

# Prediction of Cancer Incidence and Mortality in Korea, 2011

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## Purpose

To estimate the current cancer burden in Korea, cancer incidence and mortality were projected for the year 2011.

## Materials and Methods

The cancer incidence data from 1999-2008 were obtained from the Korea National Cancer Incidence Database, and the cancer mortality data from 1993-2009 were obtained from the Korea National Statistics Office. Cancer incident cases and rates in 2011 were projected from fitting a linear regression model on observed age-specific cancer incidence rates against observed years, then multiplying the projected age-specific rates by the age-specific population. For cancer mortality, a similar procedure was applied for projection except that a Joinpoint regression model was used to determine at which year the linear trend significantly changed.

## Results

A total of 216,809 new cancer cases and 71,036 cancer deaths are projected to occur in Korea in 2011. For all sites combined, the crude incidence rates are projected to be 437.9 and 420.5 and the age-standardized incidence rates are projected to be 336.5 and 279.7 per 100,000 for men and women, respectively.

## Conclusion

Cancer has become an important public health concern in Korea, and as Korea becomes an aged society, the cancer burden will continue to increase.

## Key words

Incidence, Mortality, Neoplasms, Prediction, Korea, 2011

## Introduction

Having been the leading cause of death since 1983 [1], cancer has become a major public health concern in Korea. Annually, over 170,000 patients are newly diagnosed with cancer in Korea and one out of four deaths is due to cancer [2,3]. While the cancer registration system in Korea is very efficient and can provide the nationwide cancer statistics within a relatively short time, at least a 2-year lag

time behind the current year is still needed because of the time required for data collection and compilation. In order to plan and apply a cancer control program for the current year, it is important to assess the number of new cancer cases and cancer deaths that are expected to occur during the current year. In this report, we provide the projected cancer incidence and mortality on the basis of observed data of up to year 2008.

## Materials and Methods

The Korea Ministry of Health and Welfare initiated a nationwide, hospital-based cancer registry (the Korea Central Cancer Registry [KCCR]) in 1980. The details of the history, objectives, and activities of the KCCR have been documented [4]. Incidence data from 1999-2008 were obtained from the Korea National Cancer Incidence Database (KNCI DB). Cancer cases were classified according to the International Classification of Diseases for Oncology, 3rd edition [5] and converted according to the International Classification of Diseases, 10th edition (ICD-10) [6].

Mortality data from 1993-2009 were obtained from the Korea National Statistics Office (KNSO) [1]. The cause of death was coded and classified according to ICD-10.

The cancer sites included in this report are all cancers combined and 22 common cancers: lip, mouth, and pharynx (C00-C14), esophagus (C15), stomach (C16), colon and rectum (C18-C20), liver and intrahepatic bile duct (liver) (C22), gallbladder and other parts of the biliary tract (gallbladder) (C23-C24), pancreas (C25), lung and bronchus (lung) (C33-C34), breast (C50), uterine cervix (C53),

uterine corpus (C54), ovary (C56), prostate (C61), testis (C62), kidney (C64), bladder (C67), brain and central nervous system (C70-C72), thyroid (C73), Hodgkin lymphoma (C81), non-Hodgkin lymphoma (C82-C85, C96), multiple myeloma (C90), leukemia (C91-C95), and all others.

The population data were obtained from the resident registration population at the KNSO. The mid-year population on July 1 of the respective year was applied when computing the incident cases, deaths, and rates.

Because the most recent year for which incidence and mortality data are available is usually 2-3 years behind the current year due to the time required for the data collection and analysis, we projected the expected number of new cancer cases and deaths in Korea of the current year to provide an estimate of the current cancer burden.

Linear regression models [7] were used to assess the time trend and the projection of rates. Based on the observed cancer incidence data, a linear regression model was fitted to the age-specific rates by 5-year age group against years. From the projected age-specific rates in 2011, the number of estimated cancer incident cases was calculated by multiplying the rates by age-specific population size in 2011. For thyroid and prostate cancer that showed significant curve-linear trends,

**Table 1.** Estimated new cancer cases and deaths by sex during 2011 in Korea

Sites	Estimated new cases			Estimated deaths		
	Both sexes	Male	Female	Both sexes	Male	Female
All sites	216,809	110,823	105,986	71,036	44,589	26,447
Lip, oral cavity, and pharynx	2,712	2,037	675	1,025	758	267
Esophagus	2,255	2,058	197	1,269	1,174	95
Stomach	31,036	21,075	9,961	8,955	5,855	3,100
Colon and rectum	29,766	18,063	11,703	7,765	4,375	3,390
Liver	16,687	12,443	4,244	10,989	8,240	2,749
Gallbladder <sup>a)</sup>	5,232	2,579	2,653	3,785	1,814	1,971
Pancreas	5,175	2,801	2,374	4,420	2,331	2,089
Larynx	1,040	997	43	258	236	22
Lung	21,902	15,496	6,406	15,769	11,578	4,191
Breast	15,418	62	15,356	2,081	18	2,063
Cervix uteri	3,359	-	3,359	841	-	841
Corpus uteri	1,899	-	1,899	248	-	248
Ovary	2,104	-	2,104	945	-	945
Prostate	9,526	9,526	-	1,462	1,462	-
Testis	202	202	-	20	20	-
Kidney	3,966	2,731	1,235	792	514	278
Bladder	3,915	3,153	762	948	687	261
Brain and CNS	1,809	961	848	1,020	552	468
Thyroid	38,119	5,756	32,363	360	106	254
Hodgkin lymphoma	235	145	90	43	27	16
Non-Hodgkin lymphoma	4,195	2,338	1,857	1,428	842	586
Multiple myeloma	1,138	581	557	773	387	386
Leukemia	2,774	1,555	1,219	1,631	939	692
Other and ill-defined	12,345	6,264	6,081	4,209	2,674	1,535

CNS, central nervous system. <sup>a)</sup>Includes gallbladder and other/unspecified parts of the biliary tract.

**Table 2.** Estimated crude and age-standardized cancer incidence rates by sex during 2011 in Korea

Sites	Crude incidence rates/100,000			Age-standardized incidence rates/100,000 <sup>a)</sup>		
	Both sexes	Male	Female	Both sexes	Male	Female
All sites	429.2	437.9	420.5	297.3	336.5	279.7
Lip, oral cavity, and pharynx	5.4	8.0	2.7	3.8	6.1	1.9
Esophagus	4.5	8.1	0.8	3.0	6.3	0.4
Stomach	61.4	83.3	39.5	41.7	62.9	24.4
Colon and rectum	58.9	71.4	46.4	40.1	54.2	28.4
Liver	33.0	49.2	16.8	22.6	36.6	10.2
Gallbladder <sup>b)</sup>	10.4	10.2	10.5	6.7	7.9	5.7
Pancreas	10.2	11.1	9.4	6.7	8.5	5.2
Larynx	2.1	3.9	0.2	1.4	3.0	0.1
Lung	43.4	61.2	25.4	28.3	47.3	14.5
Breast	30.5	0.2	60.9	21.3	0.2	42.2
Cervix uteri	6.6	-	13.3	4.6	-	8.9
Corpus uteri	3.8	-	7.5	2.6	-	5.1
Ovary	4.2	-	8.3	3.0	-	5.9
Prostate	18.9	37.6	-	12.6	29.5	-
Testis	0.4	0.8	-	0.4	0.8	-
Kidney	7.9	10.8	4.9	5.6	8.1	3.3
Bladder	7.8	12.5	3.0	5.1	9.6	1.6
Brain and CNS	3.6	3.8	3.4	3.1	3.4	2.8
Thyroid	75.5	22.7	128.4	54.3	16.5	92.5
Hodgkin lymphoma	0.5	0.6	0.4	0.4	0.5	0.3
Non-Hodgkin lymphoma	8.3	9.2	7.4	6.1	7.4	5.1
Multiple myeloma	2.3	2.3	2.2	1.5	1.8	1.4
Leukemia	5.5	6.1	4.8	5.1	5.9	4.4
Other and ill-defined	24.4	24.7	24.1	17.5	20.1	15.4

CNS, central nervous system. <sup>a)</sup>Age adjusted to the World Health Organization (WHO) world standard population, <sup>b)</sup>Includes gallbladder and other/unspecified parts of biliary tract.

we used a square root transformation when fitting a linear regression model and converted the predicted values back to the original scale.

To estimate the number of cancer deaths in 2011, we first ran a *Joinpoint* regression model on the data from 1993-2009 to detect the year of significant changes in the trend of cancer mortality separately by sex and cancer site. A *Joinpoint* regression describes the changes in data trends by connecting several different line segments on a log scale at "joinpoints." This analysis was performed using *Joinpoint* software (version 3.3, <http://srab.cancer.gov/joinpoint>) from the Surveillance Research Program of the National Cancer Institute in the US [8]. After identifying the year of significant trend changes from a *Joinpoint* regression analysis, a simple linear regression model was fitted to the last line segment to estimate age-specific cancer mortality rates in 2011. Similar to the method used for the projection of cancer incidence, the number of new deaths was then projected by multiplying the age-specific cancer mortality rates by respective age-specific population.

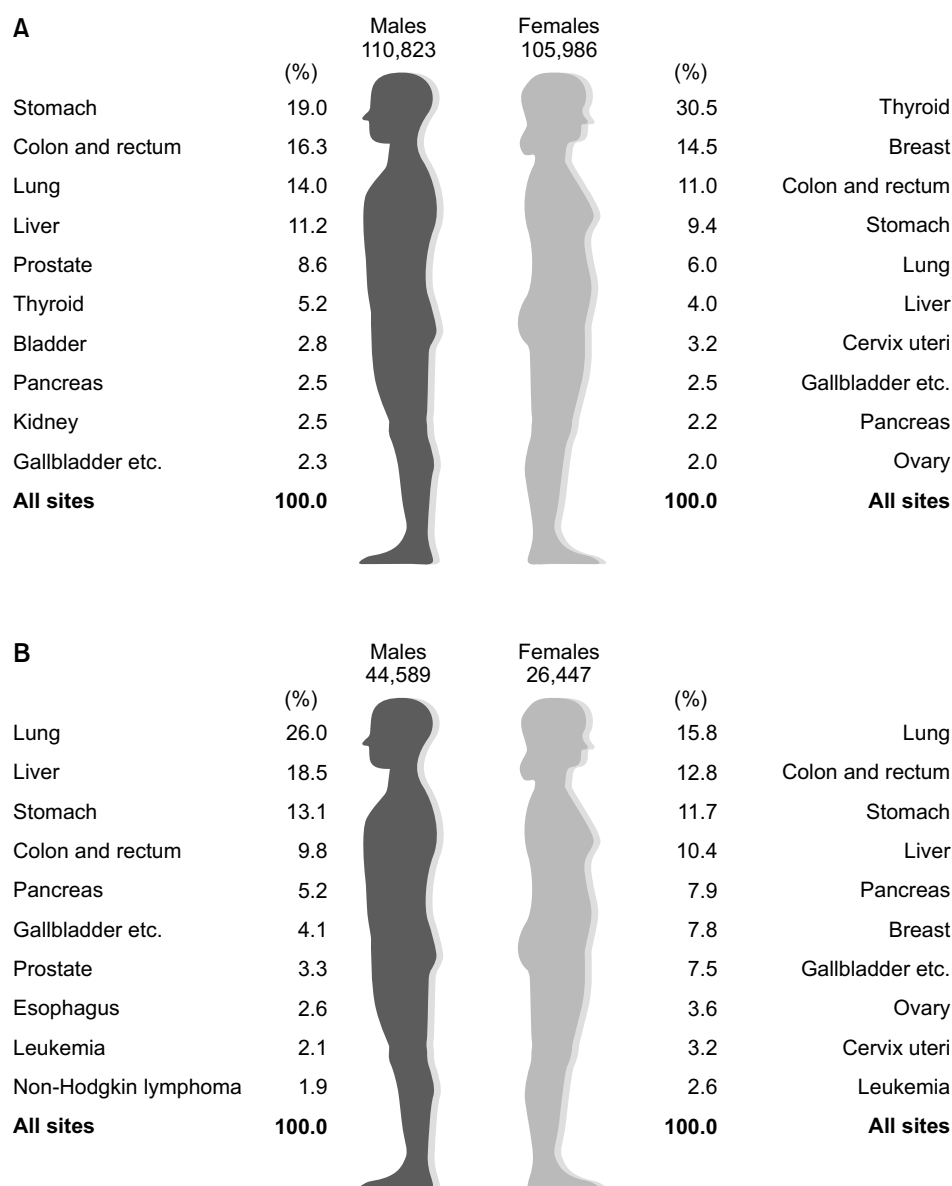
We summarized the results using the crude rates (CRs) and age-standardized rates (ASRs) of cancer incidence and mortality. The ASRs were standardized using the World Health Organization (WHO) world standard population [9].

## Results

### 1 Incidence

Table 1 presents the estimated number of new cancer cases and deaths during 2011 in Korea by sex and cancer site. It is projected that 216,809 cancer incident cases will occur during the year 2011.

Table 2 presents the estimated CRs and ASRs of cancer incidence in 2011 by sex and cancer site. The CRs of all sites combined in 2011 are projected to be 437.9 and 420.5 per 100,000 in men and women, respectively, and the ASRs of all sites combined are projected to be 336.5 and 279.7 per 100,000. In males, the five leading primary sites of cancer are expected to be the stomach (CR, 83.3; ASR, 62.9), colon and rectum (CR, 71.4; ASR, 54.2), lung (CR, 61.2; ASR, 47.3), liver (CR, 49.2; ASR, 36.6), and prostate (CR, 37.6; ASR, 29.5), accounting for 69.1% of all newly diagnosed cancers in 2011. In females, the most common cancer sites are expected to be thyroid (CR, 128.4; ASR, 92.5), breast (CR, 60.9; ASR, 42.2), colon and rectum (CR, 46.4; ASR, 28.4), stomach (CR, 39.5; ASR, 24.4), lung (CR, 25.4; ASR, 14.5), and liver (CR, 16.8; ASR, 10.2),



**Fig. 1.** Ten leading cancer types for the estimated new cancer cases and deaths by sex in 2011. (A) Estimated new cases. (B) Estimated deaths.

accounting for 75.5% of all newly diagnosed cancers (Fig. 1). Thyroid cancer alone is projected to account for 30.5% (32,363 cases) of incident cases in women in 2011.

Table 3 presents the most common cancer sites expected in 2011 by sex and age group. Leukemia and thyroid cancer will be the most common forms of cancer in both sexes 0-14 and 15-34 years of age, respectively. Gastric cancer is predicted to be the most common cancer in males 35-64 years of age, while lung cancer is predicted to be more frequent for males  $\geq 65$  years of age. The most common sites of cancer will be thyroid for females 35-64 years of age, while colorectal cancer will be the most common cancer for females  $\geq 65$  years of age.

Fig. 2 shows the age-specific incidence rates of selected cancers

for men and women in 2011. The projection indicates that the incidence of gastric, lung, liver, and colorectal cancers increases gradually with age. In women, the age-specific incidence rates of breast and thyroid cancer will increase with age until the 5th and 6th decades of life, then level off.

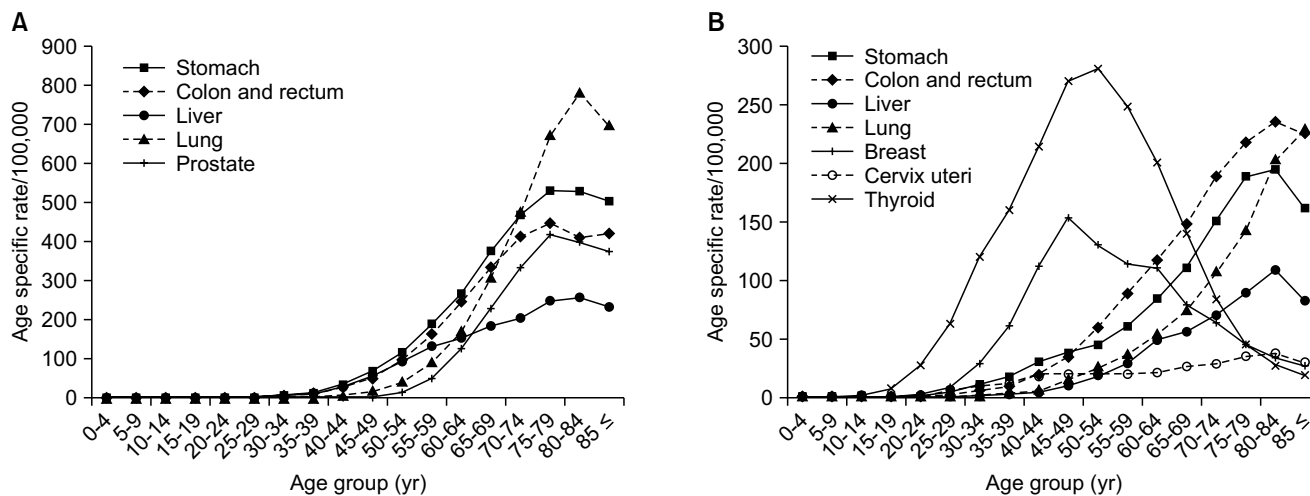
## 2 Mortality

It is estimated that 71,036 cancer deaths will occur during 2011 (Table 1). The CRs of all sites combined in 2011 are projected to become 176.2 and 104.9 per 100,000 for men and women, respectively, and the ASRs of all sites combined are expected to be 136.6

**Table 3.** Estimated cancer incidence by age group and sex during 2011 in Korea

Rank	Age group (yr)			
	0-14	15-34	35-64	≥65
<b>Male</b>				
1	Leukemia (4.7)	Thyroid (10.0)	Stomach (94.8)	Lung (480.5)
2	Brain and CNS (2.4)	Leukemia (3.3)	Colon and rectum (80.4)	Stomach (449.1)
3	Non-Hodgkin lymphoma (1.8)	Non-Hodgkin lymphoma (2.8)	Liver (66.7)	Colon and rectum (387.7)
4	Kidney (0.6)	Colon and rectum (2.6)	Lung (41.1)	Prostate (314.2)
5	Testis/Liver (0.3)	Stomach (2.5)	Thyroid (38.8)	Liver (210.0)
<b>Female</b>				
1	Leukemia (4.2)	Thyroid (57.4)	Thyroid (230.0)	Colon and rectum (191.4)
2	Brain and CNS (2.1)	Breast (10.7)	Breast (113.7)	Stomach (152.4)
3	Non-Hodgkin lymphoma (0.9)	Cervix uteri (4.5)	Colon and rectum (47.2)	Lung (126.8)
4	Ovary (0.7)	Stomach (4.5)	Stomach (41.8)	Thyroid (81.5)
5	Kidney (0.6)	Ovary (2.8)	Lung (19.9)	Liver (75.9)

CNS, central nervous system.



**Fig. 2.** Age-specific cancer incidence rates of major cancers during 2011 in Korea. (A) Male. (B) Female.

and 58.3 per 100,000 for men and women, respectively (Table 4).

In men, the five leading primary cancer sites for mortality in 2011 are predicted to be lung (CR, 45.7; ASR, 41.2), liver (CR, 32.6; ASR, 29.9), stomach (CR, 23.1; ASR, 17.3), colon and rectum (CR, 17.3; ASR, 13.3), and pancreas (CR, 9.2; ASR, 7.3). In women, lung cancer (CR, 16.6; ASR, 9.4) is projected to be the leading

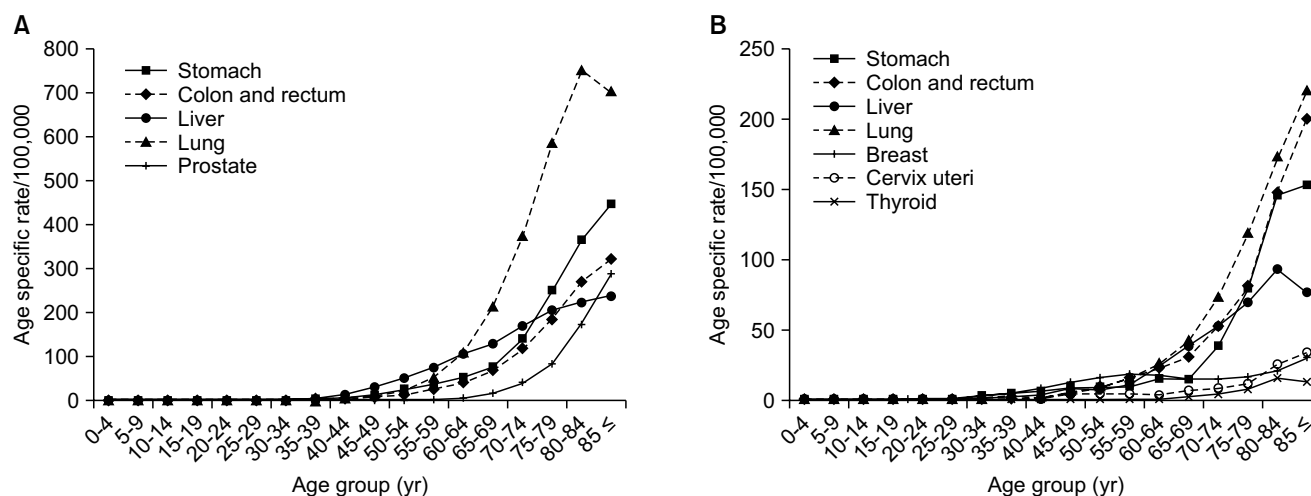
cancer site for mortality in 2011, followed by cancers of the colon and rectum (CR, 13.4; ASR, 7.4), stomach (CR, 12.3; ASR, 9.7), liver (CR, 10.9; ASR, 7.5), and gallbladder (CR, 7.8; ASR, 4.4).

Fig. 3 shows the age-specific mortality rates of the selected cancers for men and women in 2011. When examined by age, liver cancer is expected to have the highest mortality rates in Korean men up to 60

**Table 4.** Estimated crude and age-standardized cancer mortality rates by sex during 2011 in Korea

Sites	Crude mortality rates/100,000			Age-standardized mortality rates/100,000 <sup>b)</sup>		
	Both sexes	Male	Female	Both sexes	Male	Female
All sites	140.6	176.2	104.9	90.9	136.6	58.3
Lip, oral cavity, and pharynx	2.0	3.0	1.1	1.3	2.2	0.5
Esophagus	2.5	4.6	0.4	1.6	3.6	0.3
Stomach	17.7	23.1	12.3	11.2	17.3	9.7
Colon and rectum	15.4	17.3	13.4	9.8	13.3	7.4
Liver	21.8	32.6	10.9	14.6	29.9	7.5
Gallbladder <sup>b)</sup>	7.5	7.2	7.8	4.6	6.8	4.4
Pancreas	8.7	9.2	8.3	5.6	7.3	4.2
Larynx	0.5	0.9	0.1	0.3	1.9	0.1
Lung	31.2	45.7	16.6	19.8	41.2	9.4
Breast	4.1	0.1	8.2	2.8	0.1	4.8
Cervix uteri	1.7	-	3.3	1.1	-	2.8
Corpus uteri	0.5	-	1.0	0.3	-	0.4
Ovary	1.9	-	3.7	1.2	-	2.1
Prostate	2.9	5.8	-	1.7	4.5	-
Testis	0.0	0.1	-	0.0	0.0	-
Kidney	1.6	2.0	1.1	1.0	1.8	0.5
Bladder	1.9	2.7	1.0	1.1	2.9	0.5
Brain and CNS	2.0	2.2	0.9	1.5	2.3	1.7
Thyroid	0.7	0.4	1.0	0.4	0.4	0.6
Hodgkin lymphoma	0.1	0.1	0.1	0.1	0.1	0.0
Non-Hodgkin lymphoma	2.7	3.3	2.3	1.9	2.8	1.4
Multiple myeloma	1.5	1.5	1.5	1.0	1.1	0.7
Leukemia	3.2	3.7	2.7	2.4	3.3	1.9
Other and ill-defined	8.3	10.6	6.1	5.4	7.0	4.1

CNS, central nervous system. <sup>a)</sup>Age adjusted to the World Health Organization (WHO) world standard population, <sup>b)</sup>Includes gallbladder and other/unspecified parts of biliary tract.



**Fig. 3.** Age-specific cancer mortality rates of major cancers during 2011 in Korea. (A) Male. (B) Female.

years of age, followed by lung cancer. In contrast, breast cancer is expected to have the highest mortality rates in Korean women up to 55 years of age, followed by lung cancer.

## Conclusion

This report provides the estimated nationwide cancer incidence and mortality in Korea in the current year. There are 216,809 cancer cases and 71,036 cancer deaths expected during 2011 in Korea. In Korean men, gastric, colorectal, lung, liver, and prostate cancers are estimated to be the most common incident cancers, and lung, liver, gastric, colorectal, and pancreatic cancers are estimated to be the most common cancer-related deaths. In Korean women, thyroid, breast, gastric, colorectal, and lung cancer are estimated to be the most common incident cancers and lung, colorectal, stomach, liver, and gallbladder cancers are the most common cancer-related deaths.

Cancer has become an important public health concern in Korea, and as Korea becomes an aged society, the cancer burden will continue to increase. The estimated cancer statistics of the current year in this report can be used as an important source to plan and evaluate the cancer control programs in Korea. The estimates in this report, however, are projected numbers based on statistical models which

may vary from year-to-year, hence these estimates should be used with caution.

## Conflicts of Interest

Conflict of interest relevant to this article was not reported.

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