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Prediction of Cancer Incidence and Mortality in Korea, 2014

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Purpose

We studied and reported on cancer incidence and mortality rates as projected for the year 2014 in order to estimate Korea's current cancer burden.

Materials and Methods

Cancer incidence data from 1999 to 2011 were obtained from the Korea National Cancer Incidence Database, and cancer mortality data from 1993 to 2012 were acquired from Statistics Korea. Cancer incidence in 2014 was projected by fitting a linear regression model to 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 employed, except that a Joinpoint regression model was used to determine at which year the linear trend changed significantly.

Results

A total of 265,813 new cancer cases and 74,981 cancer deaths are expected to occur in Korea in 2014. Further, the crude incidence rate per 100,000 of all sites combined will likely reach 524.7 and the age-standardized incidence rate, 338.5. Meanwhile, the crude mortality rate of all sites combined and age-standardized rate are projected to be 148.0 and 84.6, respectively. Given the rapid rise in prostate cancer cases, it is anticipated to be the fourth most frequently occurring cancer site in men for the first time.

Conclusion

Cancer has become the most prominent public health concern in Korea, and as the population ages, the nation's cancer burden will continue to increase.

Key words

Incidence, Mortality, Neoplasms, Forecasting, Korea, 2014

Introduction

As the leading cause of death in Korea [1], cancer has been the country's major public health concern since 1983. Over 200,000 patients were newly diagnosed with cancer in Korea, and one in four deaths is due to cancer [2]. To plan and implement comprehensive cancer control programs, it is important to estimate, in advance, the number of new cancer

cases and deaths that could occur over the following year. Although the cancer registration system in Korea is very efficient and can provide nationwide cancer statistics within a relatively short time, a lag time of at least 2 years is required to collect, compile, and analyze the data on a specific year. In this study, however, we drew on relevant national data from the 1990s through 2012 to forecast the country's cancer incidence and mortality rates for the year 2014 in advance.

Materials and Methods

The Korean Ministry of Health and Welfare initiated a nationwide, hospital-based cancer registry, the Korea Central Cancer Registry (KCCR), in 1980. The history, objectives, and activities of the KCCR have been documented in detail elsewhere [3]. Incidence data from 1999 to 2011 were obtained for analyses from the Korea National Cancer Incidence Database (KNCI DB). Cancer cases were classified according to the International Classification of Diseases for Oncology, 3rd edition [4], and converted according to the International Classification of Diseases, 10th edition (ICD-10) [5]. Mortality data from 1993 to 2012 were acquired from Statistics Korea [1]. The cause of death was coded and classified according to ICD-10 [5].

The cancer sites included in this study were 1) all cancers combined and 2) the 24 common cancers: lip, oral cavity, 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), larynx (C32), lung and bronchus (lung) (C33-C34), breast (C50), cervix uteri (C53), corpus uteri (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 others.

Population data for 1993-2013 were obtained from the resident registration population, reported by Statistics Korea. Data on the mid-year population, as of July 1 of the respective year, were analyzed. For the year 2014, however, we used population data as of December 31, 2013, because mid-2014 resident registration population data were not yet available at the time of analysis.

Due to the time required for data collection, compilation, quality control, and analysis, incidence and mortality data for a specific year are usually available 2-3 years later. Therefore, we attempted to project, ahead of 2014, the expected number of new cancer cases and deaths in Korea

Table 1. Estimated new cancer cases and deaths by sex during 2014 in Korea

Site	Estimated new cases			Estimated deaths		
	Both	Male	Female	Both	Male	Female
All sites	265,813	131,455	134,358	74,981	46,653	28,328
Lip, oral cavity, and pharynx	3,059	2,254	805	1,037	763	274
Esophagus	2,313	2,125	188	1,215	1,135	80
Stomach	34,478	23,471	11,007	7,876	5,056	2,820
Colon and rectum	36,125	22,304	13,821	8,746	5,048	3,698
Liver	17,182	12,654	4,528	10,761	8,017	2,744
Gallbladder ^{a)}	5,841	2,918	2,923	3,962	1,912	2,050
Pancreas	5,935	3,185	2,750	5,133	2,697	2,436
Larynx	1,063	1,029	34	374	367	7
Lung	24,697	17,139	7,558	16,990	12,346	4,644
Breast	18,456	74	18,382	2,162	17	2,145
Cervix uteri	3,205	-	3,205	784	-	784
Corpus uteri	2,319	-	2,319	277	-	277
Ovary	2,271	-	2,271	1,020	-	1,020
Prostate	13,650	13,650	-	1,706	1,706	-
Testis	233	233	-	19	19	-
Kidney	4,904	3,376	1,528	978	671	307
Bladder	4,173	3,358	815	1,264	945	319
Brain and CNS	1,867	995	872	1,118	593	525
Thyroid	59,516	9,912	49,604	373	114	259
Hodgkin lymphoma	283	182	101	54	36	18
Non-Hodgkin lymphoma	5,021	2,748	2,273	1,584	917	667
Multiple myeloma	1,368	733	635	876	476	400
Leukemia	3,063	1,721	1,342	1,737	999	738
Other and ill-defined	14,791	7,394	7,397	4,935	2,819	2,116

CNS, central nervous system. ^{a)}Includes the gallbladder and other / unspecified parts of the biliary tract.

for the year so as to provide an estimate of the nation's current cancer burden. Linear regression models [6] were used to assess time trends and projections. Based on observed cancer incidence data, a linear regression model was fitted to age-specific rates by 5-year age groups against observed years. The estimated number of new cancer cases was calculated from the projected age-specific rates for 2014, by multiplying the rates by the projected 2014 age-specific population size. For thyroid and prostate cancer, which showed significant curvilinear trends, we used a square-root transformation when fitting a linear regression model and converted the predicted values back to the original scale.

To predict the cancer mortality rate in 2014, we first performed a Joinpoint regression analysis on the data available for 1993-2012 to detect the year when significant changes occurred in cancer mortality trends according to sex and cancer site. A Joinpoint regression describes changes in data trends by connecting several different line segments on a log scale at "joinpoint." This analysis was performed using the Joinpoint software (ver. 4.0; <http://surveillance.cancer.gov/joinpoint>) from the Surveillance Research Program of the US National Cancer Institute [7].

After identifying the year during which significant trend changes occurred through Joinpoint regression analysis, a simple linear regression model was fitted to the last line segment to estimate age-specific cancer mortality rates in 2014. Similar to the method used for the projection of cancer incidence, the number of new deaths in 2014 was then forecasted by multiplying age-specific cancer mortality rates by the corresponding year's age-specific population.

We summarized the results by using crude rates (CRs) and age-standardized rates (ASRs) of cancer incidence and mortality. ASRs were standardized using the world standard population [8] and expressed per 100,000 persons.

Results

1. Incidence

A total of 265,813 new cancer cases are anticipated in 2014 (Table 1, Fig. 1), with slightly more female (n=134,358) than male (n=131,455) cancer patients expected in the coming year.

The CRs per 100,000 of all sites combined in 2014 are projected to be 519.0 and 530.4 in men and women, respectively. Meanwhile, projected ASRs per 100,000 of all sites combined are 358.4 and 338.3, respectively (Table 2). In men, the five leading primary sites of cancer are expected to be the stomach (CR, 92.7; ASR, 62.7), colon and rectum (CR, 88.1; ASR, 60.1), lung (CR, 67.7; ASR, 45.6), prostate (CR, 53.9; ASR, 36.9), and liver (CR, 50.0; ASR, 33.6), accounting for 67.9% of all newly diagnosed cancers in 2014. Prostate cancer is projected to be the fourth most common cancer site in men for the first time. In women, the five leading primary sites are expected to be the thyroid (CR, 195.8; ASR, 138.3), breast (CR, 72.6; ASR, 48.5), colon and rectum (CR, 54.6; ASR, 30.5), stomach (CR, 43.5; ASR, 24.8), and lung (CR, 29.8; ASR, 15.6), accounting for 74.7% of all newly diagnosed cancers (Fig. 1). Thyroid cancer alone is projected to account for approximately 36.9% (49,604 cases) of incident cases in women in 2014.

The five most common cancer sites expected in 2014 by sex and age group are shown in Table 3. Leukemia and thyroid cancer are expected to be the most common forms of cancer in both genders for the 0-14 and 15-34 age groups. Stomach cancer is predicted to be the most prevalent in men aged 35-64 years, while lung cancer is expected to be more frequent in men aged 65 and over. Thyroid cancer is

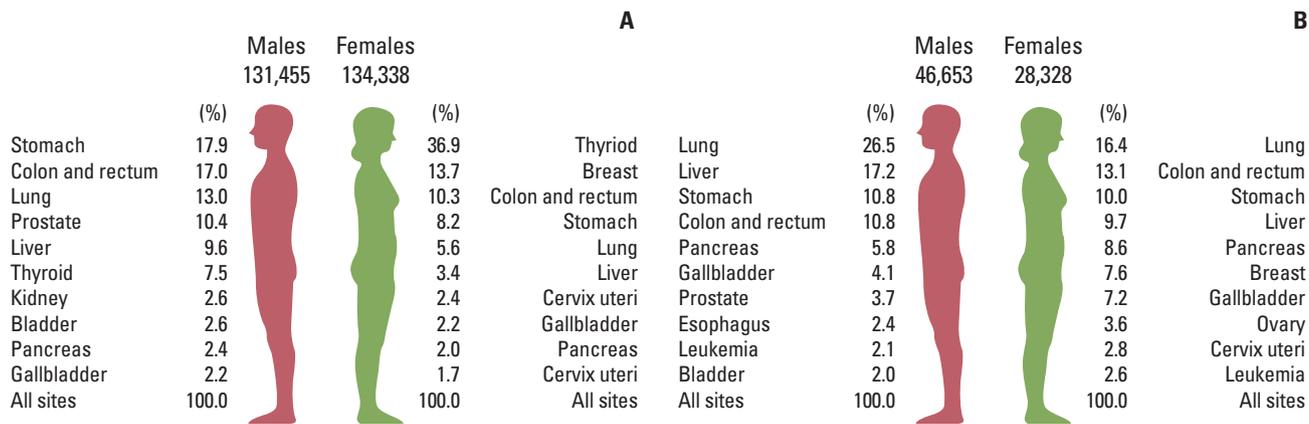


Fig. 1. The 10 leading types of estimated new cancer cases and deaths by sex in 2014. (A) Estimated new cases. (B) Estimated deaths.

Table 2. Estimated crude and age-standardized cancer incidences by sex during 2014 in Korea

Site	Crude incidence rate per 100,000			Age-standardized incidence rate per 100,000 ^{a)}		
	Both	Male	Female	Both	Male	Female
All sites	524.7	519.0	530.4	338.5	358.4	338.3
Lip, oral cavity, and pharynx	6.0	8.9	3.2	4.0	6.1	2.1
Esophagus	4.6	8.4	0.7	2.8	5.7	0.4
Stomach	68.1	92.7	43.5	42.1	62.7	24.8
Colon and rectum	71.3	88.1	54.6	44.1	60.1	30.5
Liver	33.9	50.0	17.9	21.0	33.6	9.8
Gallbladder ^{b)}	11.5	11.5	11.5	6.6	7.9	5.6
Pancreas	11.7	12.6	10.9	6.8	8.5	5.4
Larynx	2.1	4.1	0.1	1.3	2.7	0.1
Lung	48.8	67.7	29.8	28.4	45.6	15.6
Breast	36.4	0.3	72.6	24.4	0.2	48.5
Cervix uteri	6.3	-	12.7	4.2	-	8.2
Corpus uteri	4.6	-	9.2	3.0	-	6.0
Ovary	4.5	-	9.0	3.1	-	6.1
Prostate	26.9	53.9	-	16.2	36.9	-
Testis	0.5	0.9	-	0.5	0.9	-
Kidney	9.7	13.3	6.0	6.4	9.2	3.8
Bladder	8.2	13.3	3.2	4.7	8.9	1.5
Brain and CNS	3.7	3.9	3.4	3.0	3.4	2.7
Thyroid	117.5	39.1	195.8	82.6	27.6	138.3
Hodgkin lymphoma	0.6	0.7	0.4	0.5	0.6	0.4
Non-Hodgkin lymphoma	9.9	10.9	9.0	6.9	8.1	5.9
Multiple myeloma	2.7	2.9	2.5	1.6	2.0	1.4
Leukemia	6.1	6.8	5.3	5.3	6.2	4.5
Other and ill-defined	29.2	29.2	29.2	19.0	21.4	17.1

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

predicted to be the most common cancer in women 35-64 years of age, whereas colorectal cancer is expected to be the most prevalent in women aged 65 and over. These projections indicate that the incidences of stomach, lung, liver, colorectal and prostate cancers will increase gradually with age. In women, the age-specific incidence rates of colorectal, liver, lung and cervical cancers denote a rising trend in these cancers with age; however, the incidence of breast and thyroid cancer in women is expected to level off after the late 40s and early 50s, respectively (Fig. 2).

2. Mortality

It is estimated that 74,981 cancer deaths will occur in Korea during 2014 (Table 1, Fig. 1). The CRs per 100,000 of all sites combined in 2014 for men and women are projected to be

184.2 and 111.8, respectively, while the ASRs per 100,000 of all sites combined are expected to be 125.7 and 55.3, respectively (Table 4). The five leading cancer sites causing mortality in men are predicted to be lung (CR, 48.7; ASR, 32.7), liver (CR, 31.7; ASR, 21.4), stomach (CR, 20.0; ASR, 13.6), colon and rectum (CR, 19.9; ASR, 13.7), and pancreas (CR, 10.7; ASR, 7.2). During the same time period, lung cancer (CR, 18.3; ASR, 8.5) is projected to be the leading cancer site in women, causing mortality, followed by colon and rectum (CR, 14.6; ASR, 6.7), stomach (CR, 11.1; ASR, 5.2), liver (CR, 10.8; ASR, 5.4), and pancreas (CR, 9.6; ASR, 4.5).

The predicted age-specific mortality rates of the selected cancers for males and females in 2014 are shown in further detail in Fig. 3. When examined by age, Korean men and women aged 60 and over are expected to have the highest mortality rates from lung cancer.

Table 3. Estimated cancer incidence by age group and sex during 2014 in Korea

Rank	Age group (yr)			
	0-14	15-34	35-64	≥65
Male				
1	Leukemia (5.2)	Thyroid (17.1)	Stomach (102.6)	Lung (475.1)
2	Brain and CNS (2.4)	Colon and rectum (3.4)	Colon and rectum (96.2)	Stomach (444.1)
3	Non-Hodgkin lymphoma (2.2)	Leukemia (3.3)	Thyroid (66.3)	Colon and rectum (425.0)
4	Kidney (0.6)	Non-Hodgkin lymphoma (3.2)	Liver (63.6)	Prostate (399.4)
5	Liver/Testis (0.3)	Stomach (2.4)	Lung (42.4)	Liver (201.5)
Female				
1	Leukemia (4.3)	Thyroid (89.4)	Thyroid (343.4)	Colon and rectum (210.9)
2	Brain and CNS (2.0)	Breast (11.9)	Breast (131.9)	Stomach (156.9)
3	Non-Hodgkin lymphoma (1.2)	Cervix uteri (5.4)	Colon and rectum (52.8)	Lung (135.2)
4	Ovary (0.8)	Stomach (4.0)	Stomach (44.5)	Thyroid (120.5)
5	Thyroid (0.7)	Ovary (2.9)	Lung (23.1)	Liver (78.9)

CNS, central nervous system.

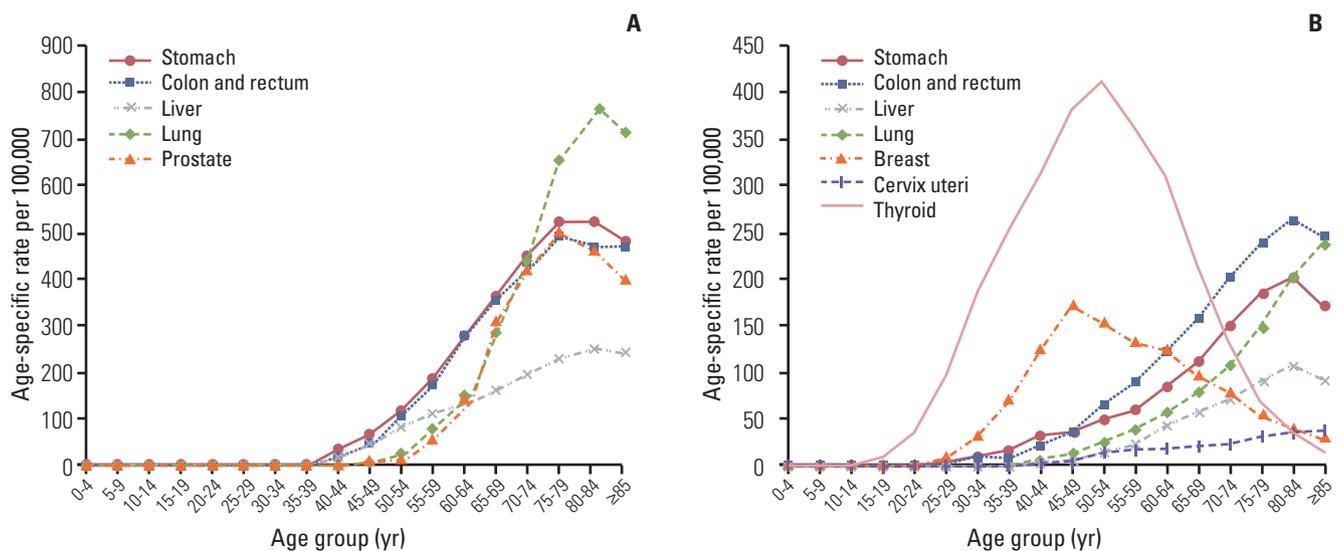


Fig. 2. Projected age-specific incidences of major cancers during 2014 in Korea. (A) Male. (B) Female.

Table 4. Estimated crude and age-standardized cancer mortality rates by sex during 2014 in Korea

Site/Type	Crude mortality rate per 100,000			Age-standardized mortality rate per 100,000 ^{a)}		
	Both	Male	Female	Both	Male	Female
All sites	148.0	184.2	111.8	84.6	125.7	55.3
Lip, oral cavity, and pharynx	2.1	3.0	1.1	1.2	2.0	0.6
Esophagus	2.4	4.5	0.3	1.4	3.0	0.1
Stomach	15.6	20.0	11.1	8.7	13.6	5.2
Colon and rectum	17.3	19.9	14.6	9.7	13.7	6.7
Liver	21.2	31.7	10.8	12.7	21.4	5.4
Gallbladder ^{b)}	7.8	7.6	8.1	4.2	5.2	3.6
Pancreas	10.1	10.7	9.6	5.7	7.2	4.5
Larynx	0.7	1.5	0.0	0.4	1.0	0.0
Lung	33.5	48.7	18.3	18.6	32.7	8.5
Breast	4.3	0.1	8.5	2.7	0.1	5.2
Cervix uteri	1.6	-	3.1	0.9	-	1.7
Corpus uteri	0.6	-	1.1	0.3	-	0.6
Ovary	2.0	-	4.0	1.2	-	2.3
Prostate	3.4	6.7	-	1.7	4.8	-
Testis	0.0	0.1	-	0.0	0.1	-
Kidney	1.9	2.7	1.2	1.1	1.8	0.6
Bladder	2.5	3.7	1.3	1.3	2.6	0.5
Brain and CNS	2.2	2.3	2.1	1.6	1.8	1.3
Thyroid	0.7	0.5	1.0	0.4	0.3	0.4
Hodgkin lymphoma	0.1	0.1	0.1	0.1	0.1	0.0
Non-Hodgkin lymphoma	3.1	3.6	2.6	1.8	2.5	1.3
Multiple myeloma	1.7	1.9	1.6	1.0	1.3	0.8
Leukemia	3.4	3.9	2.9	2.3	2.9	1.8
Other and ill-defined	9.7	11.1	8.4	5.6	7.7	4.1

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

Conclusion

A total of 265,813 new cancer cases and 74,981 cancer deaths are expected to occur in Korea during 2014. In Korean males, stomach, colorectal, lung, prostate, and liver cancers are anticipated to be the most commonly occurring, while lung, liver, stomach, colorectal, and pancreatic cancers are expected to be the most common causes of cancer-related deaths. In Korean women, thyroid, breast, colorectal, stomach, and lung cancers are anticipated to be the most prevalent, while lung, colorectal, stomach, liver, and pancreatic cancers are projected to be the most common causes of cancer-related deaths.

Cancer is, at present, one of the foremost public health concerns in Korea. The country will likely see its cancer burden continue to grow with the aging of its population. The current projections on cancer incidence and mortality for 2014 represent an important resource for planning and

evaluating cancer-control programs. As the estimates in this study are model-based, there is a need to exercise caution when using them.

Conflicts of Interest

Conflict of interest relevant to this article was not reported.

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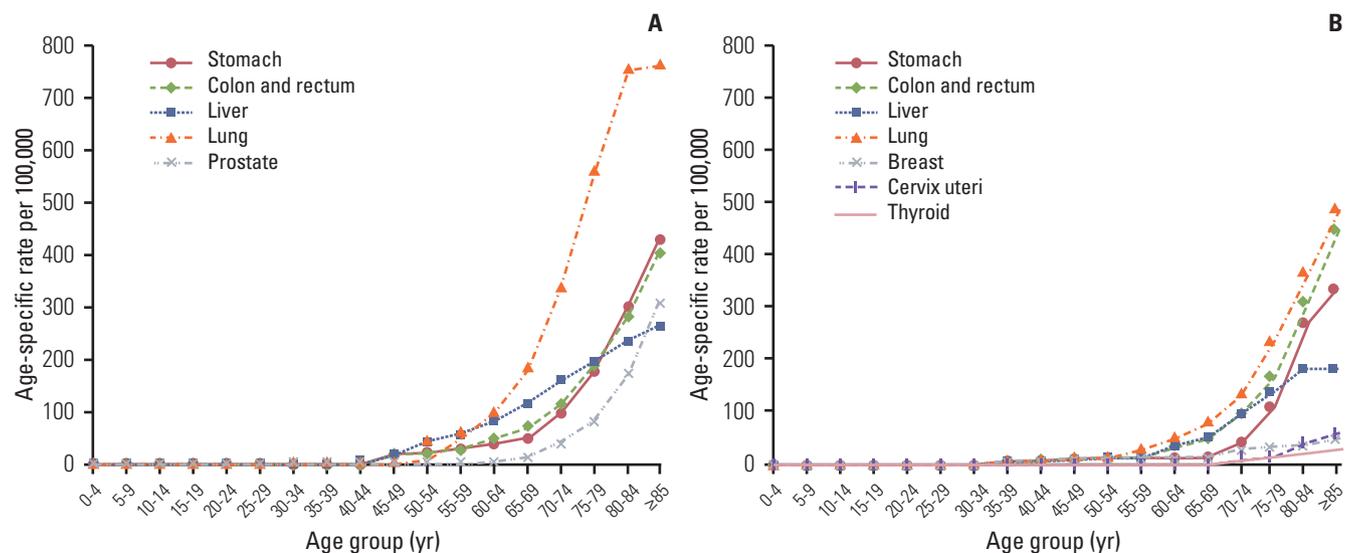


Fig. 3. Projected age-specific mortality rates of major cancers during 2014 in Korea. (A) Male. (B) Female.

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