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Prediction of Cancer Incidence and Mortality in Korea, 2015

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Purpose

For estimation of Korea's current cancer burden, this study aimed to report on the projected cancer incidence and mortality rates for the year 2015.

Materials and Methods

Cancer incidence data from 1999 to 2012 were obtained from the Korea National Cancer Incidence Database, and cancer mortality data from 1993 to 2013 were acquired from Statistics Korea. The cancer incidence in 2015 was projected by fitting a linear regression model to the observed age-specific cancer incidence rates against the observed years and then multiplying the projected age-specific rates by the age-specific population. A similar procedure was used for cancer mortality, except a Joinpoint regression model was used to determine at which year the linear trend changed significantly.

Results

A total of 280,556 new cancer cases and 76,698 cancer deaths are expected to occur in Korea in 2015. The crude incidence rate per 100,000 of all sites combined will likely reach 551.6 and the age-standardized incidence rate, 347.6. The estimated five leading primary cancer incidence sites are the stomach, colorectum, lung, prostate, and liver in men; and thyroid, breast, colorectum, stomach, and lung in women. The projected crude mortality rate of all sites combined and age-standardized rate is 150.8 and 82.4, respectively.

Conclusion

Cancer is currently one of the foremost public health concerns in Korea, and as the population ages, the nation's cancer burden will continue to increase.

Key words
Incidence, Mortality, Neoplasms, Forecasting, Korea, 2015

Introduction

As the leading cause of death in Korea [1], cancer has been the country's major public health concern since 1983. Over 210,000 patients were newly diagnosed with cancer in Korea, and one in four deaths is due to cancer [2]. Although the cancer registration system in Korea is highly efficient and can provide nationwide cancer statistics within a relatively brief period, a lag time of at least 2 years is required for collection, compilation, and analysis of the data on a specific year. For planning and implementation of comprehensive cancer control programs, it is important to assess the number of new cases and deaths that are expected to occur during the current year. In this study, we report the projected cancer incidence and mortality for the year 2015 based on data from the 1990s through 2013.

Table 1. Estimated new cancer cases and deaths by sex during 2015 in Korea

Site	Estimated new cases			Estimated deaths		
	Both	Male	Female	Both	Male	Female
All sites	280,556	137,747	142,809	76,698	47,527	29,171
Lip, oral cavity, and pharynx	3,176	2,339	837	1,062	780	282
Esophagus	2,362	2,161	201	1,214	1,136	78
Stomach	35,053	23,917	11,136	7,516	4,806	2,710
Colon and rectum	38,038	23,493	14,545	9,018	5,209	3,809
Liver	17,310	12,744	4,566	10,812	7,996	2,816
Gallbladder[a]	6,034	3,024	3,010	4,023	1,940	2,083
Pancreas	6,313	3,383	2,930	5,374	2,812	2,562
Larynx	1,049	1,019	30	365	359	6
Lung	25,640	17,673	7,967	17,559	12,736	4,823
Breast	19,540	75	19,465	2,385	18	2,367
Cervix uteri	3,100	-	3,100	761	-	761
Corpus uteri	2,429	-	2,429	288	-	288
Ovary	2,374	-	2,374	1,075	-	1,075
Prostate	14,828	14,828	-	1,840	1,840	-
Testis	248	248	-	19	19	-
Kidney	5,212	3,599	1,613	1,031	713	318
Bladder	4,245	3,419	826	1,390	1,061	329
Brain and CNS	1,891	1,016	875	1,127	596	531
Thyroid	65,829	11,338	54,491	384	116	268
Hodgkin lymphoma	298	192	106	62	42	20
Non-Hodgkin lymphoma	5,319	2,918	2,401	1,651	955	696
Multiple myeloma	1,490	806	684	911	497	414
Leukemia	3,141	1,770	1,371	1,767	1,025	742
Other and ill-defined	15,637	7,785	7,852	5,064	2,871	2,193

CNS, central nervous system. [a]Includes the gallbladder and other/unspecified parts of the biliary tract.

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 2012 were obtained from the Korea National Cancer Incidence Database (KNCI DB). Cancer cases were classified according to the International Classification of Diseases for Oncology, third edition [4], and converted according to the International Classification of Diseases, 10th edition (ICD-10) [5]. Mortality data from 1993 to 2013 were acquired from Statistics Korea [1]. The causes of death were 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 as follows: lip, oral cavity, and pharynx (C00-C14), esophagus (C15), stomach (C16), colon and rectum (C18-C20), liver and intrahepatic bile ducts (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 from 1993 to 2014 were obtained from the resident registration population, as reported by Statistics Korea. Data on the mid-year population, as of July 1 of the respective years, were analyzed. However, for the year 2015, we used population data as of December 31, 2014 because the mid-2015 resident registration population was not yet available at the time of analysis.

Due to the time required for data collection, compilation, quality control, and analysis, the incidence and mortality data for a specific year are usually available 2-3 years later.
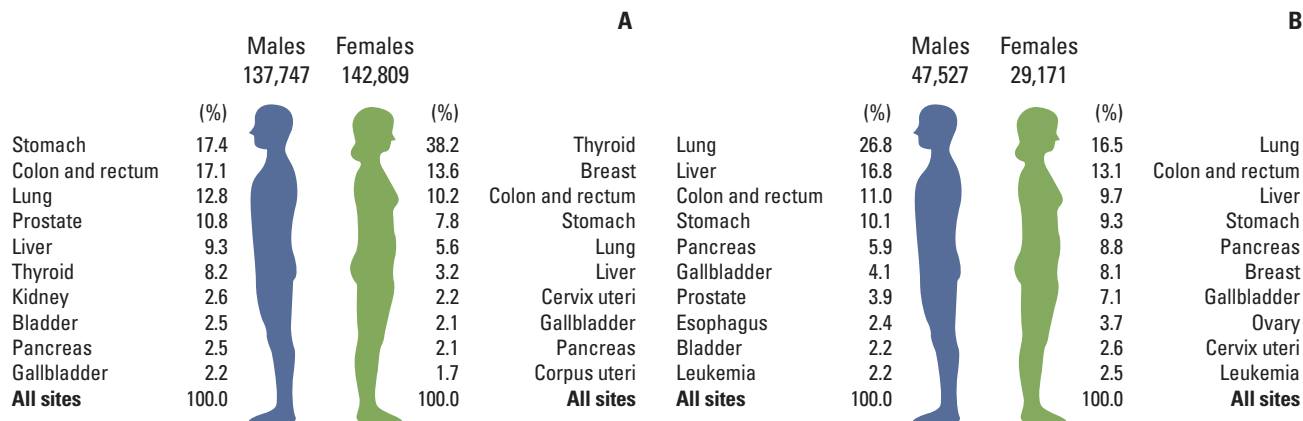
	Males 137,747	Females 142,809			Males 47,527	Females 29,171		
	(%)	(%)			(%)	(%)		
Stomach	17.4	38.2	Thyroid	Lung	26.8	16.5	Lung	
Colon and rectum	17.1	13.6	Breast	Liver	16.8	13.1	Colon and rectum	
Lung	12.8	10.2	Colon and rectum	Colon and rectum	11.0	9.7	Liver	
Prostate	10.8	7.8	Stomach	Stomach	10.1	9.3	Stomach	
Liver	9.3	5.6	Lung	Pancreas	5.9	8.8	Pancreas	
Thyroid	8.2	3.2	Liver	Gallbladder	4.1	8.1	Breast	
Kidney	2.6	2.2	Cervix uteri	Prostate	3.9	7.1	Gallbladder	
Bladder	2.5	2.1	Gallbladder	Esophagus	2.4	3.7	Ovary	
Pancreas	2.5	2.1	Pancreas	Bladder	2.2	2.6	Cervix uteri	
Gallbladder	2.2	1.7	Corpus uteri	Leukemia	2.2	2.5	Leukemia	
All sites	100.0	100.0	All sites	All sites	100.0	100.0	All sites	

Fig. 1. The 10 leading types of estimated new cancer cases and deaths by sex in 2015. (A) Estimated new cases. (B) Estimated deaths.

Therefore, to provide an estimate of the nation's current cancer burden, we attempted to project, ahead of 2015, the expected number of new cancer cases and deaths in Korea for the year. Linear regression models [6] were used to assess time trends and projections. Based on the observed cancer incidence data from 1999 to 2012, a linear regression model was fitted to age-specific rates by 5-year age groups against the observed years. The estimated number of new cancer cases was calculated from the projected age-specific rates for 2015 by multiplying the rates by the projected 2015 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 2015, we first performed a Joinpoint regression analysis on the data available for 1993-2013 to determine 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 "joinpoints." This analysis was performed using the Joinpoint software (ver. 4.0.1, 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 for estimation of age-specific cancer mortality rates in 2015. Similar to the method used for the projection of cancer incidence, the number of new deaths in 2015 was then predicted by multiplying age-specific cancer mortality rates by the year's age-specific population.

We summarized the results 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 280,556 new cancer cases are anticipated in 2015 (Table 1, Fig. 1) with more female (n=142,809) than male (n=137,747) cancer patients expected in the coming year.

The projected CRs per 100,000 of all sites combined in 2015 are 541.9 and 561.3 in men and women, respectively. Moreover, the projected ASRs per 100,000 of all sites combined are 361.1 and 353.1, respectively (Table 2). In men, the five leading primary sites of cancer are expected to be the stomach (CR, 94.1; ASR, 61.3), colon and rectum (CR, 92.4; ASR, 60.7), lung (CR, 69.5; ASR, 44.7), prostate (CR, 58.3; ASR, 38.1), and liver (CR, 50.1; ASR, 32.6), accounting for 67.3% of all newly diagnosed cancers in 2015. In women, the five leading primary sites are expected to be the thyroid (CR, 214.2; ASR, 150.4), breast (CR, 76.5; ASR, 50.5), colon and rectum (CR, 57.2; ASR, 31.0), stomach (CR, 43.8; ASR, 24.3), and lung (CR, 31.3; ASR, 15.8), accounting for 75.3% of all newly diagnosed cancers (Fig. 1). Thyroid cancer alone is projected to account for approximately 38.2% (54,491 cases) of incident cases in women in 2015.

The five most common cancer sites expected in 2015 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 sexes for the 0-14 and 15-34 age groups. Stomach

Table 2. Estimated crude and age-standardized cancer incidences by sex during 2015 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	551.6	541.9	561.3	347.6	361.1	353.1
Lip, oral cavity, and pharynx	6.2	9.2	3.3	4.0	6.1	2.1
Esophagus	4.6	8.5	0.8	2.7	5.5	0.4
Stomach	68.9	94.1	43.8	41.3	61.3	24.3
Colon and rectum	74.8	92.4	57.2	44.7	60.7	31.0
Liver	34.0	50.1	17.9	20.4	32.6	9.5
Gallbladder[b]	11.9	11.9	11.8	6.5	7.8	5.5
Pancreas	12.4	13.3	11.5	7.0	8.7	5.6
Larynx	2.1	4.0	0.1	1.2	2.6	0.1
Lung	50.4	69.5	31.3	28.2	44.7	15.8
Breast	38.4	0.3	76.5	25.4	0.2	50.5
Cervix uteri	6.1	-	12.2	4.0	-	7.8
Corpus uteri	4.8	-	9.5	3.1	-	6.2
Ovary	4.7	-	9.3	3.2	-	6.2
Prostate	29.2	58.3	-	16.9	38.1	-
Testis	0.5	1.0	-	0.5	1.0	-
Kidney	10.2	14.2	6.3	6.5	9.5	3.9
Bladder	8.3	13.5	3.2	4.6	8.7	1.5
Brain and CNS	3.7	4.0	3.4	3.0	3.4	2.6
Thyroid	129.4	44.6	214.2	90.4	31.2	150.4
Hodgkin lymphoma	0.6	0.8	0.4	0.5	0.7	0.4
Non-Hodgkin lymphoma	10.5	11.5	9.4	7.2	8.4	6.2
Multiple myeloma	2.9	3.2	2.7	1.7	2.1	1.5
Leukemia	6.2	7.0	5.4	5.3	6.2	4.4
Other and ill-defined	30.7	30.6	30.9	19.4	21.7	17.4

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

cancer is predicted to be the most prevalent in men aged 35-64 years, whereas lung cancer is expected to be more frequent in men aged 65 and over. Thyroid cancer is 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 for men. In women, the age-specific incidence rates of stomach, 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 76,698 cancer deaths will occur in Korea during 2015 (Table 1, Fig. 1). The projected CRs per 100,000 of all sites combined in 2015 for men and women are 187.0 and 114.6, respectively, whereas the projected ASRs per 100,000 of all sites combined are 121.7 and 54.5, respectively (Table 4). The predicted five leading cancer sites causing mortality in men are lung (CR, 50.1; ASR, 31.9), liver (CR, 31.5; ASR, 20.4), colon and rectum (CR, 20.5; ASR, 13.4), stomach (CR, 18.9; ASR, 12.2), and pancreas (CR, 11.1; ASR, 7.2). During the same time period, lung cancer (CR, 19.0; ASR, 8.5) is projected to be the leading cancer site in women, causing mortality, followed by the colon and rectum (CR, 15.0; ASR, 6.6), liver (CR, 11.1; ASR, 5.2), stomach (CR, 10.7; ASR, 4.7), and pancreas (CR, 10.1; ASR, 4.5). As a result of a continuous decrease in stomach cancer deaths, stomach was first predicted to be the fourth-common cancer death site in women.

The predicted age-specific mortality rates of the selected cancers for males and females in 2015 are shown in further detail in Fig. 3. When examined by age, Korean men and

Table 3. Estimated cancer incidence by age group and sex during 2015 in Korea

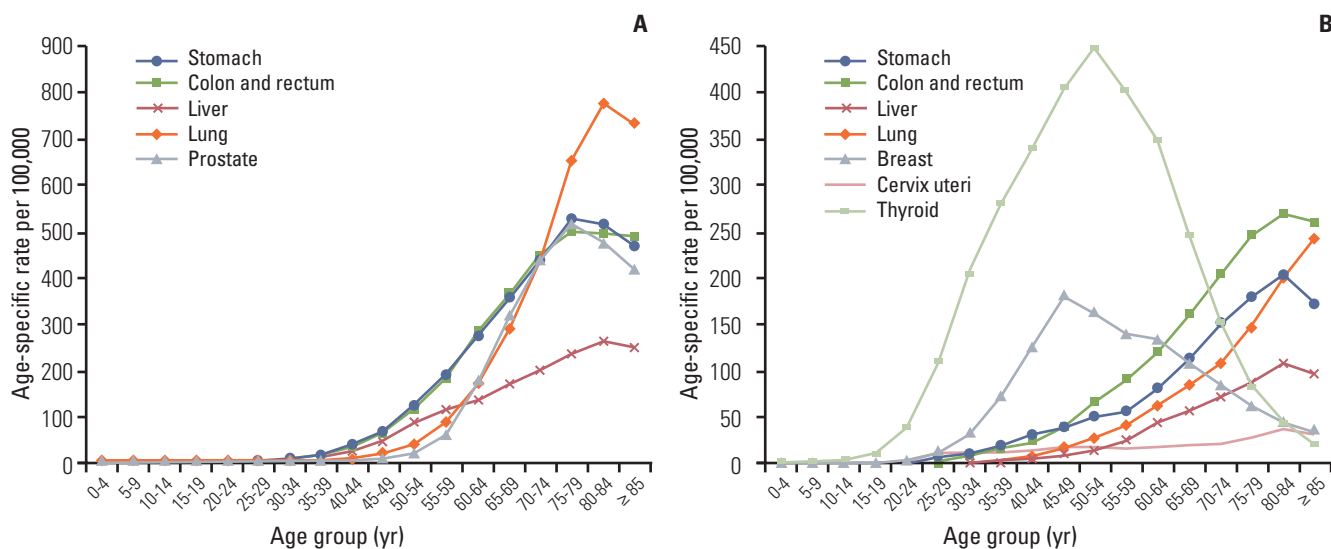| Rank	Age group (yr)			
	0-14	15-34	35-64	≥ 65
Male				
1	Leukemia	Thyroid	Stomach	Lung
	(5.2)	(19.5)	(102.9)	(469.3)
2	Brain and CNS	Colon and rectum	Colon and rectum	Stomach
	(2.5)	(3.4)	(99.1)	(433.1)
3	Non-Hodgkin lymphoma	Leukemia	Thyroid	Colon and rectum
	(2.4)	(3.3)	(74.7)	(430.3)
4	Kidney	Non-Hodgkin lymphoma	Liver	Prostate
	(0.6)	(3.3)	(61.6)	(412.1)
5	Liver	Stomach	Lung	Liver
	(0.4)	(2.2)	(42.6)	(200.6)
Female				
1	Leukemia	Thyroid	Thyroid	Colon and rectum
	(4.1)	(96.9)	(372.0)	(215.0)
2	Brain and CNS	Breast	Breast	Stomach
	(1.9)	(11.9)	(137.0)	(155.4)
3	Non-Hodgkin lymphoma	Cervix uteri	Colon and rectum	Lung
	(1.5)	(5.4)	(54.4)	(136.5)
4	Ovary	Stomach	Stomach	Thyroid
	(0.9)	(3.7)	(43.8)	(132.4)
5	Thyroid	Ovary	Lung	Liver
	(0.8)	(3.0)	(24.3)	(77.4)

CNS, central nervous system.

Fig. 2. Projected age-specific incidences of major cancers during 2015 in Korea. (A) Male. (B) Female.

Table 4. Estimated crude and age-standardized cancer mortality rates by sex during 2015 in Korea

Site	Crude mortality rate per 100,000			Age-standardized mortality rate per 100,000[a]		
	Both	Male	Female	Both	Male	Female
All sites	150.8	187.0	114.6	82.4	121.7	54.5
Lip, oral cavity, and pharynx	2.1	3.1	1.1	1.2	2.0	0.6
Esophagus	2.4	4.5	0.3	1.3	2.8	0.1
Stomach	14.8	18.9	10.7	7.8	12.2	4.7
Colon and rectum	17.7	20.5	15.0	9.5	13.4	6.6
Liver	21.3	31.5	11.1	12.2	20.4	5.2
Gallbladder[b]	7.9	7.6	8.2	4.0	4.9	3.4
Pancreas	10.6	11.1	10.1	5.7	7.2	4.5
Larynx	0.7	1.4	0.0	0.4	0.9	0.0
Lung	34.5	50.1	19.0	18.2	31.9	8.5
Breast	4.7	0.1	9.3	2.9	0.0	5.6
Cervix uteri	1.5	-	3.0	0.9	-	1.6
Corpus uteri	0.6	-	1.1	0.3	-	0.6
Ovary	2.1	-	4.2	1.2	-	2.3
Prostate	3.6	7.2	-	1.7	4.8	-
Testis	0.0	0.1	-	0.0	0.1	-
Kidney	2.0	2.8	1.2	1.1	1.8	0.6
Bladder	2.7	4.2	1.3	1.3	2.8	0.5
Brain and CNS	2.2	2.3	2.1	1.6	1.8	1.3
Thyroid	0.8	0.5	1.1	0.4	0.3	0.4
Hodgkin lymphoma	0.1	0.2	0.1	0.1	0.1	0.0
Non-Hodgkin lymphoma	3.2	3.8	2.7	1.8	2.5	1.3
Multiple myeloma	1.8	2.0	1.6	1.0	1.3	0.8
Leukemia	3.5	4.0	2.9	2.2	2.9	1.7
Other and ill-defined	10.0	11.3	8.6	5.5	7.5	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.

women aged 60 and over are expected to have the highest mortality rates from lung cancer.

Conclusion

A total of 280,556 new cancer cases and 76,698 cancer deaths are expected to occur in Korea during 2015. In Korean males, it is anticipated that stomach, colorectal, lung, prostate, and liver cancers will be the most commonly occurring, whereas it is expected that lung, liver, colorectal, stomach, and pancreatic cancers will be the most common causes of cancer-related deaths. In Korean women, it is anticipated that thyroid, breast, colorectal, stomach, and lung cancers will be the most prevalent, whereas it is projected that lung, colorectal, liver, stomach, and pancreatic cancers will be the most common causes of cancer-related deaths.

Cancer is currently 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 of cancer incidence and mortality for 2015 represent an important resource for planning and evaluation of cancer-control programs. As the estimates in this study are model-based, these results should be interpreted with caution.

Conflicts of Interest

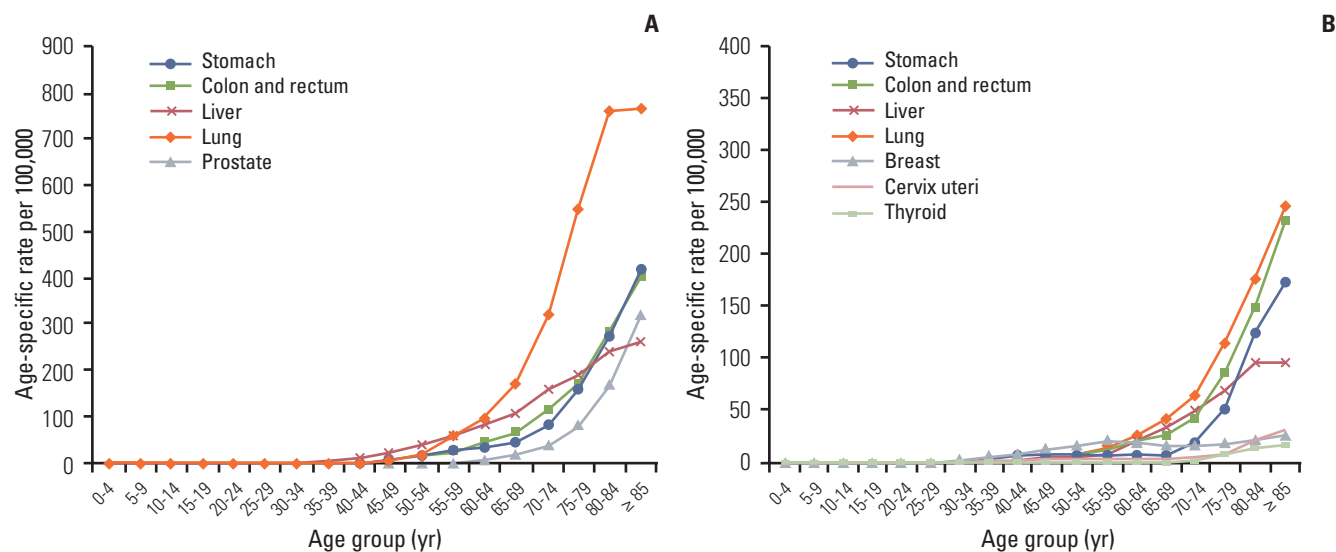Conflict of interest relevant to this article was not reported.

Fig. 3. Projected age-specific mortality rates of major cancers during 2015 in Korea. (A) Male. (B) Female.

Acknowledgments

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