

# Cancer Statistics in Korea: Incidence, Mortality, Survival, and Prevalence in 2012

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## Purpose

The aim of this study was to report nationwide cancer statistics in Korea, including incidence, mortality, survival, and prevalence, and their trends.

## Materials and Methods

Incidence data from 1993 to 2012 were obtained from the Korea National Cancer Incidence Database, and vital status was followed through December 31, 2013. Mortality data from 1983 to 2012 were obtained from Statistics Korea. Crude and age-standardized rates for incidence, mortality, and prevalence, and relative survival were calculated.

## Results

A total of 224,177 cancer cases and 73,759 cancer deaths were reported in 2012, and there were 1,234,879 prevalent cases identified in Korea as of January 1, 2013. Over the past 14 years (1999-2012), overall incidence rates have increased by 3.3% per year. The incidence rates of liver and cervical cancers have decreased, while those of thyroid, breast, prostate, and colorectal cancers have increased. Notably, incidence of thyroid cancer increased by 22.3% per year in both sexes and has been the most common cancer since 2009. The mortality for all cancers combined decreased by 2.7% per year from 2002 to 2012. Five-year relative survival rates of patients diagnosed in the last 5 years (2008-2012) have improved by 26.9% compared with those from 1993 to 1995.

## Conclusion

Overall cancer mortality rates have declined since 2002 in Korea, while incidence has increased and survival has improved.

## Key words

Incidence, Mortality, Survival, Prevalence, Neoplasms, Korea

## Introduction

Cancer has been the leading cause of death in Korea since 1983 [1] and is the most burdensome disease [2]. More than 210,000 new cancer cases are diagnosed in Korea each year, and cancer is responsible for one in four deaths [3]. This article reports the most recent nationwide cancer statistics in Korea, including incidence, mortality, survival, prevalence, and their trends.

### 1. Data sources

The Ministry of Health and Welfare, Korea, initiated a nationwide hospital-based cancer registry called the Korea Central Cancer Registry (KCCR) in 1980. The registry collected 80%-90% of cancer cases annually from more than 180 training hospitals throughout the country.

In 1999, the KCCR expanded cancer registration to cover the entire population under the Population-Based Regional Cancer Registry Program. Details of the history, objectives,

**Table 1.** Cancer incidence, prevalence, and deaths by sex in Korea, 2012

Site/Type	New cases			Deaths			Prevalent cases <sup>a)</sup>		
	Both	Male	Female	Both	Male	Female	Both	Male	Female
All sites	224,177	112,385	111,792	73,759	46,462	27,297	1,234,879	547,837	687,042
Lip, oral cavity, and pharynx	2,913	2,135	778	1,036	809	227	17,024	11,501	5,523
Esophagus	2,332	2,116	216	1,398	1,278	120	7,444	6,714	730
Stomach	30,847	20,839	10,008	9,342	6,090	3,252	207,145	137,655	69,490
Colon and rectum	28,988	17,445	11,543	8,135	4,666	3,469	173,459	103,488	69,971
Liver	16,254	12,152	4,102	11,335	8,494	2,841	51,402	38,434	12,968
Gallbladder <sup>b)</sup>	5,131	2,600	2,531	3,688	1,818	1,870	14,778	7,532	7,246
Pancreas	5,403	2,940	2,463	4,778	2,616	2,162	7,032	3,803	3,229
Larynx	1,099	1,036	63	412	389	23	8,600	8,076	524
Lung	22,118	15,367	6,751	16,654	12,175	4,479	53,480	34,422	19,058
Breast	16,589	68	16,521	2,013	20	1,993	132,139	558	131,581
Cervix uteri	3,584	-	3,584	889	-	889	43,523	-	43,523
Corpus uteri	1,979	-	1,979	244	-	244	15,191	-	15,191
Ovary	2,167	-	2,167	910	-	910	14,171	-	14,171
Prostate	9,258	9,258	-	1,460	1,460	-	49,007	49,007	-
Testis	243	243	-	13	13	-	2,210	2,210	-
Kidney	4,152	2,882	1,270	917	663	254	26,015	17,551	8,464
Bladder	3,485	2,798	687	1,221	918	303	25,497	20,754	4,743
Brain and CNS	1,703	933	770	1,186	619	567	8,626	4,508	4,118
Thyroid	44,007	8,052	35,955	373	127	246	258,795	40,921	217,874
Hodgkin lymphoma	264	177	87	64	44	20	2,006	1,281	725
Non-Hodgkin lymphoma	4,553	2,542	2,011	1,523	920	603	26,426	14,299	12,127
Multiple myeloma	1,272	696	576	823	472	351	3,842	2,042	1,800
Leukemia	2,826	1,595	1,231	1,666	919	747	14,890	8,216	6,674
Other and ill-defined	13,010	6,511	6,499	3,679	1,952	1,727	72,177	34,865	37,312

CNS, central nervous system. <sup>a)</sup>Limited-duration prevalent cases on January 1, 2013; These patients who were diagnosed between January 1, 1999 and December 31, 2012 and were alive on January 1, 2013; Multiple primary cancer cases were counted multiple times, <sup>b)</sup>Includes the gallbladder and other / unspecified parts of the biliary tract.

and activities of the KCCR have been documented elsewhere [4]. Incidence data for 1999-2012 were obtained from the Korea National Cancer Incidence Database (KNCI DB). The completeness of incidence data for 2012 was 97.7%, as determined by the Ajiki method [5].

Cancer cases were classified according to the International Classification of Diseases for Oncology, third edition [6] and converted according to the International Classification of Diseases, 10th edition (ICD-10) [7]. A total of 2,405,894 cancer cases first diagnosed between 1993 and 2012 from the KNCI DB were used in the survival analysis, and vital status was followed until December 31, 2013.

Mortality data from 1983 to 2012 were obtained from Statistics Korea [1]. Cause of death was coded and classified according to ICD-10 [7]. Population data were also obtained from Statistics Korea using the resident registration popula-

tion on July 1 of specified years.

## 2. Analysis

Crude rates (CRs) and age-specific rates of cancer incidence and mortality were calculated. Age-standardized rates (ASRs) were calculated using Segi's world standard population [8]. Cumulative risks of cancer, which represent the probability of developing cancer during one's lifetime, were also calculated. Changes in the annual ASRs of cancer incidence were examined by calculating the annual percentage change over a time period as  $(\exp(b)-1) \times 100$ , where  $b$  is the slope of the regression of log ASR for a given calendar year [9].

Prevalence was also calculated for assessment of cancer burden, which includes new and pre-existing cancer patients

**Table 2.** Crude and age-standardized cancer incidence rates by sex in Korea, 2012

Site/Type	Crude incidence rate per 100,000			Age-standardized incidence rate per 100,000 <sup>a)</sup>		
	Both	Male	Female	Both	Male	Female
All sites	445.3	446.2	444.4	299.0	326.4	290.1
Lip, oral cavity, and pharynx	5.8	8.5	3.1	3.9	6.1	2.0
Esophagus	4.6	8.4	0.9	3.0	6.1	0.5
Stomach	61.3	82.7	39.8	39.9	59.3	23.5
Colon and rectum	57.6	69.3	45.9	37.3	50.0	26.8
Liver	32.3	48.2	16.3	21.1	34.3	9.5
Gallbladder <sup>b)</sup>	10.2	10.3	10.1	6.3	7.6	5.3
Pancreas	10.7	11.7	9.8	6.7	8.4	5.4
Larynx	2.2	4.1	0.3	1.4	3.0	0.1
Lung	43.9	61.0	26.8	27.4	44.3	14.9
Breast	33.0	0.3	65.7	22.6	0.2	44.7
Cervix uteri	7.1	-	14.2	4.9	-	9.5
Corpus uteri	3.9	-	7.9	2.7	-	5.3
Ovary	4.3	-	8.6	3.1	-	6.0
Prostate	18.4	36.8	-	11.6	27.0	-
Testis	0.5	1.0	-	0.5	0.9	-
Kidney	8.2	11.4	5.0	5.6	8.2	3.2
Bladder	6.9	11.1	2.7	4.3	8.1	1.4
Brain and CNS	3.4	3.7	3.1	2.8	3.3	2.4
Thyroid	87.4	32.0	142.9	62.5	23.0	102.4
Hodgkin lymphoma	0.5	0.7	0.3	0.5	0.6	0.3
Non-Hodgkin lymphoma	9.0	10.1	8.0	6.6	7.9	5.6
Multiple myeloma	2.5	2.8	2.3	1.6	2.0	1.4
Leukemia	5.6	6.3	4.9	4.9	5.9	4.1
Other and ill-defined	25.8	25.9	25.8	17.6	20.1	15.7

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

diagnosed during a given time period who were still alive on an index date. Using the cancer incidence database data from 1999 to 2012, we defined prevalent cases as patients who were diagnosed between January 1, 1999 and December 31, 2012, and were still alive on January 1, 2013. We calculated limited-duration prevalences, namely, 1- and 5-year prevalences. For example, the 5-year prevalence was calculated as the number of people alive on January 1, 2013 who had been diagnosed with cancer within the previous 5 years. We applied this counting method using the SEER\*Stat software [10] to calculate the number of cases while adjusting for patients lost to follow-up.

The survival duration for each case was determined as the interval between the date of initial diagnosis and the date of death, date of loss to follow-up, or closing date for follow-up. Observed survival rates were calculated using the life-

table method and relative survival rates using the Ederer II method [11] were based on an algorithm written in SAS by Paul Dickman [12], with some minor modifications.

## Selected Findings

### 1. Incidence

The overall number of incident cancer cases, deaths, and prevalent cases by sex and cancer site for 2012 in Korea are shown in Table 1. A total of 224,177 incident cancer cases and 73,759 deaths were reported to occur in 2012. As of January 1, 2013, 1,234,879 prevalent cancer cases diagnosed between

**Table 3.** The top 10 leading causes of death in Korea, 2012

Rank	Cause of death	No. of deaths	Percentage of all deaths	Age-standardized death rate per 100,000 <sup>a)</sup>
	All causes	267,221	100.0	326.6
1	Cancer	73,759	27.6	90.2
2	Heart disease	26,442	9.9	30.7
3	Cerebrovascular disease	25,744	9.6	29.0
4	Intentional self-harm (suicide)	14,160	5.3	20.4
5	Diabetes mellitus	11,557	4.3	13.2
6	Pneumonia	10,314	3.9	11.4
7	Chronic lower respiratory diseases	7,831	2.9	8.5
8	Disease of liver	6,793	2.5	8.8
9	Transport accidents	6,502	2.4	9.6
10	Hypertensive diseases	5,239	2.0	5.8
	Others	78,880	29.6	99.2

Source: Mortality Data, 2012, Statistics Korea [1]. <sup>a)</sup>Age-adjusted using the world standard population.

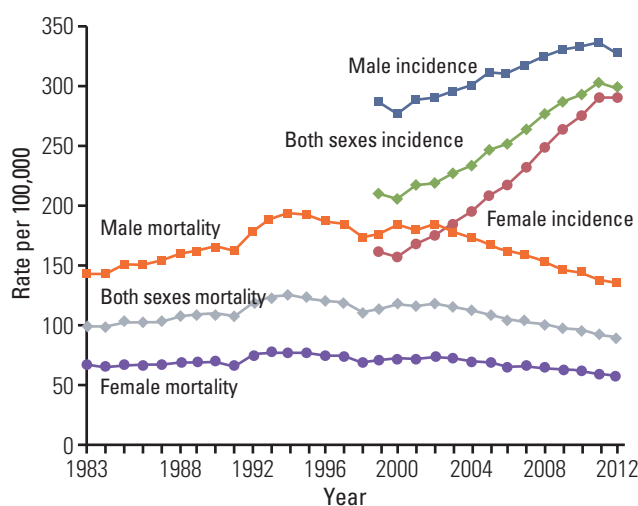
1999 and 2012 were identified. The cumulative risk of developing cancer during one’s lifetime in 2012 was 37.5% for males and 34.9% for females.

The cancer incidence rates in 2012 by sex and cancer site are shown in Table 2. The 2012 CRs per 100,000 of all sites combined were 446.2 and 444.4 for males and females, respectively. The ASRs per 100,000 of all sites combined were 326.4 and 290.1 for males and females, respectively. In males, the five leading primary cancer sites were stomach (CR, 82.7; ASR, 59.3), colon and rectum (CR, 69.3; ASR, 50.0), lung (CR, 61.0; ASR, 44.3), liver (CR, 48.2; ASR, 34.3), and prostate (CR, 36.8; ASR, 27.0), which together accounted for 66.8% of all newly diagnosed cancers in 2012. In females, the most common cancer site was thyroid (CR, 142.9; ASR, 102.4), followed by breast (CR, 65.7; ASR, 44.7), colon and rectum (CR, 45.9; ASR, 26.8), stomach (CR, 39.8; ASR, 23.5), and lung (CR, 26.8; ASR, 14.9), which together accounted for 72.3% of all newly diagnosed cancers. Thyroid cancer alone accounted for 32.2% of incident cases (n=35,955) among females in 2012.

**2. Mortality**

A total of 73,759 cancer deaths were reported in Korea for 2012, accounting for 27.6% of all deaths (Table 3). In 2012, the CRs per 100,000 for all sites combined were 184.5 and 108.5 in males and females, respectively. The ASRs per 100,000 for all sites combined were 135.2 and 57.7 for males and females, respectively. Cancers of the lung, liver, stomach, and colon/rectum were the main causes of cancer death, together accounting for approximately 61.6% of all cancer deaths in 2012 (Table 4).

In males, the five most common sites of cancer death in 2012 were lung (CR, 48.3; ASR, 35.1), liver (CR, 33.7; ASR,



**Fig. 1.** Annual age-standardized cancer incidence and death rates by sex for all sites from 1983 to 2012 in Korea. Age standardization was based on the world standard population.

24.1), stomach (CR, 24.2; ASR, 17.6), colon and rectum (CR, 18.5; ASR, 13.7), and pancreas (CR, 10.4; ASR, 7.6). In women, lung cancer (CR, 17.8; ASR, 8.9) was the leading cause of cancer death in 2012, followed by colon and rectum (CR, 13.8; ASR, 6.8), stomach (CR, 12.9; ASR, 6.5), liver (CR, 11.3; ASR, 6.1), and pancreas (CR, 8.6; ASR, 4.4).

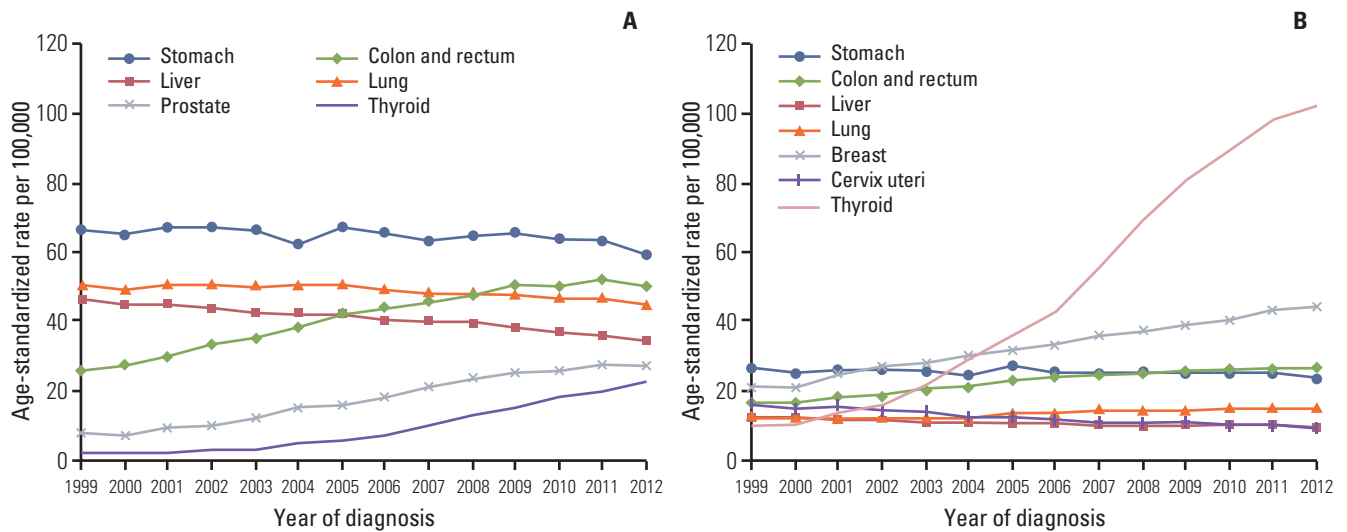
**3. Trends in cancer incidence**

The cancer incidence rates from 1999 to 2012 in Korea for all sites combined and for selected sites are shown in

**Table 4.** Crude and age-standardized cancer mortality rates by sex in Korea, 2012

Site/Type	Crude mortality rate per 100,000			Age-standardized mortality rate per 100,000 <sup>a)</sup>		
	Both	Male	Female	Both	Male	Female
All sites	146.5	184.5	108.5	90.2	135.2	57.7
Lip, oral cavity, and pharynx	2.1	3.2	0.9	1.3	2.3	0.5
Esophagus	2.8	5.1	0.5	1.7	3.7	0.2
Stomach	18.6	24.2	12.9	11.2	17.6	6.5
Colon and rectum	16.2	18.5	13.8	9.7	13.7	6.8
Liver	22.5	33.7	11.3	14.4	24.1	6.1
Gallbladder <sup>b)</sup>	7.3	7.2	7.4	4.3	5.3	3.6
Pancreas	9.5	10.4	8.6	5.8	7.6	4.4
Larynx	0.8	1.5	0.1	0.5	1.1	0.0
Lung	33.1	48.3	17.8	19.8	35.1	8.9
Breast	4.0	0.1	7.9	2.6	0.1	5.1
Cervix uteri	1.8	-	3.5	1.1	-	2.0
Corpus uteri	0.5	-	1.0	0.3	-	0.6
Ovary	1.8	-	3.6	1.2	-	2.2
Prostate	2.9	5.8	-	1.6	4.5	-
Testis	0.0	0.1	-	0.0	0.0	-
Kidney	1.8	2.6	1.0	1.1	1.9	0.5
Bladder	2.4	3.6	1.2	1.3	2.8	0.5
Brain and CNS	2.4	2.5	2.3	1.8	2.0	1.6
Thyroid	0.7	0.5	1.0	0.4	0.4	0.5
Hodgkin lymphoma	0.1	0.2	0.1	0.1	0.1	0.1
Non-Hodgkin lymphoma	3.0	3.7	2.4	1.9	2.7	1.3
Multiple myeloma	1.6	1.9	1.4	1.0	1.4	0.8
Leukemia	3.3	3.6	3.0	2.4	3.0	2.0
Other and ill-defined	7.3	7.7	6.9	4.6	5.9	3.7

CNS, central nervous system. <sup>a)</sup>Age-adjusted using the world standard population, <sup>b)</sup>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 2012 in Korea. Age standardization was based on the world standard population. (A) Male. (B) Female.

**Table 5.** Trends in cancer incidence rates for both sexes from 1999 to 2012 in Korea

Site/Type	Year												APC		
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010		2011	2012
All sites	210.5	205.1	216.7	220.1	227.8	235.0	247.9	252.1	263.4	275.8	286.6	292.9	302.8	299.0	3.3 <sup>a)</sup>
Lip, oral cavity, and pharynx	3.6	4.4	3.6	3.7	3.8	3.8	3.8	3.8	3.9	4.0	3.8	4.0	4.0	3.9	0.4
Esophagus	4.1	3.7	3.9	3.8	3.6	3.6	3.5	3.4	3.3	3.3	3.1	3.1	3.0	3.0	-2.2 <sup>a)</sup>
Stomach	43.6	42.3	44.0	43.6	43.3	41.2	44.4	42.9	41.8	42.6	43.4	42.5	42.7	39.9	-0.3
Colon and rectum	20.4	21.0	22.9	24.7	26.9	28.6	31.0	32.5	33.8	34.9	36.9	36.9	38.1	37.3	5.3 <sup>a)</sup>
Liver	27.9	26.7	27.3	26.5	25.8	25.6	25.8	24.6	24.4	24.1	23.5	22.8	22.4	21.1	-1.9 <sup>a)</sup>
Gallbladder <sup>b)</sup>	6.5	6.4	6.7	6.7	6.7	6.9	7.1	6.6	6.6	6.4	6.8	6.6	6.4	6.3	-0.2
Pancreas	5.6	5.5	5.5	5.8	5.9	6.0	6.3	6.2	6.3	6.4	6.3	6.4	6.7	6.7	1.5 <sup>a)</sup>
Larynx	2.3	2.2	2.4	2.2	2.1	1.9	2.0	1.8	1.8	1.7	1.7	1.6	1.5	1.4	-3.7 <sup>a)</sup>
Lung	28.5	27.7	28.3	28.5	27.9	28.8	29.0	28.7	28.4	28.2	28.3	28.6	28.6	27.4	0.0
Breast	10.7	10.8	12.7	13.9	14.2	15.0	16.3	16.9	18.1	18.9	19.6	20.6	22.3	22.6	6.0 <sup>a)</sup>
Cervix uteri	8.5	7.9	8.3	7.7	7.4	6.9	6.5	6.4	5.7	5.9	5.5	5.6	5.2	4.9	-4.2 <sup>a)</sup>
Corpus uteri	1.4	1.3	1.5	1.7	1.9	1.9	2.0	2.1	2.2	2.4	2.6	2.6	2.7	2.7	5.6 <sup>a)</sup>
Ovary	2.7	2.5	2.5	2.6	2.7	2.7	2.8	2.8	3.1	2.9	2.8	3.0	2.9	3.1	1.4 <sup>a)</sup>
Prostate	3.1	2.7	3.6	3.9	4.8	6.0	6.3	7.3	8.6	9.8	10.6	11.0	11.9	11.6	13.0 <sup>a)</sup>
Testis	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	4.5 <sup>a)</sup>
Kidney	3.0	2.9	3.3	3.4	3.5	3.7	4.1	4.4	4.8	5.1	5.2	5.3	5.6	5.6	5.8 <sup>a)</sup>
Bladder	4.6	4.6	4.9	4.7	5.1	5.1	5.1	4.9	5.0	4.8	4.6	4.7	4.6	4.3	-0.4
Brain and CNS	2.9	2.8	2.8	2.6	2.9	2.9	3.0	2.9	3.1	3.0	3.0	3.1	2.7	2.8	0.4
Thyroid	6.3	6.1	7.9	9.5	12.8	17.2	20.7	25.4	32.8	41.4	48.1	53.6	59.1	62.5	22.3 <sup>a)</sup>
Hodgkin lymphoma	0.2	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5	5.0 <sup>a)</sup>
Non-Hodgkin lymphoma	4.5	4.2	4.5	4.6	4.9	5.3	5.3	5.5	5.6	5.7	6.2	6.2	6.5	6.6	3.6 <sup>a)</sup>
Multiple myeloma	1.0	1.0	1.1	1.1	1.1	1.2	1.3	1.3	1.4	1.4	1.5	1.5	1.4	1.6	3.7 <sup>a)</sup>
Leukemia	4.7	4.3	4.7	4.8	4.8	4.8	4.7	4.9	4.8	5.0	5.1	5.0	5.2	4.9	0.9 <sup>a)</sup>
Other and ill-defined	14.3	13.5	13.9	13.5	15.2	15.3	16.2	16.2	17.2	17.1	17.1	17.5	18.1	17.6	2.4 <sup>a)</sup>

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

**Table 6.** Trends in cancer incidence rates in males from 1999 to 2012 in Korea

Site/Type	Year													APC	
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011		2012
All sites	285.0	276.7	288.3	290.0	295.1	299.6	311.5	310.3	316.9	323.9	330.6	331.3	336.1	326.4	1.5 <sup>a)</sup>
Lip, oral cavity, and pharynx	6.1	7.1	6.0	6.2	6.5	6.2	6.1	6.2	6.3	6.5	6.1	6.1	6.3	6.1	-0.2
Esophagus	8.8	8.0	8.3	8.2	7.7	7.7	7.6	7.2	7.0	7.0	6.6	6.5	6.2	6.1	-2.6 <sup>a)</sup>
Stomach	66.2	65.0	67.2	66.6	66.0	62.3	66.9	65.4	63.1	64.5	65.0	63.3	63.7	59.3	-0.5 <sup>a)</sup>
Colon and rectum	26.2	27.2	29.6	32.9	35.3	38.0	41.2	43.3	45.3	47.0	49.9	50.0	51.9	50.0	5.7 <sup>a)</sup>
Liver	46.8	44.7	45.1	43.9	42.3	42.2	42.6	40.3	39.8	39.5	38.2	36.8	35.9	34.3	-2.1 <sup>a)</sup>
Gallbladder <sup>b)</sup>	8.1	7.8	8.2	8.1	7.8	8.4	8.7	8.1	7.9	7.6	8.1	8.2	7.6	7.6	-0.3
Pancreas	7.8	7.6	7.6	7.9	7.7	8.0	8.3	8.0	8.2	8.4	8.1	8.0	8.6	8.4	0.8 <sup>a)</sup>
Larynx	4.9	4.5	5.1	4.7	4.5	4.1	4.3	3.8	3.8	3.5	3.6	3.4	3.2	3.0	-3.7 <sup>a)</sup>
Lung	51.4	49.8	51.1	51.0	50.0	50.8	50.9	49.2	48.7	47.6	47.5	47.5	46.4	44.3	-0.9 <sup>a)</sup>
Breast	0.2	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.1	0.3	0.2	0.2	0.2	0.2	-1.1
Prostate	8.4	7.2	9.5	10.1	12.5	15.1	15.8	18.0	20.9	23.5	25.2	26.0	27.7	27.0	11.6 <sup>a)</sup>
Testis	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	4.4 <sup>a)</sup>
Kidney	4.5	4.4	4.9	5.0	5.2	5.5	6.0	6.5	7.1	7.4	7.6	8.0	8.2	8.2	5.5 <sup>a)</sup>
Bladder	9.0	9.0	9.4	9.0	9.7	9.8	9.8	9.6	9.4	9.2	8.7	8.8	8.8	8.1	-0.6
Brain and CNS	3.2	3.1	3.1	2.9	3.3	3.3	3.3	3.2	3.4	3.4	3.5	3.5	3.0	3.3	0.6
Thyroid	2.1	1.9	2.4	2.7	3.7	4.8	5.9	7.5	10.0	13.3	15.6	18.6	20.4	23.0	23.6 <sup>a)</sup>
Hodgkin lymphoma	0.4	0.4	0.4	0.3	0.4	0.5	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	4.1 <sup>a)</sup>
Non-Hodgkin lymphoma	5.8	5.5	5.8	5.8	6.2	6.7	6.5	6.9	7.0	6.8	7.5	7.4	7.7	7.9	2.7 <sup>a)</sup>
Multiple myeloma	1.2	1.3	1.4	1.4	1.4	1.4	1.6	1.5	1.6	1.7	1.9	1.8	1.8	2.0	3.5 <sup>a)</sup>
Leukemia	5.5	5.0	5.4	5.8	5.5	5.7	5.6	5.6	5.7	5.8	6.0	6.0	6.1	5.9	1.0 <sup>a)</sup>
Other and ill-defined	17.9	16.5	16.8	16.5	18.5	18.3	19.3	18.9	20.3	19.8	20.0	19.8	20.8	20.1	1.7 <sup>a)</sup>

APC, annual percentage change; CNS, central nervous system. APC was calculated using age-standardized incidence data based on the world standard population.

<sup>a)</sup>Significantly different from zero ( $p < 0.05$ ), <sup>b)</sup>Includes the gallbladder and other/ unspecified parts of the biliary tract.

**Table 7.** Trends in cancer incidence rates in females from 1999 to 2012 in Korea

Site/Type	Year												APC <sup>a)</sup>		
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010		2011	2012
All sites	161.1	157.4	169.0	174.6	184.5	193.6	208.0	216.6	232.3	249.6	263.6	274.8	289.3	290.1	5.3 <sup>a)</sup>
Lip, oral cavity, and pharynx	1.6	2.4	1.7	1.7	1.7	1.9	1.9	1.8	1.9	1.9	1.8	2.2	2.1	2.0	1.1
Esophagus	0.6	0.6	0.6	0.5	0.6	0.5	0.4	0.5	0.5	0.5	0.4	0.4	0.4	0.5	-2.2 <sup>a)</sup>
Stomach	26.7	25.2	26.2	26.3	25.9	24.7	26.8	25.1	24.8	25.1	25.7	25.3	25.3	23.5	-0.5
Colon and rectum	16.4	16.4	17.9	18.8	20.5	21.5	23.0	24.1	24.6	25.2	26.3	26.1	26.7	26.8	4.3 <sup>a)</sup>
Liver	12.3	11.8	12.2	11.8	11.5	11.3	11.4	11.1	11.1	10.7	10.6	10.4	10.4	9.5	-1.6 <sup>a)</sup>
Gallbladder <sup>b)</sup>	5.3	5.5	5.7	5.8	5.8	5.9	6.0	5.5	5.6	5.5	5.8	5.4	5.5	5.3	-0.2
Pancreas	4.0	4.0	4.0	4.2	4.5	4.5	4.7	4.7	4.8	4.9	4.9	5.0	5.1	5.4	2.3 <sup>a)</sup>
Larynx	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.1	-7.5 <sup>a)</sup>
Lung	12.4	12.5	12.3	12.6	12.4	13.0	13.5	14.0	14.0	14.2	14.2	14.7	15.3	14.9	1.7 <sup>a)</sup>
Breast	20.9	20.9	24.7	27.2	27.9	29.4	32.0	33.3	35.7	37.2	38.8	40.7	44.0	44.7	6.1 <sup>a)</sup>
Cervix uteri	16.3	15.1	15.8	14.8	14.2	13.1	12.4	12.2	11.1	11.5	10.7	10.9	10.2	9.5	-4.0 <sup>a)</sup>
Corpus uteri	2.8	2.6	3.0	3.3	3.8	3.7	3.9	4.0	4.2	4.7	5.1	5.1	5.3	5.3	5.8 <sup>a)</sup>
Ovary	5.0	4.8	4.8	5.0	5.1	5.2	5.4	5.4	5.9	5.6	5.4	5.9	5.8	6.0	1.7 <sup>a)</sup>
Kidney	1.7	1.8	1.9	2.0	2.1	2.2	2.5	2.7	2.8	3.0	3.2	3.0	3.4	3.2	5.7 <sup>a)</sup>
Bladder	1.6	1.6	1.7	1.7	1.8	1.7	1.7	1.6	1.7	1.6	1.6	1.5	1.5	1.4	-1.0
Brain and CNS	2.6	2.5	2.5	2.4	2.6	2.6	2.8	2.7	2.9	2.7	2.6	2.7	2.4	2.4	0.1
Thyroid	10.4	10.1	13.2	16.2	21.8	29.6	35.4	43.3	55.7	69.5	80.7	88.8	98.0	102.4	22.1 <sup>a)</sup>
Hodgkin lymphoma	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.3	6.0 <sup>a)</sup>
Non-Hodgkin lymphoma	3.4	3.2	3.4	3.5	4.0	4.1	4.4	4.4	4.4	4.8	5.1	5.2	5.6	5.6	4.5 <sup>a)</sup>
Multiple myeloma	0.8	0.8	0.9	0.8	1.0	1.0	1.2	1.1	1.2	1.2	1.2	1.3	1.1	1.4	4.1 <sup>a)</sup>
Leukemia	3.9	3.8	4.1	4.0	4.1	4.1	4.0	4.4	4.2	4.3	4.2	4.1	4.5	4.1	0.7 <sup>a)</sup>
Other and ill-defined	11.8	11.5	11.8	11.5	12.8	13.1	13.9	14.1	14.8	15.0	14.9	15.7	16.0	15.7	2.9 <sup>a)</sup>

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



**Table 8.** The five major sites of cancer incidence by age group and sex in Korea, 2012

Rank	Age (yr)			
	0-14	15-34	35-64	≥ 65
<b>Male</b>				
1	Leukemia (4.8)	Thyroid (15.4)	Stomach (95.3)	Lung (441.3)
2	Brain and CNS (2.4)	Leukemia (3.1)	Colon and rectum (77.1)	Stomach (412.5)
3	Non-Hodgkin lymphoma (2.3)	Colon and rectum (3.1)	Liver (63.3)	Colon and rectum (354.9)
4	Kidney (0.5)	Non-Hodgkin lymphoma (2.8)	Thyroid (53.1)	Prostate (293.7)
5	Liver (0.4)	Stomach (2.4)	Lung (42.7)	Liver (202.8)
<b>Female</b>				
1	Leukemia (3.4)	Thyroid (69.6)	Thyroid (246.2)	Colon and rectum (184.1)
2	Non-Hodgkin lymphoma (1.8)	Breast (10.8)	Breast (119.3)	Stomach (155.4)
3	Brain and CNS (1.7)	Cervix uteri (5.2)	Colon and rectum (45.3)	Lung (125.5)
4	Ovary <sup>a)</sup> (0.9)	Stomach (3.8)	Stomach (39.7)	Thyroid (102.3)
5	Thyroid <sup>a)</sup> (0.9)	Ovary (3.0)	Lung (21.8)	Liver (71.8)

CNS, central nervous system. <sup>a)</sup>The incidence rates of ovarian and thyroid cancer are the same in the 0-14 age group.

Tables 5-7. The incidence for all sites combined increased by 3.3% per year (1.5% in males, 5.3% in females) from 1999 to 2012. The increase in cancer incidence is also illustrated in Fig. 1.

The incidence rates for colorectal and thyroid cancers have continued to increase in both sexes, as have those for prostate cancer in males and breast cancer in females (Fig. 2). In contrast, the incidences of liver cancer in both sexes, lung cancer in males, and cervical cancer in females have decreased. Notably, thyroid cancer increased rapidly, by 22.3% per year in both sexes, and has been the most common cancer since 2009. Improvements in the sensitivity of diagnostic techniques for thyroid cancer, such as the advent of ultrasound and fine-needle aspiration, have enabled detection of small-sized thyroid cancers, and screening rates have increased. Therefore, the increased incidence of thyroid cancer might reflect the identification of previously undetected diseases rather than a true increase in the occurrence of thyroid cancer [13-16]. In addition, due to the construction of a 1999-2012 KNCI DB, the completeness of the Korean cancer registry data has shown gradual improvement, and this may have contributed, in part, to the gradual overall

increases in cancer incidence, particularly among elderly patients.

The incidence of some cancer sites in 2012, including stomach, colon and rectum, decreased compared to 2011. However, these trends could be causes of random error, therefore, these results should be interpreted with caution.

#### 4. Age-specific incidence rates

The most common cancer sites by sex and age group in 2012 are shown in Table 8. Leukemia and thyroid cancer were the most common cancer in both sexes in patients aged 0-14 and 15-34 years, respectively. For males, stomach cancer was the most common cancer in those aged 35-64, while lung cancer was more frequent among patients aged 65 and over. Thyroid cancer was the most common cancer in females aged 35-64 years, and colorectal cancer was the most common cancer among older females aged 65 and over.

The age-specific incidence rates for selected cancers in males and females in 2012 are shown in Fig. 3. The graphs show that the incidences of stomach, lung, liver, and colorectal cancers increased gradually with age. Incidences of breast

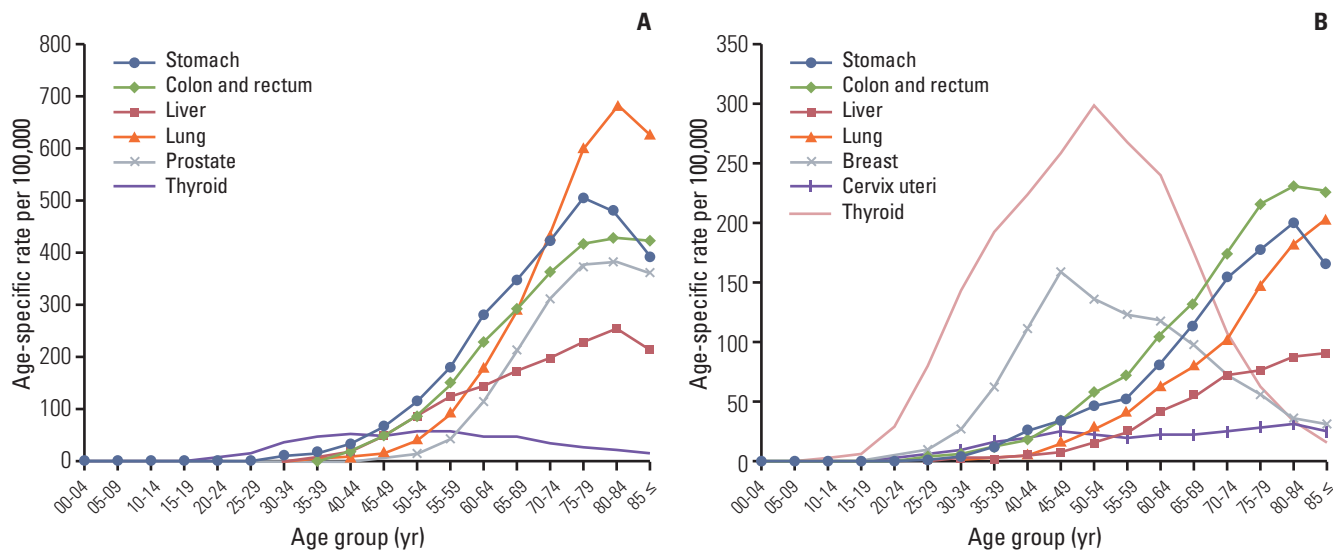


Fig. 3. Age-specific incidence rates of major cancers for 2012 in Korea. (A) Male. (B) Female.

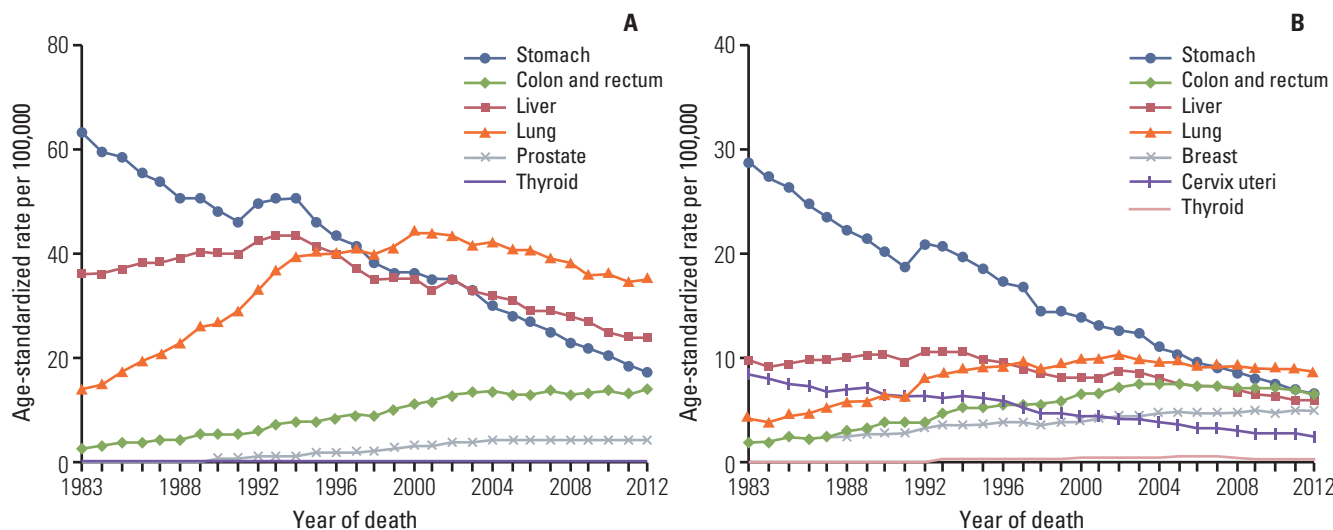


Fig. 4. Annual age-standardized cancer mortalities of selected cancers by sex from 1983 to 2012 in Korea. Age standardization was based on the world standard population. (A) Male. (B) Female.

and thyroid cancers in females were highest among patients in their late 40s and early 50s, respectively, and leveled off thereafter. The age-specific pattern of breast cancer is different from those in Western countries [17].

### 5. Trends in cancer mortality

The trends in cancer deaths for all sites combined and for selected sites are shown in Figs. 1 and 4. ASRs of mortality for all sites combined decreased by 2.7% per year in both

sexes since 2002. Lung cancer surpassed stomach cancer as the leading cause of cancer death in 1999 and is expected to account for 22.6% of all cancer deaths in 2012. However, the ASRs of mortality due to lung cancer have decreased slightly in both males and females since 2002. The ASRs of mortality due to stomach and cervical cancers have also shown a continuous decrease. Along with significant increases in prostate and female breast cancer incidence rates, mortality rates of these cancers have also continued to increase.

**Table 9.** Trends in the 5-year relative survival rates (%) by year of diagnosis from 1993 to 2012 in Korea

Site/Type	Both					Male					Female				
	1993-1995	1996-2000	2001-2005	2008-2012	Change <sup>a)</sup>	1993-1995	1996-2000	2001-2005	2008-2012	Change <sup>a)</sup>	1993-1995	1996-2000	2001-2005	2008-2012	Change <sup>a)</sup>
All sites	41.2	44.0	53.8	68.1	26.9	31.7	35.3	45.3	59.6	27.9	53.4	55.3	64.0	76.6	23.2
Lip, oral cavity, and pharynx	41.1	46.7	54.2	62.2	21.1	35.8	41.1	49.3	57.9	22.1	58.1	63.8	67.7	73.9	15.8
Esophagus	12.7	15.2	21.2	31.7	19.0	11.8	14.3	20.4	31.2	19.4	23.7	24.2	29.5	37.4	13.7
Stomach	42.8	46.6	57.7	71.5	28.7	43.0	46.9	58.4	72.2	29.2	42.6	46.0	56.4	70.0	27.4
Colon and rectum	54.8	58.0	66.6	74.8	20.0	55.3	59.0	68.5	76.9	21.6	54.2	56.8	64.1	71.8	17.6
Liver	10.7	13.2	20.2	30.1	19.4	9.9	12.9	20.1	30.4	20.5	13.6	14.2	20.4	29.3	15.7
Gallbladder <sup>b)</sup>	17.3	19.7	22.8	28.3	11.0	16.6	20.3	23.4	29.5	12.9	18.0	19.1	22.3	27.2	9.2
Pancreas	9.4	7.6	8.1	8.8	-0.6	8.8	7.3	8.1	8.5	-0.3	10.1	8.1	8.1	9.3	-0.8
Larynx	59.7	62.3	66.1	73.4	13.7	60.2	62.8	66.8	73.6	13.4	55.4	57.8	58.2	69.6	14.2
Lung	11.3	12.7	16.2	21.9	10.6	10.4	11.6	15.0	19.4	9.0	14.2	16.2	19.7	28.2	14.0
Breast	77.9	83.2	88.5	91.3	13.4	75.1	85.6	87.0	90.0	14.9	78.0	83.2	88.5	91.3	13.3
Cervix uteri	77.5	80.0	81.3	80.3	2.8	-	-	-	-	-	77.5	80.0	81.3	80.3	2.8
Corpus uteri	81.5	81.8	84.6	86.9	5.4	-	-	-	-	-	81.5	81.8	84.6	86.9	5.4
Ovary	58.7	58.9	61.4	61.9	3.2	-	-	-	-	-	58.7	58.9	61.4	61.9	3.2
Prostate	55.9	67.2	80.2	92.3	36.4	55.9	67.2	80.2	92.3	36.4	-	-	-	-	-
Testis	85.4	90.4	90.6	94.2	8.8	85.4	90.4	90.6	94.2	8.8	-	-	-	-	-
Kidney	62.0	66.1	73.4	79.9	17.9	60.8	64.4	72.8	79.4	18.6	64.5	69.7	74.5	81.0	16.5
Bladder	69.1	73.1	75.5	75.4	6.3	70.0	74.8	77.3	77.6	7.6	65.5	66.3	68.5	66.5	1.0
Brain and CNS	38.5	39.0	40.7	42.2	3.7	37.2	37.5	40.1	40.5	3.3	40.2	40.7	41.4	44.3	4.1
Thyroid	94.2	94.9	98.3	100.1	5.9	87.2	89.5	95.8	100.4	13.2	95.4	95.9	98.7	100.0	4.6
Hodgkin lymphoma	68.0	71.2	76.6	82.6	14.6	67.6	68.1	74.6	82.1	14.5	68.6	77.4	80.6	83.5	14.9
Non-Hodgkin lymphoma	46.6	50.8	59.9	67.5	20.9	45.3	48.9	58.1	65.6	20.3	48.7	53.5	62.4	69.7	21.0
Multiple myeloma	22.1	19.8	29.3	36.4	14.3	21.1	17.8	29.6	35.8	14.7	23.3	22.1	28.9	37.1	13.8
Leukemia	26.5	33.3	41.8	48.9	22.4	26.2	32.3	41.6	48.8	22.6	26.8	34.6	42.0	49.2	22.4
Other and ill-defined	42.1	45.9	55.9	67.3	25.2	37.4	42.4	52.2	63.7	26.3	47.4	50.0	59.9	71.0	23.6

CNS), central nervous system. <sup>a)</sup>Percentage change in 5-year relative survival from 1993 to 1995 and 2008 to 2012, <sup>b)</sup>Includes the gallbladder and other/ unspecified parts of the biliary tract.

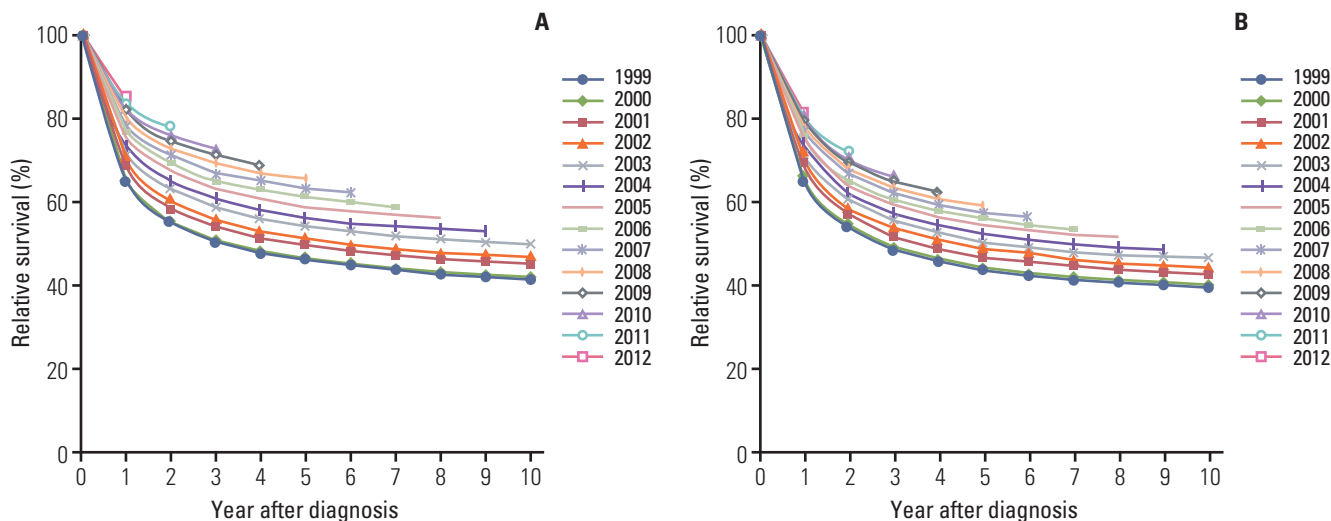
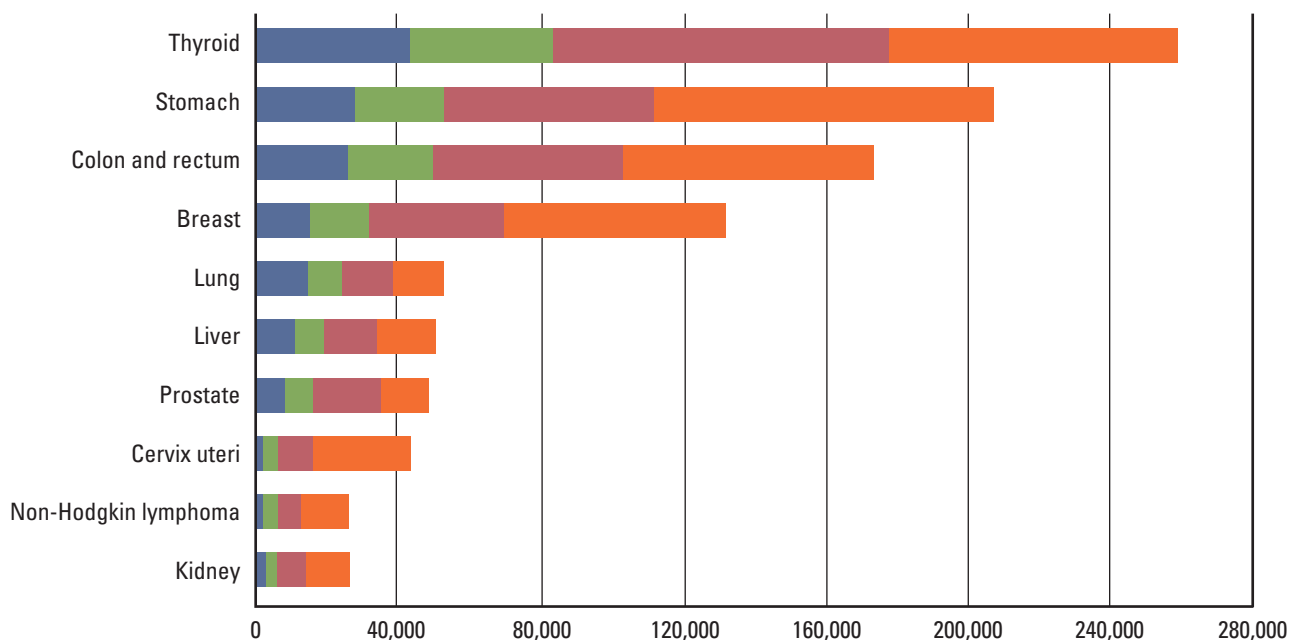


Fig. 5. Trends in relative survival by year of diagnosis from 1999 to 2012. (A) All sites for both sexes. (B) All sites except thyroid cancer for both sexes.



	Cancer prevalent cases										
	Thyroid	Stomach	Colon and rectum	Breast	Lung	Liver	Prostate	Cervix uteri	Non-Hodgkin lymphoma	Kidney	All cancers
Under 1 yr	43,791	27,781	26,663	16,384	15,297	11,531	8,976	3,430	3,893	3,841	196,987
1-2 yr	40,697	25,167	23,559	15,584	9,366	8,198	8,329	3,314	3,261	3,387	167,992
2-5 yr	94,531	59,471	53,285	37,689	14,411	15,698	17,976	9,384	7,487	7,948	377,010
5-14 yr	79,776	94,726	69,952	62,482	14,406	15,975	13,726	27,395	11,785	10,839	492,890
Total	258,795	207,145	173,459	132,139	53,480	51,402	49,007	43,523	26,426	26,015	1,234,879

Fig. 6. Prevalence of major cancer sites by time since diagnosis on January 1, 2013 in Korea.

**Table 10.** Crude and age-standardized rates of cancer prevalence by sex on January 1, 2013 in Korea

Site/Type	Crude prevalence rate per 100,000 <sup>a)</sup>			Age-standardized prevalence rate per 100,000 <sup>b)</sup>		
	Both	Male	Female	Both	Male	Female
All sites	2,452.8	2,175.0	2,730.9	1,649.2	1,592.2	1,788.0
Lip, oral cavity, and pharynx	33.8	45.7	22.0	23.0	33.2	14.3
Esophagus	14.8	26.7	2.9	9.5	19.3	1.6
Stomach	411.4	546.5	276.2	265.6	391.3	162.9
Colon and rectum	344.5	410.9	278.1	221.5	296.6	161.8
Liver	102.1	152.6	51.5	68.8	109.7	32.3
Gallbladder <sup>c)</sup>	29.4	29.9	28.8	18.4	21.6	16.0
Pancreas	14.0	15.1	12.8	9.2	10.9	7.7
Larynx	17.1	32.1	2.1	11.0	23.4	1.2
Lung	106.2	136.7	75.8	68.3	99.1	44.8
Breast	262.5	2.2	523.0	176.5	1.6	346.7
Cervix uteri	86.4	-	173.0	57.5	-	111.7
Corpus uteri	30.2	-	60.4	20.6	-	40.4
Ovary	28.1	-	56.3	20.3	-	40.2
Prostate	97.3	194.6	-	58.4	141.6	-
Testis	4.4	8.8	-	4.0	7.8	-
Kidney	51.7	69.7	33.6	35.4	50.5	22.1
Bladder	50.6	82.4	18.9	31.3	59.9	9.9
Brain and CNS	17.1	17.9	16.4	15.0	16.0	13.9
Thyroid	514.0	162.5	866.0	358.7	114.8	600.7
Hodgkin lymphoma	4.0	5.1	2.9	3.4	4.3	2.5
Non-Hodgkin lymphoma	52.5	56.8	48.2	38.7	44.3	33.8
Multiple myeloma	7.6	8.1	7.2	5.0	5.8	4.4
Leukemia	29.6	32.6	26.5	28.4	31.8	25.1
Other and ill-defined	143.4	138.4	148.3	100.5	108.6	93.9

CNS, central nervous system. <sup>a)</sup>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, 2012 and who were alive on January 1, 2013; Multiple primary cancer cases were counted multiple times, <sup>b)</sup>Age-adjusted using the world standard population, <sup>c)</sup>Includes the gallbladder and other/ unspecified parts of the biliary tract.

## 6. Survival rates

The trends in relative survival for all sites combined among both sexes by year of diagnosis from 1999 to 2012 are shown in Fig. 5. The relative survival for all sites combined increased with year of diagnosis, and also increased when we excluded thyroid cancer cases in our analysis.

Table 9 shows the 5-year relative survival rates for four diagnosis periods: 1993-1995, 1996-2000, 2001-2005, and 2008-2012. The 5-year relative survival rate of patients diagnosed with cancer in the most recent period (2008-2012) was 68.1% for all sites combined in both sexes (59.6% in males and 76.6% in females). When compared with earlier periods, notable improvements in the 5-year relative survival rates were observed for all sites combined. The higher cancer survival

rate in females might be explained in part by cancers common in females (e.g., thyroid and breast cancers) having relatively good prognoses.

When examined by year of diagnosis and cancer site, the 5-year relative survival rates appeared to be higher for most major cancers in patients diagnosed from 2008 to 2012 compared with those diagnosed from 1993 to 1995, with the exception of pancreatic cancer. The greatest improvements were seen in cancers of the prostate, stomach, leukemia, lip/oral cavity/pharynx, and non-Hodgkin lymphoma. The improving survival rates could be attributable to early detection and improved treatments [18,19]; however, this requires further evaluation. Only pancreatic cancer showed no improvement in 5-year relative survival rate compared with 1993-1995. A lack of progress in early detection and

treatment could explain the observed absence of improvement in the survival rate for pancreatic cancer [20].

## 7. Prevalence rates

The cancer prevalence rates by sex and cancer site on January 1, 2013 in Korea are shown in Table 10. The CRs per 100,000 of cancer prevalence for all sites combined were 2,175.0 and 2,730.9 in males and females, respectively, and the ASRs per 100,000 of cancer prevalence for all sites combined were 1,592.2 and 1,788.0 in males and females, respectively. In males, the five leading primary sites of cancer for prevalence were stomach (CR, 546.5; ASR, 391.3), colon and rectum (CR, 410.9; ASR, 296.6), prostate (CR, 194.6; ASR, 141.6), thyroid (CR, 162.5; ASR, 114.8), and liver (CR, 152.6; ASR, 109.7), which together accounted for 67.4% of all prevalent cancer cases. In females, the most common cancer site was thyroid (CR, 866.0; ASR, 600.7), followed by breast (CR, 523.0; ASR, 346.7), colon and rectum (CR, 278.1; ASR, 161.8), stomach (CR, 276.2; ASR, 162.9), and cervix uteri (CR, 173.0; ASR, 111.7), which together accounted for 77.5% of all prevalent cancer cases.

The prevalence by time since diagnosis is shown in Fig. 6. For all cancers combined, the 2-year prevalence constituted 29.6% of all prevalent cases. The 2-year prevalence, as a percentage of the total prevalence, was highest for thyroid (23.1%), followed by stomach (14.5%) and colon and rectum (13.8%), which had high incidence rates and good prognoses.

For all cancers combined in both sexes, the 2-5-year and > 5-year prevalences accounted for 30.5% and 39.9% of the total prevalence, respectively. The long-term prevalences for lung and liver cancers were relatively low due to low survival rates of lung and liver cancer patients.

## Conflicts of Interest

Conflict of interest relevant to this article was not reported.

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## References

1. Statistics Korea [Internet]. Daejeon: Statistics Korea; 2014 [cited 2014 Jan 4]. Available from: <http://kosis.kr>.
2. Yoon SJ, Bae SC, Lee SI, Chang H, Jo HS, Sung JH, et al. Measuring the burden of disease in Korea. *J Korean Med Sci*. 2007; 22:518-23.
3. Jung KW, Won YJ, Kong HJ, Oh CM, Lee DH, Lee JS. Cancer statistics in Korea: incidence, mortality, survival, and prevalence in 2011. *Cancer Res Treat*. 2014;46:109-23.
4. Shin HR, Won YJ, Jung KW, Kong HJ, Yim SH, Lee JK, et al. Nationwide cancer incidence in Korea, 1999~2001; first result using the national cancer incidence database. *Cancer Res Treat*. 2005;37:325-31.
5. Ajiki W, Tsukuma H, Oshima A. Index for evaluating completeness of registration in population-based cancer registries and estimation of registration rate at the Osaka Cancer Registry between 1966 and 1992 using this index. *Nihon Koshu Eisei Zasshi*. 1998;45:1011-7.
6. Fritz A, Percy C, Jack A, Shanmugaratnam K, Sobin L, Parkin DM, et al. *International classification of diseases for oncology*. 3rd ed. Geneva: World Health Organization; 2000.
7. World Health Organization. *International statistical classification of diseases and related health problems*. 10th rev. Geneva: World Health Organization; 1994.
8. Segi M. *Cancer mortality for selected sites in 24 countries (1950-1957)*. Sendai: Tohoku University School of Medicine; 1960.
9. Howlader N, Noone A, Krapcho M, Garshell J, Neyman N, Altekruse SF, et al. *SEER cancer statistics review, 1975-2010*. Bethesda, MD: National Cancer Institute; 2013.
10. National Cancer Institute. *SEER\*Stat Program, version 6.6.1* [Internet]. Bethesda, MD: National Cancer Institute; 2013 [cited 2013 Jan 4]. Available from: <http://seer.cancer.gov/seerstat/>.
11. Ederer F, Heise H. *Instructions to IBM 650 programmers in processing survival computations*. Methodological note. No. 10. Bethesda, MD: National Cancer Institute; 1959.
12. Paul Dickman [Internet]. Stockholm: PaulDickman.com; 2014 [cited 2014 Jan 14]. Available from: <http://www.pauldickman.com>.
13. Davies L, Welch HG. Increasing incidence of thyroid cancer in the United States, 1973-2002. *JAMA*. 2006;295:2164-7.

14. Enewold L, Zhu K, Ron E, Marrogi AJ, Stojadinovic A, Peoples GE, et al. Rising thyroid cancer incidence in the United States by demographic and tumor characteristics, 1980-2005. *Cancer Epidemiol Biomarkers Prev.* 2009;18:784-91.
15. Han MA, Choi KS, Lee HY, Kim Y, Jun JK, Park EC. Current status of thyroid cancer screening in Korea: results from a nationwide interview survey. *Asian Pac J Cancer Prev.* 2011; 12:1657-63.
16. Kim SY. Study to provide evidence of health screening service for thyroid cancer. Seoul: National Evidence-based Healthcare Collaborating Agency; 2012.
17. Forman D, Bray F, Brewster DH, Gombe Mbalawa C, Kohler B, Pineros M, et al. Cancer incidence in five continents. Vol. 10 (electronic version). Lyon: IARC Press; 2013.
18. Jung KW, Yim SH, Kong HJ, Hwang SY, Won YJ, Lee JK, et al. Cancer survival in Korea 1993-2002: a population-based study. *J Korean Med Sci.* 2007;22 Suppl:S5-10.
19. Gondos A, Bray F, Hakulinen T, Brenner H; EUNICE Survival Working Group. Trends in cancer survival in 11 European populations from 1990 to 2009: a model-based analysis. *Ann Oncol.* 2009;20:564-73.
20. Dickman PW, Adami HO. Interpreting trends in cancer patient survival. *J Intern Med.* 2006;260:103-17.