

Cancer Statistics in Korea: Incidence, Mortality, Survival and Prevalence in 2010

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Purpose

This article gives an overview of nationwide cancer statistics, including incidence, mortality, survival and prevalence, and their trends in Korea based on 2010 cancer incidence data.

Materials and Methods

Incidence data from 1993 to 2010 were obtained from the Korea National Cancer Incidence Database, and vital status was followed until 31 December 2011. Mortality data from 1983 to 2010 were obtained from Statistics Korea. Crude and age-standardized rates for incidence, mortality, prevalence, and relative survival were calculated.

Results

In total, 202,053 cancer cases and 72,046 cancer deaths occurred during 2010, and 960,654 prevalent cancer cases were identified in Korea as of 1 January 2011. The incidence of all cancers combined showed an annual increase of 3.3% from 1999 to 2010. The incidences of liver and cervical cancers have decreased while those of thyroid, breast, prostate and colorectal cancers have increased. Notably, thyroid cancer, which is the most common cancer in Korea, increased by 24.2% per year rapidly in both sexes. The mortality of all cancers combined showed a decrease by 2.7% annually from 2002 to 2010. Five-year relative survival rates of patients who were diagnosed with cancer from 2006 to 2011 had improved by 22.9% compared with those from 1993 to 1995.

Conclusion

While the overall cancer incidence in Korea has increased rapidly, age-standardized cancer mortality rates have declined since 2002 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 associated with the largest disease burden [2]. More than 190,000 new cancer cases are diagnosed annually in Korea, and one in four deaths results from cancer [3,4]. This article provides an overview of nationwide cancer statistics, including the incidence, mortality, prevalence and survival rates, 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) as early as 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 and

activities of the KCCR have been documented [5]. Incidence data from 1999 to 2010 were obtained from the Korea National Cancer Incidence Database (KNCI DB). The completeness of incidence data for 2010 was 97.1%, as determined by the Ajiki method [6].

Cancer cases were classified according to the International Classification of Diseases for Oncology, 3rd edition [7] and converted according to the International Classification of Diseases, 10th edition (ICD-10) [8]. The survival analysis used 1,992,568 cancer cases first diagnosed during 1993-2010 from the KNCI DB, and followed vital status until 31 December 2011.

Mortality data from 1983-2010 were obtained from Statistics Korea [1]. Cause of death was coded and classified according to ICD-10. 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 determined using the world standard population [9]. 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 [10].

Prevalence was also calculated to assess the cancer burden, which reflects new and pre-existing cancer patients diag-

Table 1. Numbers of incident cancer cases, deaths, and prevalent cancer cases during 2010 in Korea by sex

Site/Type	New cases			Deaths			Prevalent cases ^{a)}		
	Both	Male	Female	Both	Male	Female	Both	Male	Female
All sites	202,053	103,014	99,039	72,046	45,209	26,837	960,654	434,365	526,289
Lip, oral cavity and pharynx	2,695	1,916	779	963	742	221	13,961	9,464	4,497
Esophagus	2,199	2,017	182	1,352	1,254	98	6,303	5,689	614
Stomach	30,092	20,179	9,913	10,032	6,512	3,520	169,868	112,811	57,057
Colon and rectum	25,782	15,612	10,170	7,645	4,322	3,323	136,055	80,717	55,338
Liver	15,921	11,818	4,103	11,205	8,350	2,855	43,351	32,542	10,809
Gallbladder ^{b)}	4,877	2,532	2,345	3,502	1,758	1,744	12,349	6,337	6,012
Pancreas	4,637	2,505	2,132	4,306	2,323	1,983	5,583	3,052	2,531
Larynx	1,144	1,071	73	416	383	33	7,583	7,120	463
Lung	20,711	14,650	6,061	15,623	11,416	4,207	43,564	28,784	14,780
Breast	14,277	69	14,208	1,868	10	1,858	103,418	472	102,946
Cervix uteri	3,857	-	3,857	956	-	956	38,488	-	38,488
Corpus uteri	1,752	-	1,752	222	-	222	11,935	-	11,935
Ovary	1,981	-	1,981	895	-	895	11,782	-	11,782
Prostate	7,848	7,848	-	1,328	1,328	-	35,372	35,372	-
Testis	206	206	-	9	9	-	1,774	1,774	-
Kidney	3,598	2,520	1,078	797	562	235	20,203	13,639	6,564
Bladder	3,415	2,752	663	1,100	822	278	21,921	17,823	4,098
Brain and CNS	1,715	922	793	1,182	645	537	7,527	3,951	3,576
Thyroid	36,021	6,231	29,790	356	94	262	174,918	26,264	148,654
Hodgkin lymphoma	243	167	76	48	30	18	1,609	1,035	574
Non-Hodgkin lymphoma	3,940	2,171	1,769	1,457	817	640	20,838	11,394	9,444
Multiple myeloma	1,070	563	507	763	399	364	3,073	1,624	1,449
Leukemia	2,684	1,540	1,144	1,618	922	696	12,287	6,793	5,494
Other and ill-defined	11,388	5,725	5,663	4,403	2,511	1,892	56,892	27,708	29,184

CNS, central nervous system. ^{a)}Limited-duration prevalent cases on January 1, 2011. These are patients who were diagnosed between January 1, 1999 and December 31, 2010 and who were known alive on January 1, 2011. Multiple primary cancer cases were counted multiple times, ^{b)}Includes the gallbladder and other /unspecified parts of the biliary tract.

nosed during a given period of time still alive on an index date. Using cancer incidence database data from 1999 to 2010, we defined prevalent cases on January 1, 2011 as patients who were diagnosed between January 1, 1999 and December 31, 2010 and who were alive on January 1, 2011. We calculated limited-duration prevalences, such as the 1- and 5-year prevalences. For example, the 5-year prevalence was calculated as the number of people alive on January 1, 2011 who had been diagnosed with cancer within the previous 5 years. We applied this counting method using the SEER*Stat software [11] to calculate the number of cases, while adjusting for patients lost to follow-up [10].

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 by the Ederer II method [12] using an algorithm written in SAS by Dickman [13], with some minor modifications.

Selected Findings

1. Incidence

Table 1 presents the overall number of incident cancer cases, deaths, and prevalent cases during 2010 in Korea by sex and cancer site. In 2010, 202,053 incident cancer cases and 72,046 deaths were identified. As of 1 January 2011, 960,654 prevalent cancer cases diagnosed between 1999 and 2010 were identified. In 2010, the cumulative risk of developing cancer during one's lifetime was 37.6% for males and 33.3% for females.

Table 2 shows cancer incidence rates in 2010 by sex. The CRs of all sites combined in 2010 were 412.4 and 397.7 per 100,000 in males and females, respectively. The ASRs of all sites combined were 324.1 and 268.7 per 100,000 in males and females, respectively. In males, the five leading primary cancer sites were the stomach (CR, 80.8; ASR, 62.3), colon and

Table 2. Crude and age-standardized cancer incidence rates during 2010 in Korea by sex

Site/Type	Crude incidence rate per 100,000			Age-standardized incidence rate per 100,000 ^{a)}		
	Both	Male	Female	Both	Male	Female
All sites	405.1	412.4	397.7	286.4	324.1	268.7
Lip, oral cavity, and pharynx	5.4	7.7	3.1	3.9	5.9	2.1
Esophagus	4.4	8.1	0.7	3.1	6.4	0.4
Stomach	60.3	80.8	39.8	41.8	62.3	24.9
Colon and rectum	51.7	62.5	40.8	35.9	48.6	25.3
Liver	31.9	47.3	16.5	22.3	36.0	10.2
Gallbladder ^{b)}	9.8	10.1	9.4	6.5	8.1	5.4
Pancreas	9.3	10.0	8.6	6.3	7.9	4.9
Larynx	2.3	4.3	0.3	1.6	3.4	0.2
Lung	41.5	58.7	24.3	28.0	46.5	14.3
Breast	28.6	0.3	57.1	20.2	0.2	39.8
Cervix uteri	7.7	-	15.5	5.5	-	10.6
Corpus uteri	3.5	-	7.0	2.5	-	5.0
Ovary	4.0	-	8.0	2.9	-	5.7
Prostate	15.7	31.4	-	10.7	25.3	-
Testis	0.4	0.8	-	0.4	0.8	-
Kidney	7.2	10.1	4.3	5.2	7.8	3.0
Bladder	6.8	11.0	2.7	4.6	8.7	1.5
Brain and CNS	3.4	3.7	3.2	3.0	3.4	2.6
Thyroid	72.2	24.9	119.6	52.7	18.3	87.4
Hodgkin lymphoma	0.5	0.7	0.3	0.4	0.6	0.3
Non-Hodgkin lymphoma	7.9	8.7	7.1	6.0	7.1	5.0
Multiple myeloma	2.1	2.3	2.0	1.5	1.7	1.3
Leukemia	5.4	6.2	4.6	5.0	6.0	4.1
Other and ill-defined	22.8	22.9	22.7	16.7	19.0	14.9

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

Table 3. The 10 leading causes of death in Korea during 2010

Rank	Cause of death	No. of deaths	Deaths (%)	Age-standardized death rate per 100,000 ^{a)}
	All causes	255,405	100.0	344.8
1	Cancer	69,780	28.2	96.3
2	Cerebrovascular disease	25,838	10.4	33.3
3	Heart disease	22,347	9.2	30.1
4	Intentional self-harm (suicide)	15,413	6.1	23.4
5	Diabetes mellitus	9,757	4.1	13.1
6	Pneumonia	7,147	2.9	9.4
7	Chronic lower respiratory diseases	6,914	2.8	8.7
8	Disease of the liver	6,868	2.7	9.5
9	Transport accidents	6,324	2.7	10.8
10	Hypertensive diseases	4,749	1.9	6.0
	Others	74,485	29.2	104.3

Source: Mortality data, 2010, Statistics Korea [1]. ^{a)}Age-adjusted using the world standard population.

Table 4. Crude and age-standardized cancer mortality rates during 2010 in Korea by sex

Site/Type	Crude mortality rate per 100,000			Age-standardized mortality rate per 100,000 ^{a)}		
	Both	Male	Female	Both	Male	Female
All sites	144.4	181.0	107.8	96.3	144.7	61.6
Lip, oral cavity, and pharynx	1.9	3.0	0.9	1.3	2.3	0.5
Esophagus	2.7	5.0	0.4	1.8	4.0	0.2
Stomach	20.1	26.1	14.1	13.2	20.7	7.8
Colon and rectum	15.3	17.3	13.3	10.1	14.0	7.3
Liver	22.5	33.4	11.5	15.4	25.8	6.6
Gallbladder ^{b)}	7.0	7.0	7.0	4.5	5.7	3.7
Pancreas	8.6	9.3	8.0	5.7	7.4	4.4
Larynx	0.8	1.5	0.1	0.5	1.2	0.1
Lung	31.3	45.7	16.9	20.5	36.6	9.1
Breast	3.7	0.0	7.5	2.6	0.0	5.0
Cervix uteri	1.9	-	3.8	1.3	-	2.3
Corpus uteri	0.4	-	0.9	0.3	-	0.6
Ovary	1.8	-	3.6	1.2	-	2.3
Prostate	2.7	5.3	-	1.6	4.6	-
Testis	0.0	0.0	-	0.0	0.0	-
Kidney	1.6	2.3	0.9	1.1	1.8	0.5
Bladder	2.2	3.3	1.1	1.4	2.8	0.5
Brain and CNS	2.4	2.6	2.2	1.8	2.2	1.4
Thyroid	0.7	0.4	1.1	0.5	0.3	0.5
Hodgkin lymphoma	0.1	0.1	0.1	0.1	0.1	0.0
Non-Hodgkin lymphoma	2.9	3.3	2.6	2.0	2.6	1.5
Multiple myeloma	1.5	1.6	1.5	1.0	1.3	0.8
Leukemia	3.2	3.7	2.8	2.5	3.1	1.9
Other and ill-defined	8.8	10.1	7.6	6.0	8.2	4.4

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

Table 5. Trends in cancer incidence rates in both sexes during 1999-2010 in Korea

Site/Type	Year										APC		
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008		2009	2010
All sites	210.5	205.1	216.7	220.1	227.4	234.5	247.3	251.4	262.3	274.5	284.6	286.4	3.3 ^{b)}
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	3.9	0.2
Esophagus	4.1	3.7	3.9	3.8	3.6	3.5	3.5	3.4	3.3	3.3	3.1	3.1	-2.2 ^{b)}
Stomach	43.6	42.3	44.0	43.6	43.2	41.1	44.4	42.8	41.7	42.5	43.3	41.8	-0.2
Colon and rectum	20.4	21.0	22.9	24.7	26.8	28.6	30.9	32.4	33.6	34.6	36.6	35.9	5.9 ^{b)}
Liver	27.9	26.7	27.3	26.5	25.7	25.6	25.8	24.5	24.3	24.0	23.4	22.3	-1.8 ^{b)}
Gallbladder ^{b)}	6.5	6.4	6.7	6.7	6.7	6.9	7.1	6.6	6.6	6.4	6.7	6.5	0.0
Pancreas	5.6	5.5	5.5	5.8	5.9	6.0	6.3	6.2	6.3	6.4	6.3	6.3	1.4 ^{b)}
Larynx	2.3	2.2	2.4	2.2	2.1	1.9	2.0	1.8	1.8	1.6	1.7	1.6	-3.6 ^{b)}
Lung	28.5	27.7	28.3	28.5	27.9	28.8	28.9	28.7	28.4	28.1	28.1	28.0	0.0
Breast	10.7	10.8	12.7	13.9	14.2	14.9	16.2	16.9	18.0	18.8	19.5	20.2	6.1 ^{b)}
Cervix uteri	8.5	7.9	8.3	7.7	7.4	6.8	6.4	6.3	5.7	5.9	5.5	5.5	-4.3 ^{b)}
Corpus uteri	1.4	1.3	1.5	1.7	1.9	1.9	2.0	2.1	2.1	2.4	2.6	2.5	6.0 ^{b)}
Ovary	2.7	2.5	2.5	2.6	2.7	2.7	2.8	2.8	3.0	2.9	2.7	2.9	1.3 ^{b)}
Prostate	3.1	2.7	3.6	3.9	4.8	6.0	6.3	7.3	8.6	9.7	10.5	10.7	14.3 ^{b)}
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	4.0 ^{b)}
Kidney	3.0	2.9	3.3	3.4	3.5	3.7	4.1	4.4	4.8	5.0	5.2	5.2	6.1 ^{b)}
Bladder	4.6	4.6	4.9	4.7	5.1	5.1	5.1	4.9	5.0	4.8	4.5	4.6	-0.1
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	3.0	0.8 ^{b)}
Thyroid	6.3	6.1	7.9	9.5	12.8	17.2	20.7	25.4	32.8	41.3	47.9	52.7	24.2 ^{b)}
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	4.6 ^{b)}
Non-Hodgkin lymphoma	4.5	4.2	4.5	4.6	4.9	5.3	5.3	5.5	5.5	5.6	6.1	6.0	3.3 ^{b)}
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	4.0 ^{b)}
Leukemia	4.7	4.3	4.7	4.8	4.8	4.8	4.7	4.9	4.8	5.0	5.0	5.0	0.9 ^{b)}
Other and ill-defined	14.3	13.5	13.9	13.5	15.1	15.2	16.1	16.0	17.0	16.9	16.8	16.7	-

APC, annual percentage change; CNS, central nervous system. APC was calculated using age-standardized incidence data based on the world standard population. ^{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 incidence rates in males during 1999-2010 in Korea

Site/Type	Year										APC		
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008		2009	2010
All sites	285.0	276.7	288.3	290.0	294.6	299.2	311.0	309.6	315.8	322.5	328.3	324.1	1.5 ^{b)}
Lip, oral cavity, and pharynx	6.1	7.1	6.0	6.2	6.5	6.2	6.1	6.1	6.3	6.5	6.1	5.9	-0.5
Esophagus	8.8	8.0	8.3	8.2	7.7	7.7	7.6	7.2	6.9	7.0	6.6	6.4	-2.6 ^{b)}
Stomach	66.2	65.0	67.2	66.6	65.9	62.3	66.9	65.3	63.0	64.3	64.8	62.3	-0.4 ^{b)}
Colon and rectum	26.2	27.2	29.6	32.9	35.3	37.9	41.1	43.2	45.2	46.7	49.6	48.6	6.4 ^{b)}
Liver	46.8	44.7	45.1	43.9	42.3	42.1	42.6	40.2	39.7	39.3	38.0	36.0	-2.1 ^{b)}
Gallbladder ^{b)}	8.1	7.8	8.2	8.1	7.8	8.4	8.7	8.1	7.9	7.6	8.0	8.1	-0.1
Pancreas	7.8	7.6	7.6	7.9	7.7	8.0	8.3	8.0	8.2	8.4	8.1	7.9	0.6 ^{b)}
Larynx	4.9	4.5	5.1	4.7	4.5	4.1	4.3	3.7	3.8	3.5	3.6	3.4	-3.6 ^{b)}
Lung	51.4	49.8	51.1	51.0	49.9	50.8	50.8	49.2	48.7	47.5	47.3	46.5	-0.8 ^{b)}
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	-1.6
Prostate	8.4	7.2	9.5	10.1	12.4	15.1	15.7	17.9	20.8	23.4	24.9	25.3	12.8 ^{b)}
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	3.9 ^{b)}
Kidney	4.5	4.4	4.9	5.0	5.2	5.5	6.0	6.5	7.0	7.4	7.6	7.8	5.8 ^{b)}
Bladder	9.0	9.0	9.4	9.0	9.7	9.8	9.8	9.6	9.4	9.1	8.6	8.7	-0.3
Brain and CNS	3.2	3.1	3.1	2.9	3.3	3.3	3.3	3.1	3.4	3.4	3.4	3.4	1.0 ^{b)}
Thyroid	2.1	1.9	2.4	2.7	3.7	4.8	5.9	7.5	10.0	13.3	15.5	18.3	24.8 ^{b)}
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	3.7 ^{b)}
Non-Hodgkin lymphoma	5.8	5.5	5.8	5.8	6.2	6.6	6.5	6.9	7.0	6.8	7.4	7.1	2.5 ^{b)}
Multiple myeloma	1.2	1.3	1.4	1.4	1.4	1.4	1.6	1.5	1.6	1.7	1.9	1.7	3.4 ^{b)}
Leukemia	5.5	5.0	5.4	5.8	5.5	5.7	5.6	5.6	5.7	5.8	5.9	6.0	1.0 ^{b)}
Other and ill-defined	17.9	16.5	16.8	16.5	18.4	18.2	19.2	18.7	20.1	19.6	19.7	19.0	-

APC was calculated using age-standardized incidence data based on the 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 7. Trends in cancer incidence rates in females during 1999-2010 in Korea

Site/Type	Year										APC		
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008		2009	2010
All sites	161.1	157.4	169.0	174.6	184.1	193.1	207.3	215.9	231.2	248.3	261.8	268.7	5.3 ^{a)}
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	2.1	1.0
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	-2.8 ^{b)}
Stomach	26.7	25.2	26.2	26.3	25.9	24.7	26.8	25.0	24.7	25.1	25.6	24.9	-0.4
Colon and rectum	16.4	16.4	17.9	18.8	20.5	21.5	22.9	24.0	24.5	25.0	26.1	25.3	4.7 ^{b)}
Liver	12.3	11.8	12.2	11.8	11.5	11.3	11.4	11.1	11.1	10.6	10.6	10.2	-1.6 ^{b)}
Gallbladder ^{b)}	5.3	5.5	5.7	5.8	5.8	5.9	6.0	5.5	5.6	5.5	5.8	5.4	0.0
Pancreas	4.0	4.0	4.0	4.2	4.5	4.5	4.7	4.7	4.7	4.9	4.8	4.9	2.2 ^{b)}
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	-7.7 ^{b)}
Lung	12.4	12.5	12.3	2.6	12.4	13.0	13.5	14.0	13.9	14.1	14.0	14.3	1.6 ^{b)}
Breast	20.9	20.9	24.7	27.2	27.8	29.2	31.8	33.2	35.5	37.0	38.5	39.8	6.3 ^{b)}
Cervix uteri	16.3	15.1	15.8	14.8	14.2	13.1	12.3	12.2	11.0	11.4	10.6	10.6	-4.2 ^{b)}
Corpus uteri	2.8	2.6	3.0	3.3	3.8	3.7	3.9	4.0	4.2	4.7	5.1	5.0	6.2 ^{b)}
Ovary	5.0	4.8	4.8	5.0	5.1	5.2	5.4	5.4	5.9	5.6	5.3	5.7	1.6 ^{b)}
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	6.0 ^{b)}
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	-0.7
Brain and CNS	2.6	2.5	2.5	2.4	2.5	2.6	2.8	2.6	2.8	2.6	2.5	2.6	0.5
Thyroid	10.4	10.1	13.2	16.2	21.8	29.5	35.3	43.2	55.5	69.3	80.4	87.4	24.2 ^{b)}
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	5.9 ^{b)}
Non-Hodgkin lymphoma	3.4	3.2	3.4	3.5	3.9	4.1	4.4	4.4	4.3	4.7	5.0	5.0	4.3 ^{b)}
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	4.7 ^{b)}
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	0.7 ^{b)}
Other and ill-defined	11.8	11.5	11.8	11.5	12.7	13.0	13.8	14.0	14.6	14.8	14.6	14.9	-

APC was calculated using age-standardized incidence data based on the 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.

rectum (CR, 62.5; ASR, 48.6), lung (CR, 58.7; ASR, 46.5), liver (CR, 47.3; ASR, 36.0), and prostate (CR, 31.4; ASR, 25.3), which together accounted for 68.1% of all newly diagnosed cancers in 2010. In females, the most common cancer sites were the thyroid (CR, 119.6; ASR, 87.4), breast (CR, 57.1; ASR, 39.8), colon and rectum (CR, 40.8; ASR, 25.3), stomach (CR, 39.8; ASR, 24.9), lung (CR, 24.3; ASR, 14.3), and liver (CR, 16.5; ASR, 10.2), which together accounted for 70.8% of all newly diagnosed cancers. Thyroid cancer alone accounted for 30.1% of incident cases (n=29,790) in females in 2010.

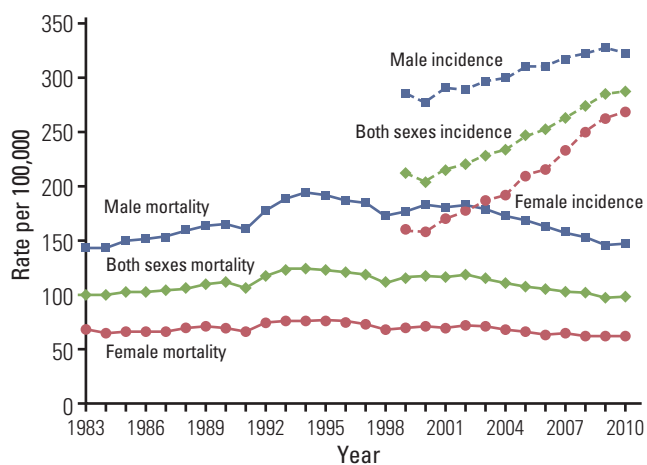


Fig. 1. Annual age-standardized cancer incidence and death rates for all sites during 1983-2010 in Korea by sex. Age standardization was based on the world standard population.

2. Mortality

In total, 72,046 cancer deaths were reported in Korea during 2010, accounting for 28.2% of all deaths (Table 3). In 2010, the CRs for all sites combined were 181.0 and 107.8 per 100,000 in males and females, respectively. The ASRs of all sites combined were 144.7 and 61.6 per 100,000 for males and females, respectively. Cancers of the lung, liver, stomach, and colon/rectum were the most common fatal cancers, together accounting for about 61.8% of all cancer deaths in 2010 (Table 4).

In males, the five leading fatal primary cancer sites in 2010 were the lung (CR, 45.7; ASR, 36.6), liver (CR, 33.4; ASR, 25.8), stomach (CR, 26.1; ASR, 20.7), colon and rectum (CR, 17.3; ASR, 14.0) and pancreas (CR, 9.3; ASR, 7.4). In women, lung cancer (CR, 16.9; ASR, 9.1) was the most fatal cancer site in 2010, followed by the stomach (CR, 14.1; ASR, 7.8), colon and rectum (CR, 13.3; ASR, 7.3), liver (CR, 11.5; ASR, 6.6), and breast (CR, 7.5; ASR, 5.0).

3. Trends in cancer incidence

Tables 5-7 present the cancer incidence rates during 1999-2010 in Korea for all sites combined and for selected sites. The incidence for all sites combined increased by 3.3% annually (1.5% in males, 5.3% in females) from 1999 to 2010.

The rapid increase in cancer incidence is also illustrated in Fig. 1. As shown in Fig. 2, the incidence rates of colorectal and thyroid cancers have continued to increase in both sexes, as have those of prostate cancer in males and breast cancer in females. In contrast, the incidences of liver cancer in both sexes, lung cancer in males and cervical cancer in females

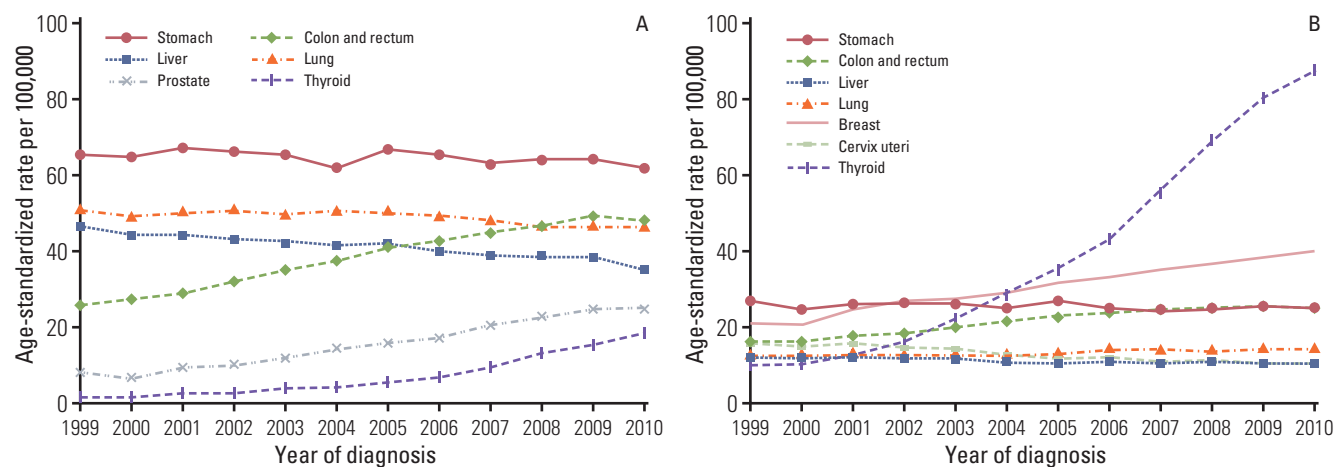


Fig. 2. Trends in age-standardized incidences of selected cancers during 1999-2010 in Korea by sex. Age standardization was based on the world standard population. (A) Male. (B) Female.

Table 8. The five major sites of cancer incidence during 2010 in Korea by age group and sex

Rank	Age (yr)			
	0-14	15-34	35-64	≥ 65
Male				
1	Leukemia (5.1)	Thyroid (11.2)	Stomach (95.2)	Lung (455.0)
2	Brain and CNS (2.5)	Leukemia (3.1)	Colon and rectum (72.1)	Stomach (433.2)
3	Non-Hodgkin lymphoma (2.0)	Colon and rectum (2.7)	Liver (66.4)	Colon and rectum (340.6)
4	Kidney (0.5)	Non-Hodgkin lymphoma (2.6)	Thyroid (42.9)	Prostate (274.1)
5	Testis (0.3)	Stomach (2.6)	Lung (42.5)	Liver (199.3)
Female				
1	Leukemia (3.6)	Thyroid (59.9)	Thyroid (209.8)	Colon and rectum (175.7)
2	Brain and CNS (1.7)	Breast (10.0)	Breast (106.5)	Stomach (162.2)
3	Ovary (0.8)	Cervix uteri (5.6)	Stomach (40.8)	Lung (121.5)
4	Thyroid (0.7)	Stomach (4.3)	Colon and rectum (40.5)	Thyroid (85.0)
5	Non-Hodgkin lymphoma (0.6)	Ovary (3.0)	Cervix uteri (23.0)	Liver (77.8)

CNS, central nervous system.

have decreased. Stomach cancer incidence rates remained the same in males and females. One notable trend was the sharp (24.2% annual) increase in the incidence of thyroid cancer in both sexes. Improvements in the sensitivity of diagnostic techniques for thyroid cancer, such as the advent of ultra-

sound and fine-needle aspiration, have enabled the detection of subclinical disease. Therefore, the increased incidence of thyroid cancer may reflect the identification of previously undetected disease with these improved diagnostic techniques and increased screening rates, rather than a true

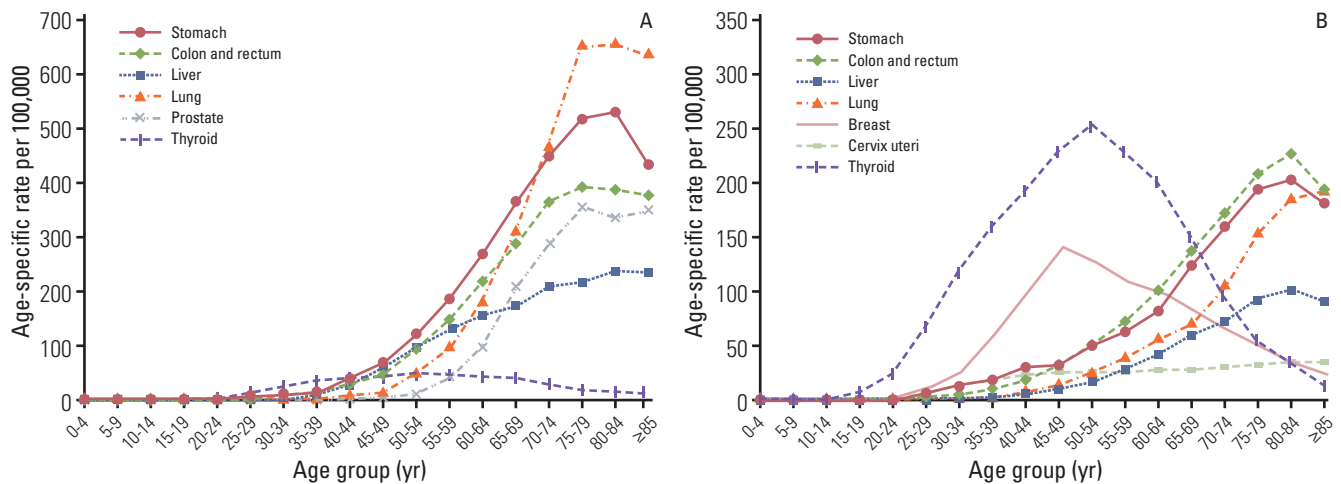


Fig. 3. Age-specific incidence rates of major cancers during 2010 in Korea. (A) Male. (B) Female.

Table 9. Trends in the 5-year relative survival rates (%) during 1993-2010 in Korea by year of diagnosis

Site/Type	Both						Male						Female					
	1993-1995	1996-2000	2001-2005	2006-2010	Change ^{a)}		1993-1995	1996-2000	2001-2005	2006-2010	Change ^{a)}		1993-1995	1996-2000	2001-2005	2006-2010	Change ^{a)}	
All sites	41.2	44.0	53.7	64.1	22.9	31.7	35.3	45.2	55.4	23.7	53.4	55.3	63.9	73.3	19.9			
Lip, oral cavity, and pharynx	41.1	46.7	54.1	60.1	19.0	35.8	41.1	49.3	56.3	20.5	58.1	63.8	67.7	70.2	12.1			
Esophagus	12.7	15.2	21.1	29.4	16.7	11.8	14.3	20.4	28.7	16.9	23.7	24.2	29.5	36.8	13.1			
Stomach	42.8	46.6	57.7	67.0	24.2	43.0	46.9	58.4	67.7	24.7	42.6	46.0	56.3	65.7	23.1			
Colon and rectum	54.8	58.0	66.6	72.6	17.8	55.3	59.0	68.5	74.5	19.2	54.2	56.8	64.1	69.9	15.7			
Liver	10.7	13.2	20.1	26.7	16.0	9.9	12.9	20.1	26.7	16.8	13.6	14.2	20.3	26.8	13.2			
Gallbladder ^{b)}	17.3	19.7	22.8	26.7	9.4	16.6	20.3	23.3	27.9	11.3	18.0	19.1	22.3	25.5	7.5			
Pancreas	9.4	7.6	8.0	8.0	-1.4	8.8	7.3	8.0	7.7	-1.1	10.1	8.1	8.1	8.3	-1.8			
Larynx	59.7	62.3	66.1	72.3	12.6	60.2	62.8	66.7	72.7	12.5	55.4	57.8	58.2	66.0	10.6			
Lung	11.3	12.7	16.2	19.7	8.4	10.4	11.6	14.9	17.5	7.1	14.2	16.2	19.7	25.4	11.2			
Breast	77.9	83.2	88.5	91.0	13.1	75.1	85.6	87.0	89.6	14.5	78.0	83.2	88.5	91.0	13.0			
Cervix uteri	77.5	80.0	81.2	80.2	2.7	-	-	-	-	-	77.5	80.0	81.2	80.2	2.7			
Corpus uteri	81.5	81.8	84.6	86.2	4.7	-	-	-	-	-	81.5	81.8	84.6	86.2	4.7			
Ovary	58.7	58.9	61.3	60.4	1.7	-	-	-	-	-	58.7	58.9	61.3	60.4	1.7			
Prostate	55.9	67.2	80.1	90.2	34.3	55.9	67.2	80.1	90.2	34.3	-	-	-	-	-			
Testis	85.4	90.4	90.6	92.5	7.1	85.4	90.4	90.6	92.5	7.1	-	-	-	-	-			
Kidney	62.0	66.1	73.3	77.7	15.7	60.8	64.4	72.8	77.7	16.9	64.5	69.7	74.4	77.8	13.3			
Bladder	69.1	73.1	75.5	76.3	7.2	70.0	74.8	77.3	78.3	8.3	65.5	66.3	68.5	68.4	2.9			
Brain and CNS	38.5	39.0	40.5	42.6	4.1	37.2	37.5	39.9	41.4	4.2	40.2	40.7	41.2	44.0	3.8			
Thyroid	94.2	94.9	98.3	99.8	5.6	87.2	89.5	95.8	99.8	12.6	95.4	95.9	98.7	99.7	4.3			
Hodgkin lymphoma	68.0	71.2	76.7	80.8	12.8	67.6	68.1	74.7	80.4	12.8	68.6	77.4	80.6	81.4	12.8			
Non-Hodgkin lymphoma	46.6	50.8	59.9	64.9	18.3	45.3	48.9	58.0	63.2	17.9	48.7	53.5	62.3	67.0	18.3			
Multiple myeloma	22.1	19.8	29.2	35.1	13.0	21.1	17.8	29.5	35.3	14.2	23.3	22.1	28.9	34.9	11.6			
Leukemia	26.5	33.3	41.8	47.2	20.7	26.2	32.3	41.6	46.2	20.0	26.8	34.6	41.9	48.4	21.6			
Other and ill-defined	42.1	45.9	55.6	64.2	22.1	37.4	42.4	52.0	60.4	23.0	47.4	50.0	59.6	68.1	20.7			

CNS, central nervous system. ^{a)}Change in 5-year relative survival between 1993-1995 and 2006-2010 as a percentage. ^{b)}Includes the gallbladder and other/ unspecified parts of the biliary tract.

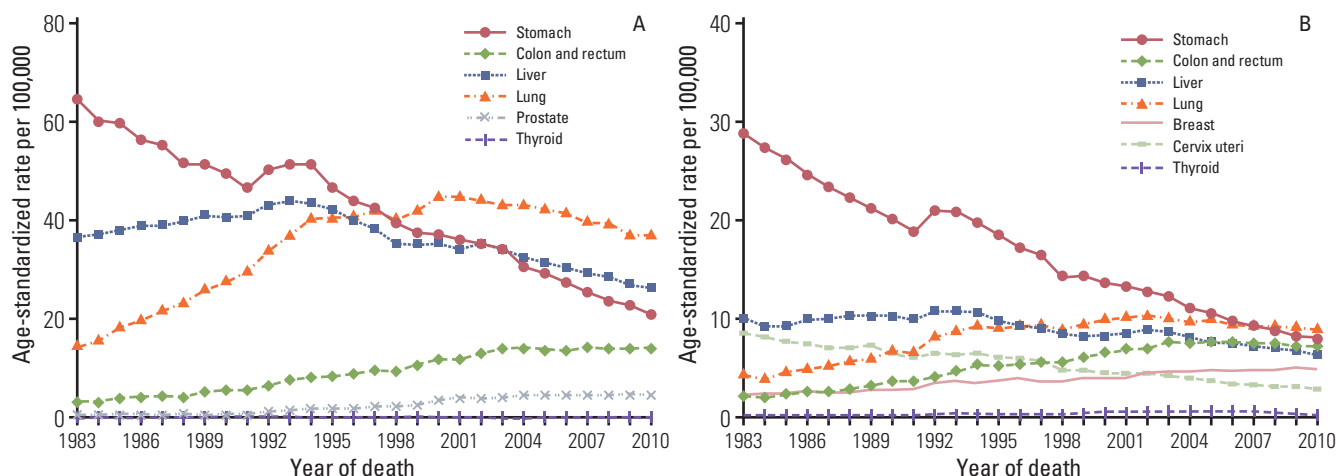


Fig. 4. Annual age-standardized mortalities of selected cancers during 1983-2010 in Korea by sex. Age standardization was based on the world standard population. (A) Male. (B) Female.

Table 10. Crude and age-standardized rates of cancer prevalence on January 1, 2011 in Korea by sex

Site/Type	Crude prevalence rate per 100,000 ^{a)}			Age-standardized prevalence rate per 100,000 ^{b)}		
	Both	Male	Female	Both	Male	Female
All sites	1925.9	1739.0	2113.4	1370.9	1369.7	1446.7
Lip, oral cavity, and pharynx	28.0	37.9	18.1	20.2	29.3	12.4
Esophagus	12.6	22.8	2.5	8.8	18.0	1.5
Stomach	340.6	451.7	229.1	236.4	349.3	144.6
Colon and rectum	272.8	323.2	222.2	188.8	252.4	138.7
Liver	86.9	130.3	43.4	62.5	100.1	28.9
Gallbladder ^{c)}	24.8	25.4	24.1	16.9	20.0	14.6
Pancreas	11.2	12.2	10.2	7.8	9.6	6.4
Larynx	15.2	28.5	1.9	10.6	22.6	1.1
Lung	87.3	115.2	59.4	60.5	90.8	37.4
Breast	207.3	1.9	413.4	145.8	1.5	286.0
Cervix uteri	77.2	-	154.6	53.9	-	104.5
Corpus uteri	23.9	-	47.9	17.2	-	33.7
Ovary	23.6	-	47.3	17.7	-	34.9
Prostate	70.9	141.6	-	46.5	114.1	-
Testis	3.6	7.1	-	3.3	6.4	-
Kidney	40.5	54.6	26.4	29.5	42.3	18.4
Bladder	43.9	71.4	16.5	29.5	56.5	9.4
Brain and CNS	15.1	15.8	14.4	13.5	14.5	12.5
Thyroid	350.7	105.2	596.9	253.0	76.9	427.5
Hodgkin lymphoma	3.2	4.1	2.3	2.8	3.5	2.0
Non-Hodgkin lymphoma	41.8	45.6	37.9	31.9	37.1	27.5
Multiple myeloma	6.2	6.5	5.8	4.4	5.0	3.8
Leukemia	24.6	27.2	22.1	24.2	27.0	21.5
Other and ill-defined	114.1	110.9	117.2	85.1	92.6	79.2

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, 2010 and who were alive on January 1, 2011. Multiple primary cancer cases were counted multiple times, ^{b)}Age-adjusted using the world standard population, ^{c)}Includes the gallbladder and other/unspecified parts of the biliary tract.

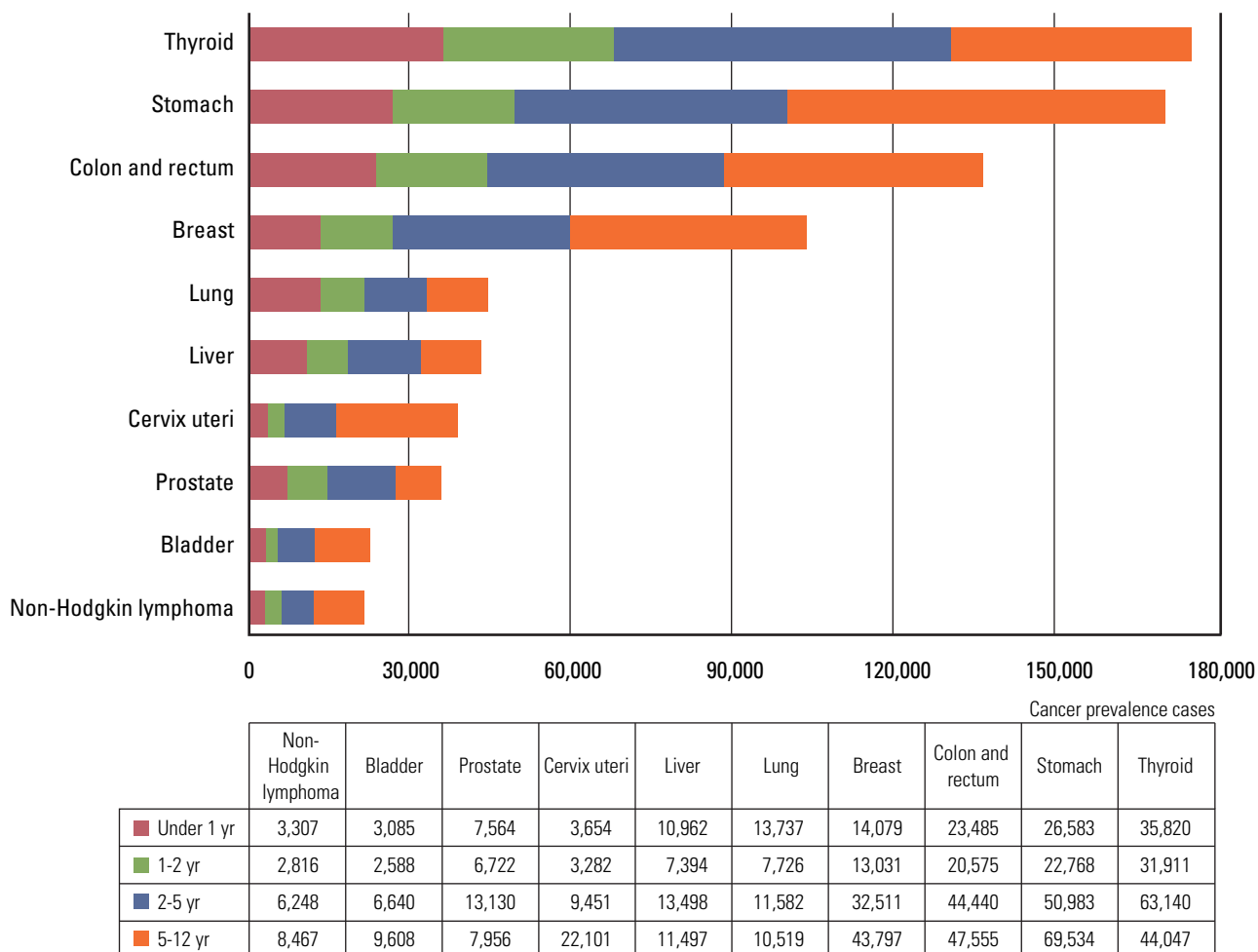


Fig. 5. Numbers of prevalent cases for major cancer sites on January 1, 2011 in Korea by time since diagnosis.

increase in the occurrence of thyroid cancer [14-17]. Furthermore, due to the construction of a 1999-2010 KNCDDB, the completeness of the Korea cancer registry data has improved gradually, and this may have contributed, in part, to the gradual overall increases in cancer incidence, particularly among elderly patients.

4. Age-specific incidence rates

Table 8 presents the most common cancer sites by sex and age group in 2010. Leukemia and thyroid cancer were the most common cancer in both sexes in subjects aged 0-14 and 15-34 years, respectively. For males, stomach cancer was the most common cancer in 35-64-year-olds, while lung cancer was more frequent among patients aged ≥ 65 years. Thyroid cancer was the most common cancer in middle-aged Korean females (age, 35 to 64 years), and colorectal cancer was the most common cancer among older females (≥ 65 years).

Fig. 3 shows the age-specific incidence rates for selected

cancers in males and females in 2010. The data show that the incidences of stomach, lung, liver, and colorectal cancers increased gradually with age. Incidences of breast and thyroid cancers in females were highest in those in their late 40s and early 50s, respectively, and leveled off thereafter. This pattern is different from those in Western countries [18].

5. Trends in cancer mortality

Figs. 1 and 4 show the trends in cancer deaths for all sites combined and for selected sites. ASRs of mortality showed an annual decrease of 2.7% for all sites combined in both sexes since 2002. Lung cancer surpassed stomach cancer as the leading cause of cancer deaths in 1999 and is expected to account for 21.7% of all cancer deaths in 2010. The ASRs of mortality due to lung cancer have decreased slightly in males since 2001, but have increased in females. The ASRs of mortality due to stomach and cervical cancers have decreased continuously. Along with the significant increases

in colorectal, prostate and female breast cancer incidence rates, the mortality rates of these cancers have also continued to increase.

6. Survival rates

Table 9 shows the 5-year relative survival rates for four diagnosis periods: 1993-1995, 1996-2000, 2001-2005, and 2006-2010. Patients who were diagnosed with cancer in the most recent period (2006-2010) had a 5-year relative survival rate of 64.1% for all sites combined in both sexes (55.4% in males and 73.3% 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 than in males may be partly explained by cancers common in females (e.g., thyroid, breast, and cervix 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 during 2006-2010 compared with those diagnosed during 1993-1995, with the exception of pancreatic cancer. The greatest improvements were seen in prostate cancer, stomach cancer, non-Hodgkin lymphoma, leukemia, and colorectal cancer. The improving survival rates could be attributable to early detection and improved treatments [19, 20], but 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 [21].

7. Prevalence rates

Table 10 shows the cancer prevalent rates on January 1, 2011 in Korea by sex and cancer site. The CRs of cancer prevalence for all sites combined were 1,739.0 and 2,113.4 per 100,000 in males and females, respectively, and the ASRs of cancer prevalence for all sites combined were 1,369.7 and 1,446.7 per 100,000 in males and females, respectively. In males, the five leading primary sites of cancer for prevalence were the stomach (CR, 451.7; ASR, 349.3), colon and rectum

(CR, 323.2; ASR, 252.4), prostate (CR, 141.6; ASR, 114.1), liver (CR, 130.3; ASR, 100.1), and lung (CR, 115.2; ASR, 90.8), which together accounted for 66.8% of all prevalent cancer cases. In females, the most common cancer sites were the thyroid (CR, 596.9; ASR, 427.5), breast (CR, 413.4; ASR, 286.0), stomach (CR, 229.1; ASR, 144.6), colon and rectum (CR, 222.2; ASR, 138.7), cervix (CR, 154.6; ASR, 104.5), and lung (CR, 59.4; ASR, 37.4), which together accounted for 79.3% of all prevalent cancer cases.

Fig. 5 shows prevalence by time since diagnosis with cancer. For all cancers combined, the 1-2-year prevalence represented 33.0% of all prevalent cases. The 1-2-year prevalence, as a percentage of the total prevalence, was highest for thyroid cancer (21.4%), followed by stomach cancer (15.6%) and colorectal cancer (13.9%), which had high incidence rates and good prognoses. For all cancers combined, the 2-5-year and >5-year prevalences accounted for 31.6% and 35.4%, respectively, of the total prevalence in both sexes. The long-term prevalences of lung and liver cancers were relatively low due to their low survival rates.

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; 2012 [cited 2013 Jan 4]. Available from: <http://kostat.go.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, Park S, Kong HJ, Won YJ, Lee JY, Seo HG, et al. Cancer statistics in Korea: incidence, mortality, survival, and prevalence in 2009. *Cancer Res Treat*. 2012;44:11-24.
4. Won YJ, Sung J, Jung KW, Kong HJ, Park S, Shin HR, et al. Nationwide cancer incidence in Korea, 2003-2005. *Cancer Res Treat*. 2009;41:122-31.
5. 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.
6. 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.
 7. 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.
 8. World Health Organization. *International statistical classification of diseases and related health problems.* 10th rev. Geneva: World Health Organization; 1994.
 9. Segi M. *Cancer mortality for selected sites in 24 countries (1950-1957).* Sendai: Tohoku University School of Medicine; 1960.
 10. Altekruse SF, Kosary CL, Krapcho M, Neyman N, Aminou R, Waldron W, et al. *SEER cancer statistics review, 1975-2007.* Bethesda, MD: National Cancer Institute; 2010.
 11. National Cancer Institute. *SEER*Stat Program, version 6.6.1* [Internet]. Bethesda, MD: U. S. National Cancer Institute; [cited 2013 Jan 4]. Available from: <http://seer.cancer.gov/seerstat/2010>.
 12. Ederer F, Heise H. *Instructions to IBM programmers in processing survival computations.* Methodological note No. 10. Bethesda, MD: National Cancer Institute; 1959.
 13. Paul Dickman [Internet]. Stockholm: PaulDickman.com; [cited 2010 Apr 14]. Available from: <http://www.pauldickman.com>.
 14. Davies L, Welch HG. Increasing incidence of thyroid cancer in the United States, 1973-2002. *JAMA.* 2006;295:2164-7.
 15. 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.
 16. 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.
 17. Kim SY. Study to provide evidence of health screening service for thyroid cancer. Seoul: National Evidence based Healthcare Collaborating Agency; 2012 [cited 2013 Jan 4]. Available from: <http://www.neca.re.kr/>.
 18. Curado MP, Edwards B, Shin HR, Storm H, Ferlay J, Heanue M, et al. *Cancer incidence in five continents.* Vol. 9. Lyon: IARC Press; 2007.
 19. 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.
 20. 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.
 21. Dickman PW, Adami HO. Interpreting trends in cancer patient survival. *J Intern Med.* 2006;260:103-17.