidence/mortality cases divided by the mid-year population of the specified years. The ASR is a weighted average of the age-specific rates, where the weights are the proportions of persons in the corresponding age groups of a standard population [10]. In this report, ASRs were calculated using Segi's world standard population [11]. The cumulative risk of developing cancer from birth to life expectancy was calculated using cumulative rates; that is, the sum of the age-specific rates from birth to life expectancy, as follows [12]:

$$\text{Cumulative risk of developing cancer from birth to life expectancy} = 100 \times \left(1 - e^{-\frac{\text{cumulative rate}}{100}} \right)$$

Trends in ASRs were summarized as an annual percentage change (APC) by using a Joinpoint regression. APC is the average percentage change of ASRs and is calculated as follows [10]:

$$APC = \frac{R_{y+1} - R_y}{R_y} \times 100 = (e^{b_1} - 1) \times 100$$

, where $\log(R_y) = b_0 + b_1 y$,

$\log(R_y)$ is the natural log transformed age standardized rates.

y =year, b_0 =intercept, b_1 =slope

The survival duration for each cancer case was determined as the interval between the date of initial diagnosis and the date of death, date of loss of follow-up, or closing date for follow-up, whichever came first. The 5-year relative survival rate was calculated as the ratios of the observed survival of the cancer patients to the expected survival of the general population, which was derived from the standard life table provided by Statistics Korea. Trends in 5-year relative survival rates were evaluated as percentage differences in 5-year relative survival rates from 1993-1995 and 2012-2016. Relative survival rates were calculated using the Ederer II method [13] with some minor corrections, based on an algorithm by Paul Dickman [14].

Prevalent cases were defined as the number of cancer patients alive on January 1, 2017 among all cancer patients diagnosed between 1999 and 2016. Limited-duration prevalences were calculated using SEER*Stat software. Any p-values less than 0.05 were considered statistically significant. SEER*Stat 8.1.2 (National Cancer Institute, Bethesda, MD), Joinpoint 4.1.1 (National Cancer Institute), and SAS ver. 9.4 (SAS Institute, Cary, NC) were used for statistical analysis.

Selected Findings

1. Incidence

A total of 229,180 cancer cases were newly diagnosed in 2016, which included 120,068 men (52.4%) and 109,112 women (47.6%) (Table 1). Stomach cancer was the most commonly diagnosed cancer in 2016, followed by colorectal, thyroid, lung, and breast cancer. The overall cumulative risk of developing cancer from birth to life expectancy was 36.2%. The cumulative risk of developing cancer from birth to life expectancy was higher in men (38.3%) than in women

Table 1. Cancer incidence, deaths, and prevalence by sex in Korea, 2016

Site/Type	New cases			Deaths			Prevalent cases ^{a)}		
	Both sexes	Men	Women	Both sexes	Men	Women	Both sexes	Men	Women
All sites	229,180	120,068	109,112	78,194	48,208	29,986	1,739,951	764,103	975,848
Lip, oral cavity, and pharynx	3,543	2,527	1,016	1,203	909	294	23,639	15,847	7,792
Esophagus	2,499	2,245	254	1,524	1,379	145	9,777	8,780	997
Stomach	30,504	20,509	9,995	8,264	5,318	2,946	273,701	181,234	92,467
Colon and rectum	28,127	16,672	11,455	8,358	4,659	3,699	236,431	140,852	95,579
Liver	15,771	11,774	3,997	11,001	8,044	2,957	64,864	48,666	16,198
Gallbladder ^{b)}	6,685	3,490	3,195	4,408	2,248	2,160	21,011	10,776	10,235
Pancreas	6,655	3,384	3,271	5,614	2,901	2,713	10,595	5,502	5,093
Larynx	1,167	1,101	66	334	310	24	10,532	9,914	618
Lung	25,780	17,790	7,990	17,963	13,324	4,639	76,544	47,438	29,106
Breast	21,839	92	21,747	2,472	16	2,456	198,006	743	197,263
Cervix uteri	3,566	-	3,566	897	-	897	52,758	-	52,758
Corpus uteri	2,771	-	2,771	313	-	313	23,135	-	23,135
Ovary	2,630	-	2,630	1,204	-	1,204	19,509	-	19,509
Prostate	11,800	11,800	-	1,745	1,745	-	77,635	77,635	-
Testis	288	288	-	14	14	-	3,204	3,204	-
Kidney	5,043	3,410	1,633	1,032	724	308	38,836	26,161	12,675
Bladder	4,361	3,488	873	1,389	1,029	360	33,543	27,347	6,196
Brain and CNS	2,015	1,104	911	1,327	720	607	11,116	5,734	5,382
Thyroid	26,051	5,538	20,513	346	104	242	379,946	65,336	314,610
Hodgkin lymphoma	312	202	110	51	33	18	2,807	1,770	1,037
Non-Hodgkin lymphoma	4,766	2,766	2,000	1,820	1,068	752	30,093	17,130	12,963
Multiple myeloma	1,535	837	698	1,010	527	483	5,798	3,050	2,748
Leukemia	3,416	1,991	1,425	1,842	1,025	817	20,751	11,553	9,198
Other and ill-defined	18,056	9,060	8,996	4,063	2,111	1,952	115,720	55,431	60,289

CNS, central nervous system. ^{a)}Limited-duration prevalent cases on January 1, 2016. These are patients who were diagnosed between January 1, 1999 and December 31, 2016 and who were alive on January 1, 2017. Multiple primary cancer cases were counted multiple times, ^{b)}Includes the gallbladder and other/unspecified parts of the biliary tract.

(33.3%) (data not shown).

The total CR and ASR for overall cancer incidences in 2016 were 448.4 and 269.0 per 100,000, respectively (Table 2). According to sex, CRs for all sites combined were 470.3 per 100,000 in men and 426.5 per 100,000 in women. The ASRs were 298.0 and 254.6 per 100,000 in men and women, respectively. Stomach cancer (CR, 80.3 per 100,000) was the most common cancer in men, followed by lung (CR, 69.7 per 100,000), colorectal (CR, 65.3 per 100,000), prostate (CR, 46.2 per 100,000), and liver cancer (CR, 46.1 per 100,000). These five cancers accounted for 65.4% of newly diagnosed cases in men during the study period. In contrast, breast cancer (CR, 85.0 per 100,000) was the most common cancer among women, followed by thyroid (CR, 80.2 per 100,000), colorectal (CR, 44.8 per 100,000), stomach (CR, 39.1 per 100,000), and lung cancer (CR, 31.2 per 100,000). These five cancers accounted for 65.7% of cases in women.

2. Mortality

The total number of deaths from cancer in 2016 was 78,194, accounting for 27.8% of all deaths (Table 3). According to sex, 61.7% and 38.3% of cancer deaths occurred in men and women, respectively (Table 1).

The total CR and ASR for cancer deaths were 153.0 and 79.8 per 100,000, respectively, in 2016 (Table 4). The total CR and ASR for cancer deaths per 100,000 were higher among men (CR, 188.8; ASR, 115.5) than in women (CR, 117.2; ASR, 53.6).

According to the cancer sites, lung cancer (CR, 52.2 per 100,000) was the leading cause of death in men, followed by liver (CR, 31.5 per 100,000), stomach (CR, 20.8 per 100,000), colorectal (CR, 18.3 per 100,000), and pancreatic cancer (CR, 11.4 per 100,000). The top five causes of deaths from cancer in women included lung (CR, 18.1 per 100,000), colorectal

Table 2. Crude and age-standardized cancer incidence rates by sex in Korea, 2016

Site/Type	Crude incidence rate per 100,000			Age-standardized incidence rate per 100,000 ^{a)}		
	Both sexes	Men	Women	Both sexes	Men	Women
All sites	448.4	470.3	426.5	269.0	298.0	254.6
Lip, oral cavity, and pharynx	6.9	9.9	4.0	4.2	6.4	2.3
Esophagus	4.9	8.8	1.0	2.7	5.4	0.5
Stomach	59.7	80.3	39.1	34.0	49.6	20.5
Colon and rectum	55.0	65.3	44.8	30.7	40.4	22.4
Liver	30.9	46.1	15.6	17.6	28.5	7.8
Gallbladder ^{b)}	13.1	13.7	12.5	6.7	8.3	5.5
Pancreas	13.0	13.3	12.8	7.0	8.1	6.0
Larynx	2.3	4.3	0.3	1.3	2.6	0.1
Lung	50.4	69.7	31.2	27.1	42.3	15.4
Breast	42.7	0.4	85.0	27.7	0.2	54.9
Cervix uteri	7.0	0.0	13.9	4.6	-	9.1
Corpus uteri	5.4	0.0	10.8	3.4	-	6.8
Ovary	5.1	0.0	10.3	3.4	-	6.7
Prostate	23.1	46.2	0.0	12.5	28.2	-
Testis	0.6	1.1	0.0	0.6	1.1	-
Kidney	9.9	13.4	6.4	6.1	8.7	3.8
Bladder	8.5	13.7	3.4	4.5	8.4	1.6
Brain and CNS	3.9	4.3	3.6	3.1	3.5	2.7
Thyroid	51.0	21.7	80.2	36.6	15.6	58.1
Hodgkin lymphoma	0.6	0.8	0.4	0.5	0.6	0.4
Non-Hodgkin lymphoma	9.3	10.8	7.8	6.2	7.7	4.8
Multiple myeloma	3.0	3.3	2.7	1.7	2.0	1.4
Leukemia	6.7	7.8	5.6	5.6	6.6	4.7
Other and ill-defined	35.3	35.5	35.2	21.2	23.7	19.1

CNS, central nervous system. ^{a)}Age-adjusted using the Segi's world standard population, ^{b)}Includes the gallbladder and other / unspecified parts of the biliary tract.

Table 3. The top 10 leading causes of death in Korea, 2016

Rank	Cause of death	No. of deaths (%)	Age-standardized death rate per 100,000 ^{a)}
	All causes	280,827 (100)	280.8
1	Cancer	78,194 (27.8)	79.8
2	Heart disease	9,807 (3.5)	9.0
3	Cerebrovascular disease	5,416 (1.9)	4.6
4	Pneumonia	29,735 (10.6)	27.8
5	Intentional self-harm (suicide)	23,415 (8.3)	21.4
6	Diabetes mellitus	16,476 (5.9)	14.3
7	Chronic lower respiratory diseases	6,992 (2.5)	6.0
8	Disease of liver	6,798 (2.4)	7.7
9	Transport accidents	5,150 (1.8)	6.8
10	Hypertensive diseases	13,092 (4.7)	17.7
	Others	85,752 (30.5)	85.9

Source: Mortality Data, 2016, Statistics Korea [1]. ^{a)}Age-adjusted using the Segi's world standard population.

Table 4. Crude and age-standardized cancer mortality rates by sex in Korea, 2016

Site/Type	Crude mortality rate per 100,000			Age-standardized mortality rate per 100,000 ^{a)}		
	Both sexes	Men	Women	Both sexes	Men	Women
All sites	153.0	188.8	117.2	79.8	115.5	53.6
Lip, oral cavity, and pharynx	2.4	3.6	1.1	1.3	2.2	0.5
Esophagus	3.0	5.4	0.6	1.6	3.2	0.2
Stomach	16.2	20.8	11.5	8.3	12.7	5.0
Colon and rectum	16.4	18.3	14.5	8.2	11.1	5.9
Liver	21.5	31.5	11.6	11.7	19.2	5.2
Gallbladder ^{b)}	8.6	8.8	8.4	4.2	5.3	3.4
Pancreas	11.0	11.4	10.6	5.7	7.0	4.6
Larynx	0.7	1.2	0.1	0.3	0.8	0.0
Lung	35.1	52.2	18.1	17.6	31.2	7.7
Breast	4.8	0.1	9.6	2.9	0.0	5.5
Cervix uteri	1.8	0.0	3.5	1.0	-	1.8
Corpus uteri	0.6	0.0	1.2	0.4	-	0.7
Ovary	2.4	0.0	4.7	1.3	-	2.5
Prostate	3.4	6.8	0.0	1.5	4.2	-
Testis	0.0	0.1	0.0	0.0	0.0	-
Kidney	2.0	2.8	1.2	1.1	1.8	0.5
Bladder	2.7	4.0	1.4	1.3	2.5	0.5
Brain and CNS	2.6	2.8	2.4	1.7	2.0	1.4
Thyroid	0.7	0.4	0.9	0.3	0.2	0.4
Hodgkin lymphoma	0.1	0.1	0.1	0.1	0.1	0.0
Non-Hodgkin lymphoma	3.6	4.2	2.9	1.9	2.6	1.4
Multiple myeloma	2.0	2.1	1.9	1.0	1.2	0.9
Leukemia	3.6	4.0	3.2	2.3	2.8	1.9
Other and ill-defined	7.9	8.3	7.6	4.3	5.3	3.5

CNS, central nervous system. ^{a)}Age-adjusted using the world standard population, ^{b)}Includes the gallbladder and other/ unspecified parts of the biliary tract.

(CR, 14.5 per 100,000), liver (CR, 11.6 per 100,000), stomach (CR, 11.5 per 100,000), and pancreatic cancer (CR, 10.6 per 100,000).

3. Trends in cancer incidence and mortality

Fig. 1 shows trends in cancer incidence and mortality from 1983 to 2016. The ASR for all-cancer incidence increased by 3.6% annually from 1999 to 2011, and then started to decrease from 2011 to 2016 (APC, -3.1%) (Table 5). Cases of stomach, colorectum, lung, and thyroid cancers started to decrease around 2011. Specifically, ASR for thyroid cancer increased rapidly to 22.6% from 1999 to 2011, but then decreased swiftly by 12.6% annually starting in 2011. The incidence of breast cancer increased constantly throughout the period; however, the APC slowed from 2005 onward. Conversely, the incidence rates of cervix and liver showed a constant

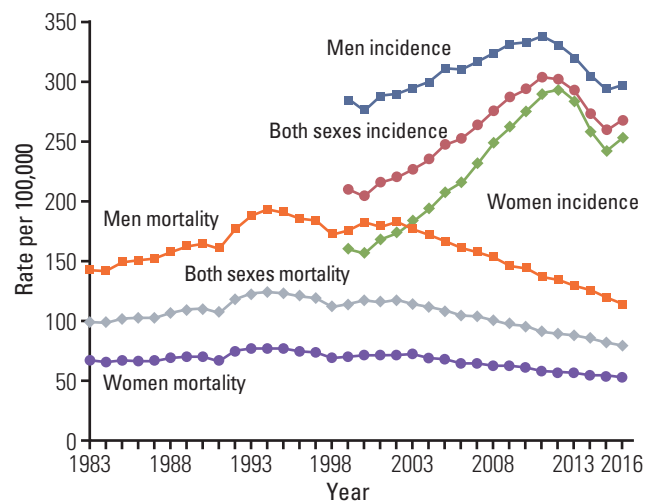


Fig. 1. Annual age-standardized cancer incidence and death rates by sex for all sites from 1983 to 2016 in Korea. Age standardization was based on the Segi's world standard population.

Table 5. Trends in cancer incidence rates from 1999 to 2016 in Korea

Site/Type	Both sexes						Men			Women								
	1999		2016		Trend 2		1999		2016		Trend 1		Trend 2					
	Year	APC	Year	APC	Year	APC	Year	APC	Year	APC	Year	APC	Year	APC				
All sites	210.5	269.0	1999-2011	3.6 ^{a)}	2011-2016	-3.1 ^{a)}	285.0	298.0	1999-2011	1.7 ^{a)}	2011-2016	-3.0 ^{a)}	161.1	254.6	1999-2011	5.8 ^{a)}	2011-2016	-3.5 ^{a)}
Lip, oral cavity, and pharynx	3.6	4.2	1999-2016	0.6 ^{a)}	-	-	6.1	6.4	1999-2016	-0.1	-	-	1.6	2.3	1999-2016	1.5 ^{a)}	-	-
Esophagus	4.1	2.7	1999-2016	-2.2 ^{a)}	-	-	8.8	5.4	1999-2016	-2.7 ^{a)}	-	-	0.6	0.5	1999-2016	-1.5 ^{a)}	-	-
Stomach	43.6	34.0	1999-2011	-0.2	2011-2016	-4.9 ^{a)}	66.2	49.6	1999-2011	-0.4 ^{a)}	2011-2016	-5.4 ^{a)}	26.7	20.5	1999-2011	-0.4	2011-2016	-4.5 ^{a)}
Colon and rectum	20.4	30.7	1999-2010	6.0 ^{a)}	2010-2016	-4.5 ^{a)}	26.2	40.4	1999-2010	6.5 ^{a)}	2010-2016	-5.0 ^{a)}	16.4	22.4	1999-2010	4.9 ^{a)}	2010-2016	-3.9 ^{a)}
Liver	27.9	17.6	1999-2010	-1.7 ^{a)}	2010-2016	-4.4 ^{a)}	46.8	28.5	1999-2009	-1.9 ^{a)}	2009-2016	-4.1 ^{a)}	12.3	7.8	1999-2010	-1.5 ^{a)}	2010-2016	-4.8 ^{a)}
Gallbladder ^{b)}	6.5	6.7	1999-2004	1.5	2004-2016	-0.3	8.1	8.3	1999-2016	0.1	-	-	5.4	5.5	1999-2003	2.4	2003-2016	-0.5 ^{a)}
Pancreas	5.6	7.0	1999-2016	1.4 ^{a)}	-	-	7.8	8.1	1999-2016	0.5 ^{a)}	-	-	4.0	6.0	1999-2016	2.3 ^{a)}	-	-
Larynx	2.3	1.3	1999-2016	-3.6 ^{a)}	-	-	4.9	2.6	1999-2016	-3.8 ^{a)}	-	-	0.4	0.1	1999-2007	-9.0 ^{a)}	2007-2016	-4.1 ^{a)}
Lung	28.5	27.1	1999-2011	0.1	2011-2016	-1.4 ^{a)}	51.4	42.3	1999-2005	-0.1	2005-2016	-1.6 ^{a)}	12.4	15.4	1999-2011	2.0 ^{a)}	2011-2016	-0.1
Breast	10.7	27.7	1999-2005	7.6 ^{a)}	2005-2016	4.5 ^{a)}	0.2	0.2	1999-2016	-0.8	-	-	20.9	54.9	1999-2005	7.8 ^{a)}	2005-2016	4.6 ^{a)}
Cervix uteri	8.5	4.6	1999-2016	-3.8 ^{a)}	-	-	-	-	-	-	-	-	16.3	9.1	1999-2016	-3.6 ^{a)}	-	-
Corpus uteri	1.4	3.4	1999-2003	8.8 ^{a)}	2003-2016	4.6 ^{a)}	-	-	-	-	-	-	2.8	6.8	1999-2003	9.1 ^{a)}	2003-2016	4.7 ^{a)}
Ovary	2.7	3.4	1999-2016	1.6 ^{a)}	-	-	-	-	-	-	-	-	5.0	6.7	1999-2016	1.9 ^{a)}	-	-
Prostate	3.1	12.5	1999-2009	15.1 ^{a)}	2009-2016	1.0	8.4	28.2	1999-2009	13.5 ^{a)}	2009-2016	0.2	-	-	-	-	-	-
Testis	0.3	0.6	1999-2016	4.9 ^{a)}	-	-	0.6	1.1	1999-2016	4.7 ^{a)}	-	-	-	-	-	-	-	-
Kidney	3.0	6.1	1999-2009	6.6 ^{a)}	2009-2016	1.7 ^{a)}	4.5	8.7	1999-2010	6.0 ^{a)}	2010-2016	0.8	1.7	3.8	1999-2008	6.9 ^{a)}	2008-2016	2.2 ^{a)}
Bladder	4.6	4.5	1999-2004	2.2 ^{a)}	2004-2016	-1.2 ^{a)}	9.0	8.4	1999-2004	2.0 ^{a)}	2004-2016	-1.5 ^{a)}	1.6	1.6	1999-2003	2.2	2003-2016	-1.4 ^{a)}
Brain and CNS	2.9	3.1	1999-2016	0.2	-	-	3.2	3.5	1999-2016	0.3	-	-	2.6	2.7	1999-2016	0.1	-	-
Thyroid	6.3	36.6	1999-2011	22.6 ^{a)}	2011-2016	-12.6 ^{a)}	2.1	15.6	1999-2012	22.5 ^{a)}	2012-2016	-14.0 ^{a)}	10.4	58.1	1999-2011	22.3 ^{a)}	2011-2016	-13.5 ^{a)}
Hodgkin lymphoma	0.2	0.5	1999-2016	4.0 ^{a)}	-	-	0.4	0.6	1999-2016	3.2 ^{a)}	-	-	0.1	0.4	1999-2016	5.1 ^{a)}	-	-
Non-Hodgkin lymphoma	4.3	6.2	1999-2016	2.4 ^{a)}	-	-	5.6	7.7	1999-2016	2.0 ^{a)}	-	-	3.3	4.8	1999-2016	2.6 ^{a)}	-	-
Multiple myeloma	1.0	1.7	1999-2012	3.7 ^{a)}	2012-2016	0.8	1.2	2.0	1999-2012	3.5 ^{a)}	2012-2016	0.5	0.8	1.4	1999-2006	6.1 ^{a)}	2006-2016	2.2 ^{a)}
Leukemia	4.7	5.6	1999-2016	1.0 ^{a)}	-	-	5.5	6.6	1999-2016	1.1 ^{a)}	-	-	3.9	4.7	1999-2016	0.8 ^{a)}	-	-
Other and ill-defined	14.4	21.2	1999-2007	3.6 ^{a)}	2007-2016	1.7 ^{a)}	18.1	23.7	1999-2016	1.9 ^{a)}	-	-	11.9	19.1	1999-2008	4.2 ^{a)}	2008-2016	1.7 ^{a)}

APC was calculated using age-standardized incidence data based on the Segi's world standard population. APC, annual percentage change; CNS, central nervous system. ^{a)}Significantly different from zero ($p < 0.05$). ^{b)}Includes the gallbladder and other/ unspecified parts of the biliary tract.

Table 6. Trends in cancer mortality rates from 1999 to 2016 in Korea

Site/Type	Both sexes						Men						Women										
	1999		2016		Trend 2		1999		2016		Trend 1		Trend 2		1999		2016		Trend 1		Trend 2		
	Year	APC	Year	APC	Year	APC	Year	APC	Year	APC	Year	APC	Year	APC	Year	APC	Year	APC	Year	APC	Year	APC	
All sites	114.3	79.8	1999-2002	1.1	2002-2016	-2.7 ^{a)}	176.6	115.5	1999-2002	1.3	2002-2016	-3.2 ^{a)}	70.6	53.6	1999-2002	1.0	2002-2016	-2.2 ^{a)}					
Lip, oral cavity, and pharynx	1.1	1.3	1999-2016	-1.8 ^{a)}	-	-	2.0	2.2	1999-2016	-2.0 ^{a)}	-	-	0.4	0.5	1999-2016	-2.5 ^{a)}	-	-					
Esophagus	3.1	1.6	1999-2016	-4.3 ^{b)}	-	-	6.8	3.2	1999-2016	-4.6 ^{b)}	-	-	0.5	0.2	1999-2010	-6.4 ^{b)}	2010-2016	-0.6					
Stomach	23.8	8.3	1999-2003	-3.2 ^{a)}	2003-2016	-6.7 ^{b)}	36.9	12.7	1999-2003	-2.5 ^{a)}	2003-2016	-7.1 ^{a)}	14.6	5.0	1999-2003	-4.4 ^{b)}	2003-2016	-6.6 ^{b)}					
Colon and rectum	7.7	8.2	1999-2004	5.8 ^{b)}	2004-2016	-1.5 ^{a)}	10.5	11.1	1999-2010	1.9 ^{a)}	2010-2016	-3.8 ^{a)}	6.0	5.9	1999-2004	5.1 ^{a)}	2004-2016	-2.0 ^{a)}					
Liver	20.4	11.7	1999-2002	1.0	2002-2016	-3.8 ^{b)}	35.3	19.2	1999-2002	0.2	2002-2016	-3.9 ^{a)}	8.3	5.2	1999-2002	2.9	2002-2016	-3.8 ^{b)}					
Gallbladder ^{b)}	5.2	4.2	1999-2001	6.9	2001-2016	-2.6 ^{b)}	6.8	5.3	1999-2001	5.5	2001-2016	-2.6 ^{a)}	4.1	3.4	1999-2001	9.0	2001-2016	-2.6 ^{b)}					
Pancreas	5.4	5.7	1999-2016	0.3 ^{b)}	-	-	7.6	7.0	1999-2016	-0.4 ^{a)}	-	-	3.9	4.6	1999-2016	0.9 ^{a)}	-	-					
Larynx	1.6	0.3	1999-2016	-9.5 ^{b)}	-	-	3.4	0.8	1999-2016	-9.1 ^{a)}	-	-	0.4	0.0	1999-2010	-15.3 ^{a)}	2010-2016	-8.0 ^{b)}					
Lung	22.4	17.6	1999-2002	1.9	2002-2016	-2.1 ^{a)}	41.5	31.2	1999-2001	4.3	2001-2016	-2.5 ^{a)}	9.4	7.7	1999-2002	2.6	2002-2016	-1.7 ^{b)}					
Breast	2.2	2.9	1999-2016	1.4 ^{b)}	-	-	0.1	0.0	1999-2016	-4.3 ^{a)}	-	-	4.2	5.5	1999-2016	1.6 ^{b)}	-	-					
Cervix uteri	1.4	1.0	1999-2003	8.3 ^{b)}	2003-2016	-5.1 ^{a)}	-	-	-	-	-	-	2.6	1.8	1999-2003	7.7 ^{a)}	2003-2016	-4.8 ^{b)}					
Corpus uteri	0.1	0.4	1999-2002	52.0 ^{b)}	2002-2016	3.4 ^{b)}	-	-	-	-	-	-	0.1	0.7	1999-2002	51.7 ^{a)}	2002-2016	3.7 ^{b)}					
Ovary	0.9	1.3	1999-2001	10.2	2001-2016	0.4	-	-	-	-	-	-	1.7	2.5	1999-2006	1.0 ^{b)}	-	-					
Prostate	0.9	1.5	1999-2004	9.7 ^{b)}	2004-2016	0.1	2.6	4.2	1999-2004	9.6 ^{a)}	2002-2016	-0.4	-	-	-	-	-	-					
Testis	0.0	0.0	1999-2016	-2.6	-	-	0.1	0.0	1999-2016	-3.1 ^{a)}	-	-	-	-	-	-	-	-					
Kidney	1.1	1.1	1999-2016	-0.1	-	-	1.8	1.8	1999-2016	0.0	-	-	0.5	0.5	1999-2016	-0.7	-	-					
Bladder	1.3	1.3	1999-2011	10.0	2011-2016	-1.7 ^{a)}	2.6	2.5	1999-2016	-1.6 ^{a)}	-	-	0.5	0.5	1999-2001	10.3	2001-2016	-1.7 ^{a)}					
Brain and CNS	1.9	1.7	1999-2002	4.2	2002-2016	-1.9 ^{b)}	2.2	2.0	1999-2016	-1.5 ^{a)}	-	-	1.6	1.4	1999-2016	-1.4 ^{b)}	-	-					
Thyroid	0.4	0.3	1999-2003	7.4 ^{b)}	2003-2016	-4.4 ^{b)}	0.3	0.2	1999-2003	10.3	2003-2016	-4.5 ^{a)}	0.5	0.4	1999-2004	4.5	2004-2016	-4.9 ^{b)}					
Hodgkin lymphoma	0.0	0.1	1999-2004	22.5 ^{b)}	2004-2016	-1.4	0.0	0.1	1999-2004	19.5 ^{a)}	2004-2016	-2.3	0.0	0.0	1999-2003	43.6 ^{b)}	2003-2016	0.0					
Non-Hodgkin lymphoma	2.1	1.9	1999-2016	-0.5 ^{a)}	-	-	3.0	2.6	1999-2016	-0.8 ^{a)}	-	-	1.4	1.4	1999-2016	-0.2	-	-					
Multiple myeloma	0.6	1.0	1999-2003	12.7 ^{a)}	2003-2016	0.9	0.8	1.2	1999-2003	11.0 ^{a)}	2003-2016	0.8	0.4	0.9	1999-2005	9.8 ^{a)}	2005-2016	0.3					
Leukemia	2.9	2.3	1999-2016	-1.7 ^{a)}	-	-	3.5	2.8	1999-2016	-1.6 ^{a)}	-	-	2.4	1.9	1999-2016	-1.9 ^{a)}	-	-					
Other and ill-defined	7.8	4.3	1999-2016	-3.1 ^{a)}	-	-	9.0	5.3	1999-2008	-0.3	2009-2016	-5.7 ^{a)}	7.0	3.5	1999-2005	-7.0 ^{a)}	2005-2016	-2.1 ^{a)}					

APC was calculated using age-standardized incidence data based on the Segi's world standard population. APC, annual percentage change; CNS, central nervous system. ^{a)}Significantly different from zero ($p < 0.05$). ^{b)}Includes the gallbladder and other/ unspecified parts of the biliary tract.

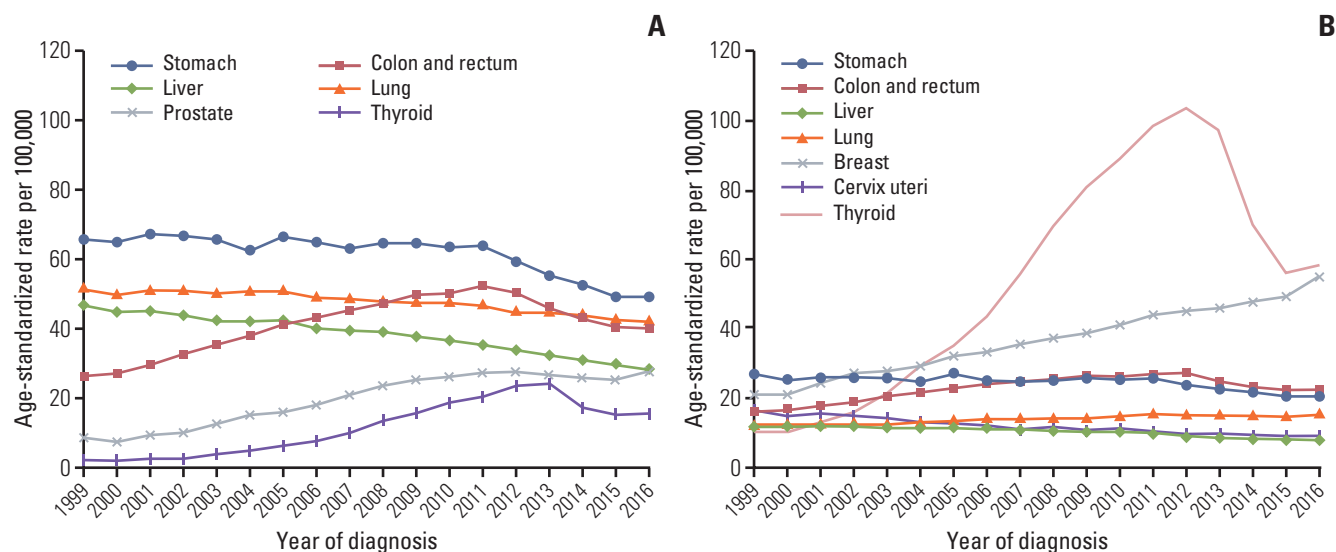


Fig. 2. Trends in age-standardized incidences of selected cancers by sex from 1999 to 2016 in Korea. (A) Men. (B) Women. Age standardization was based on the Segi's world standard population.

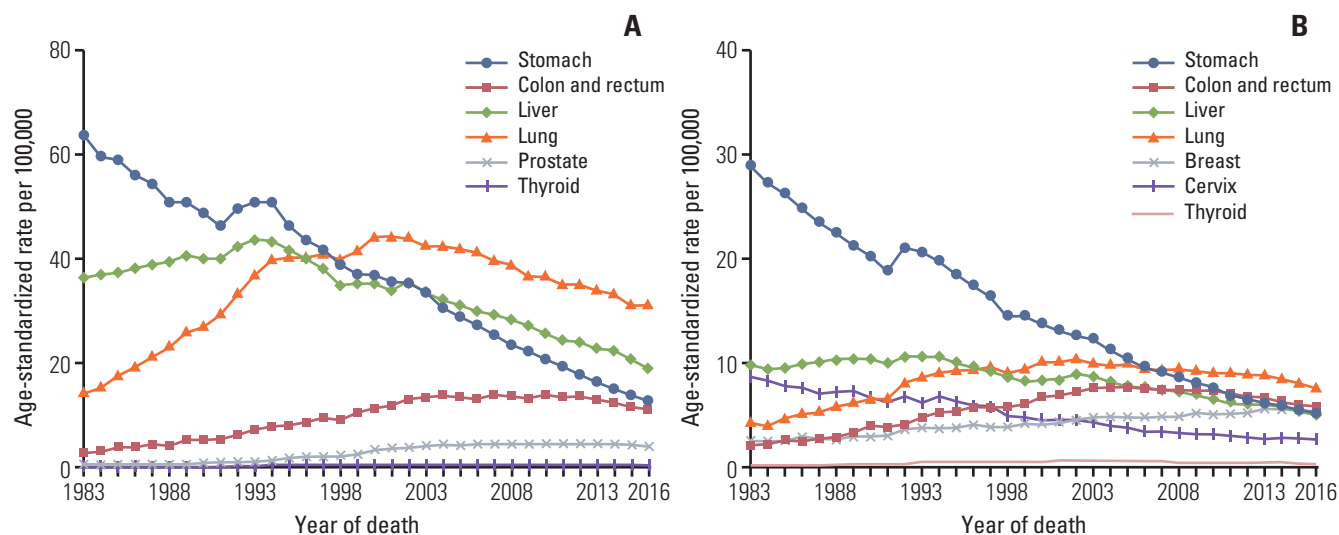


Fig. 3. Annual age-standardized cancer mortalities of selected cancers by sex from 1983 to 2016 in Korea. (A) Men. (B) Women. Age standardization was based on the Segi's world standard population.

decrease for the whole period. Thyroid cancer decreased the most drastically starting in the early 2010s (Fig. 2).

The ASR for all-cancer mortality rate increased until 2002 (Table 6). After that year, it started to decrease (2002-2016; APC, -2.7%). The same patterns were evident in men and women. Cancer incidence at most sites, including the cervix uteri, thyroid, liver, gallbladder, lung, brain and central nerv-

ous system, and colorectum started to decrease in the early 2000s. Furthermore, cancers of the lips, oral cavity and pharynx, esophagus, stomach, larynx, and non-Hodgkin lymphoma decreased from 1999. Breast cancer showed constant increasing trends for the whole period (Fig. 3).

Table 7. The five common sites of cancer incidence by age group and sex in Korea, 2016

Rank	Age (yr)			
	0-14	15-34	35-64	≥ 65
Men				
1	Leukemia (5.2)	Thyroid (13.7)	Stomach (85.6)	Lung (435.1)
2	Non-Hodgkin lymphoma (2.9)	Leukemia (3.8)	Colon and rectum (65.1)	Stomach (353.1)
3	Brain and CNS (2.3)	Non-Hodgkin lymphoma (3.1)	Liver (55.6)	Prostate (313.4)
4	Kidney (0.6)	Colon and rectum (2.6)	Lung (44.0)	Colon and rectum (302.6)
5	Liver (0.4)	Testis (2.3)	Thyroid (33.3)	Liver (175.5)
Women				
1	Leukemia (4.5)	Thyroid (50.5)	Breast (147.5)	Colon and rectum (175.2)
2	Brain and CNS (2.0)	Breast (12.0)	Thyroid (127.9)	Stomach (137.2)
3	Non-Hodgkin lymphoma (1.2)	Cervix uteri (5.7)	Colon and rectum (37.6)	Lung (126.8)
4	Ovary (0.5)	Ovary (3.3)	Stomach (37.6)	Breast (89.5)
5	Kidney (0.4)	Leukemia (2.8)	Lung (24.9)	Liver (65.6)

CNS, central nervous system.

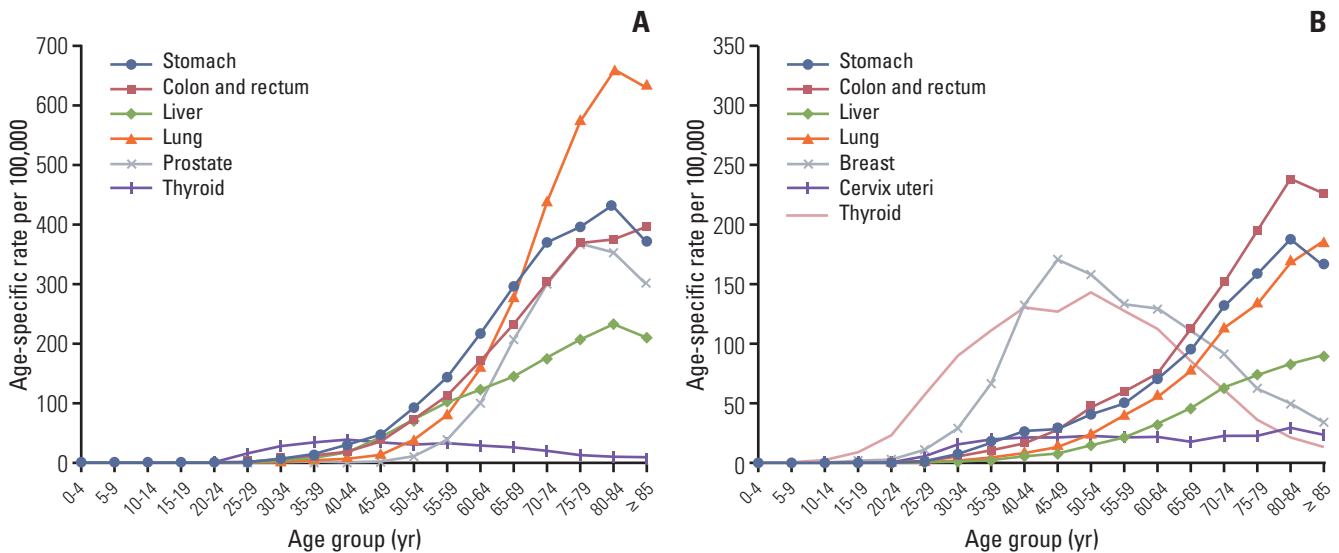


Fig. 4. Age-specific incidence rates of common cancers for 2016 in Korea. (A) Men. (B) Women.

4. Age-specific incidence rates

Leukemia was the most commonly diagnosed cancer among children between 0-14 years of age. Thyroid cancer was the most common cancer among adolescents and young adults between 15 and 34 years of age (Table 7). Stomach cancer was the most commonly diagnosed cancer among men aged 35 to 64 years, while lung cancer was the most common among men aged 65 years and above (Fig. 4A). In contrast,

breast cancer was the most commonly diagnosed cancer among women aged 35 to 64 years, while colorectal cancer was the most common among women aged 65 years and above. Thyroid and breast cancers showed an inverted U-shaped incidence rate by age (Fig. 4B).

5. Survival rates

The 5-year relative survival rates for all cancer combined

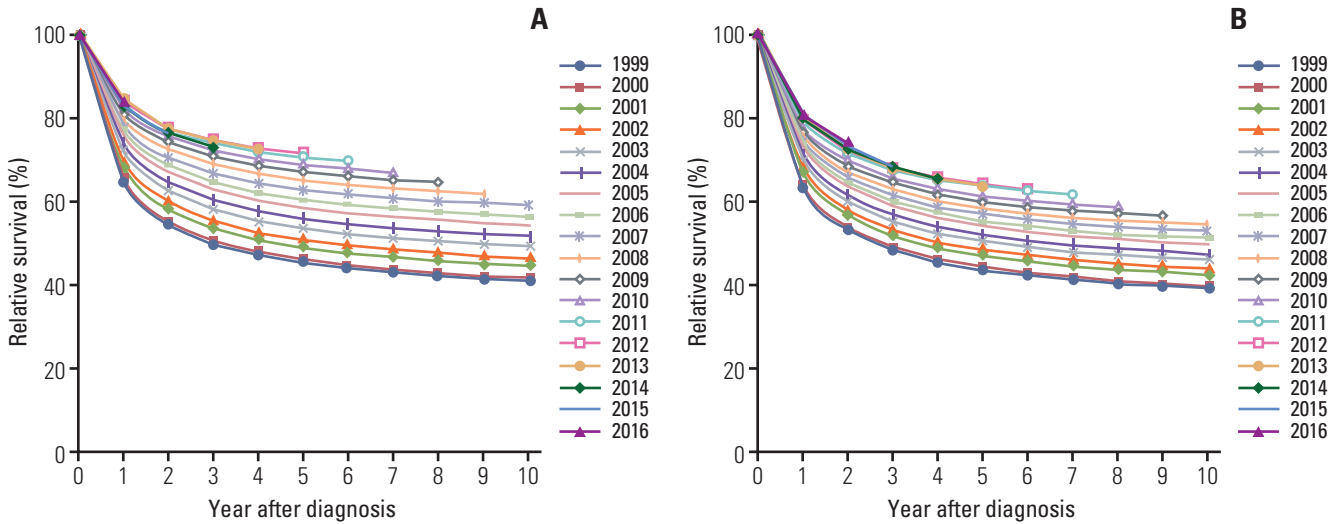
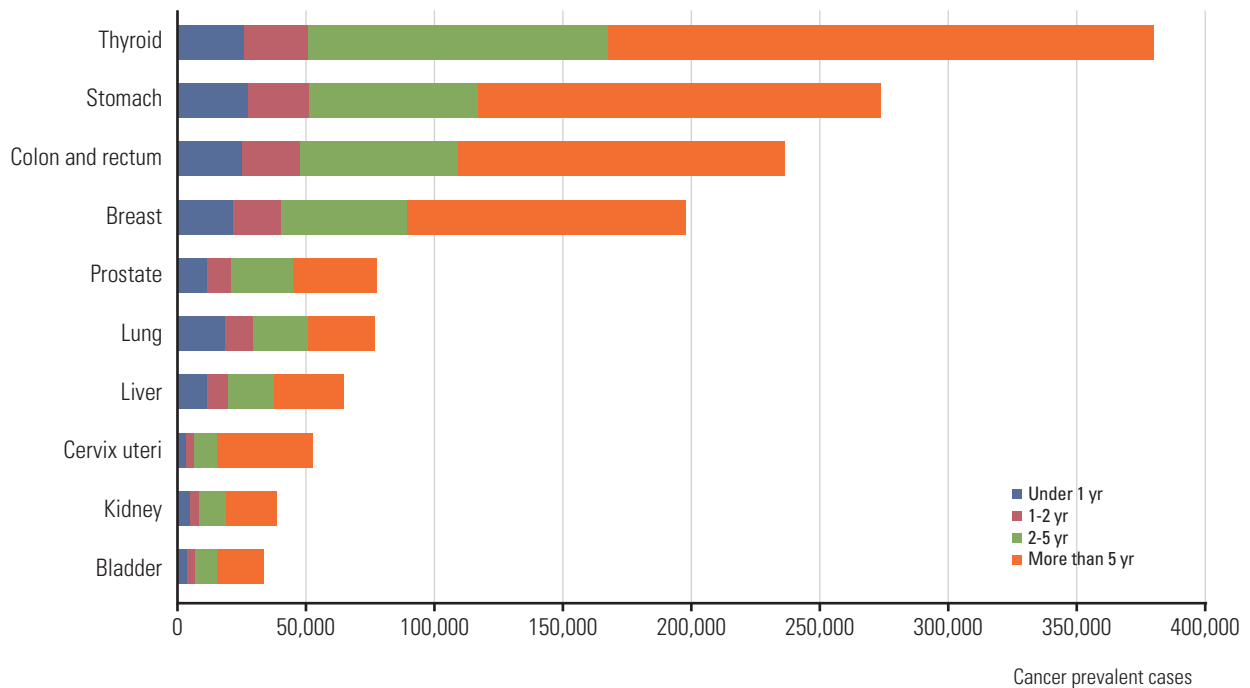


Fig. 5. Trends in relative survival by year of diagnosis from 1999 to 2016. (A) All sites for both sexes. (B) All sites except thyroid cancer for both sexes.



Time since diagnosis	Cancer prevalent cases										
	Thyroid	Stomach	Colon and rectum	Breast	Prostate	Lung	Liver	Cervix uteri	Kidney	Bladder	All cancers
Under 1 yr	25,905	27,707	25,666	21,581	11,480	18,681	11,515	3,405	4,700	4,001	201,371
1-2 yr	25,026	23,615	22,136	18,723	9,517	11,333	8,204	3,203	3,977	3,310	162,999
2-5 yr	116,871	65,548	61,408	48,969	24,218	20,728	17,636	8,634	10,377	7,917	458,701
More than 5 yr	212,144	156,831	127,221	108,733	32,420	25,802	27,509	37,516	19,782	18,315	916,880
Total	379,946	273,701	236,431	198,006	77,635	76,544	64,864	52,758	38,836	33,543	1,739,951

Fig. 6. Prevalence of common cancer sites by time period after cancer diagnosis. Prevalent cases were defined as the number of cancer patients alive on January 1, 2017 among all cancer patients diagnosed between 1999 and 2016.

Table 9. Crude and age-standardized rates of cancer prevalence by sex on January 1, 2017 in Korea

Site/Type	Crude prevalence rate per 100,000 ^{a)}			Age-standardized prevalence rate per 100,000 ^{b)}		
	Both sexes	Men	Women	Both sexes	Men	Women
All sites	3,404.1	2,993.2	3,814.1	2,046.2	1,896.1	2,281.5
Lip, oral cavity, and pharynx	46.2	62.1	30.5	28.2	39.7	18.2
Esophagus	19.1	34.4	3.9	10.5	20.9	1.9
Stomach	535.5	709.9	361.4	297.8	433.6	185.7
Colon and rectum	462.6	551.8	373.6	254.8	338.9	186.9
Liver	126.9	190.6	63.3	74.7	119.1	34.6
Gallbladder ^{c)}	41.1	42.2	40.0	21.8	25.6	18.9
Pancreas	20.7	21.6	19.9	11.9	13.5	10.6
Larynx	20.6	38.8	2.4	11.2	23.6	1.2
Lung	149.8	185.8	113.8	82.7	113.6	58.9
Breast	387.4	2.9	771.0	239.0	1.8	470.0
Cervix uteri	103.2	-	206.2	62.6	-	122.3
Corpus uteri	45.3	-	90.4	28.0	-	55.1
Ovary	38.2	-	76.3	25.5	-	50.6
Prostate	151.9	304.1	-	76.1	180.5	-
Testis	6.3	12.6	-	5.7	11.1	-
Kidney	76.0	102.5	49.5	46.3	65.8	29.0
Bladder	65.6	107.1	24.2	34.4	65.2	10.9
Brain and CNS	21.7	22.5	21.0	18.3	19.5	17.1
Thyroid	743.3	255.9	1,229.7	487.5	171.0	801.9
Hodgkin lymphoma	5.5	6.9	4.1	4.5	5.5	3.5
Non-Hodgkin lymphoma	58.9	67.1	50.7	40.8	49.1	33.1
Multiple myeloma	11.3	11.9	10.7	6.4	7.3	5.7
Leukemia	40.6	45.3	36.0	37.4	41.8	33.0
Other and ill-defined	226.4	217.1	235.6	139.9	149.0	132.6

CNS, central nervous system. ^{a)}Crude prevalence rate: number of prevalent cases divided by the corresponding person-years of observation. Prevalent cases were defined as patients who were diagnosed between January 1, 1999 and December 31, 2016 and who were alive on January 1, 2017. Multiple primary cancer cases were counted multiple times, ^{b)}Age-adjusted using the Segi's world standard population, ^{c)}Includes the gallbladder and other/unspecified parts of the biliary tract.

improved remarkably in both sexes, from 41.2% in 1993-1995 to 70.6% in 2012-2016 (Table 8). After excluding thyroid cancer, the 5-year relative survival rates for all cancer still increased from 1999 to 2016 (Fig. 5B).

The 5-year relative survival rate during 2012-2016 for all cancer combined was 63.2% in men and 78.0% in women, respectively. The 5-year relative survival rate for thyroid cancer was over 100%, while the 5-year relative survival rates for testis, prostate, and breast cancer were over 90% in 2012-2016 for both sexes, respectively. However, the 5-year relative survival rate for pancreatic cancer was only 11.4% in both sexes in 2012-2016.

When compared to the 5-year relative survival rate for men in 1993-1995, prostate cancer diagnosed from 2012 to 2016 showed the most outstanding improvement, followed by

stomach, leukemia, 'lip, oral cavity, and pharynx,' esophagus and liver cancer. Among women, stomach cancer diagnosed during 2012-2016 showed the greatest improvement in 5-year relative survival rates compared to those between 1993 and 1995, followed by lung, leukemia, multiple myeloma, liver, and colorectal cancer.

6. Prevalence rates

A total of 1,739,951 cancer prevalent cases were identified on January 1, 2017 (Table 1). Of these cases, 764,103 (43.9%) were men and 975,848 (56.1%) were women. The overall CR and ASR for cancer prevalence were 3,404.1 per 100,000 individuals and 2,046.2 per 100,000 individuals for both sexes, respectively, in 2016 (Table 9).

The five most common cancers for men were stomach (CR, 709.9 per 100,000), colorectal (CR, 551.8 per 100,000), prostate (CR, 304.1 per 100,000), thyroid (CR, 255.9 per 100,000), and liver cancer (CR, 190.6 per 100,000). In contrast, thyroid cancer was most common in women (CR, 1,229.7 per 100,000), followed by breast (CR, 771.0 per 100,000), colorectal (CR, 373.6 per 100,000), stomach (CR, 361.4 per 100,000), and cervix uteri cancer (CR, 206.2 per 100,000).

Analysis of the period after cancer diagnosis revealed that stomach cancer (14.1%) was the most prevalent cancer within 2 years after diagnosis, followed by thyroid (14.0%) and colorectal cancer (13.1%) (Fig. 6). Thyroid cancer (25.5%) was most prevalent for 2-5 years, followed by stomach (14.3%) and colorectal cancer (13.4%). After 5 years, thyroid cancer (23.1%) was the most prevalent cancer, followed by stomach (17.1%) and colorectal cancer (13.9%).

Conflicts of Interest

Conflict of interest relevant to this article was not reported.

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