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Prediction of Cancer Incidence and Mortality in Korea, 2018

Kyu-Won Jung, MS[1,2]
Young-Joo Won, PhD[1,2,3]
Hyun-Joo Kong, MS[1,2]
Eun Sook Lee, MD, PhD[1,4]

[1]The Korea Central Cancer Registry, National Cancer Center, Goyang, [2]National Cancer Control Institute, National Cancer Center, Goyang, [3]Department of Cancer Control and Population Health, National Cancer Center Graduate School of Cancer Science and Policy, National Cancer Center, Goyang, [4]National Cancer Center Graduate School of Cancer Science and Policy, National Cancer Center, Goyang, Korea

Purpose

This study aimed to report on cancer incidence and mortality for the year 2018 to estimate Korea's current cancer burden.

Materials and Methods

Cancer incidence data from 1999 to 2015 were obtained from the Korea National Cancer Incidence Database, and cancer mortality data from 1993 to 2016 were acquired from Statistics Korea. Cancer incidence and mortality were projected by fitting a linear regression model to observed age-specific cancer rates against observed years, then multiplying the projected age-specific rates by the age-specific population. The *Joinpoint* regression model was used to determine at which year the linear trend changed significantly, we only used the data of the latest trend.

Results

A total of 204,909 new cancer cases and 82,155 cancer deaths are expected to occur in Korea in 2018. The most common cancer sites were lung, followed by stomach, colorectal, breast and liver. These five cancers represent half of the overall burden of cancer in Korea. For mortality, the most common sites were lung cancer, followed by liver, colorectal, stomach and pancreas.

Conclusion

The incidence rate of all cancer in Korea are estimated to decrease gradually, mainly due to decrease of thyroid cancer. These up-to-date estimates of the cancer burden in Korea could be an important resource for planning and evaluation of cancer-control programs.

Correspondence: Young-Joo Won, PhD
The Korea Central Cancer Registry,
National Cancer Center, 323 Ilsan-ro,
Ilsandong-gu, Goyang 10408, Korea
Tel: 82-31-920-2015
Fax: 82-31-920-2179
E-mail: astra67@ncc.re.kr

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 to collect, and analyze 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 2018 based on the data from the 1990s through 2016.

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 2015 were obtained from the Korea National Cancer Incidence Database. 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 2016 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 as follows: 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-C86, C96), multiple myeloma (C90), leukemia (C91-C95), and other and ill defined.
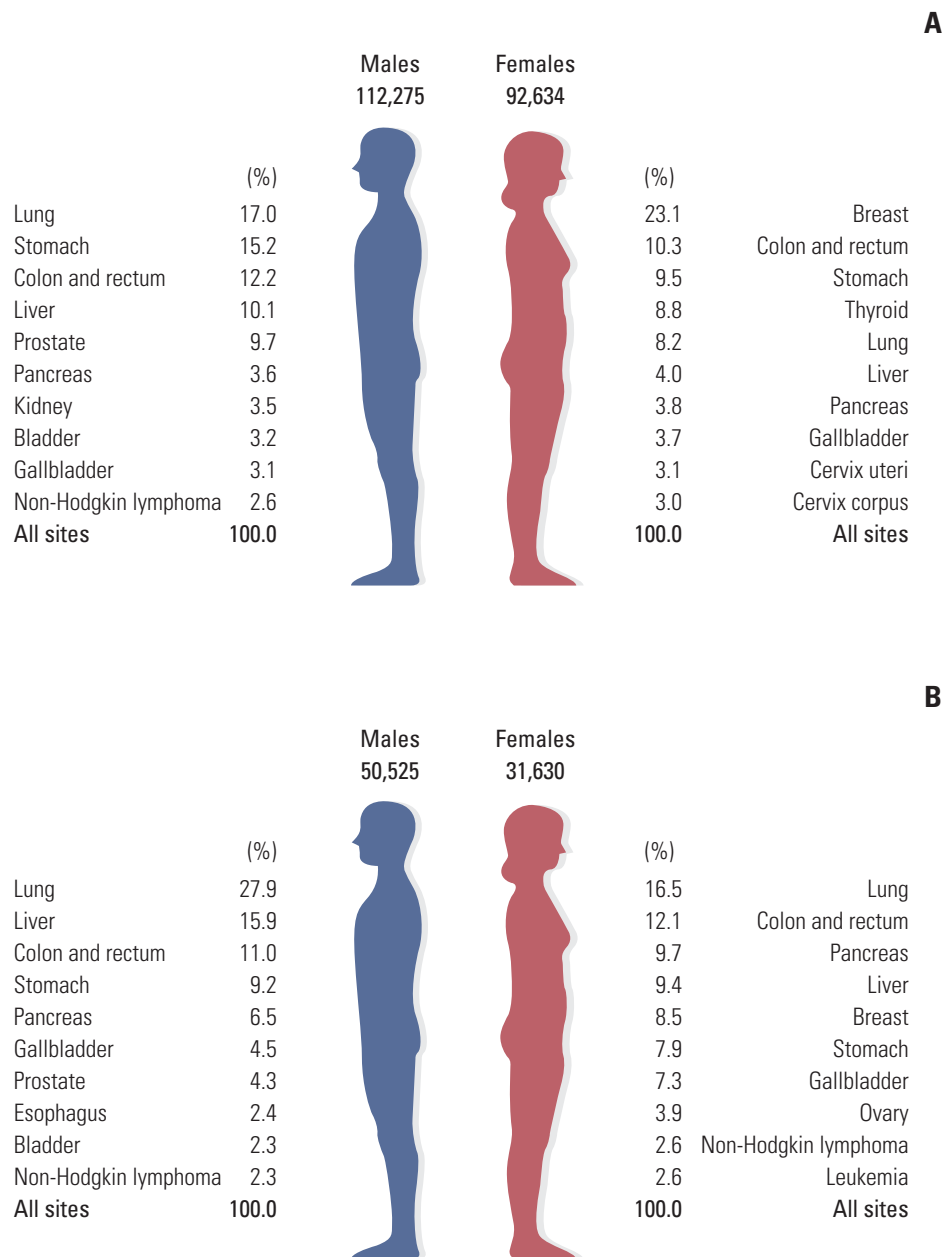
Population data from 1993 to 2018 were obtained from the resident registration population, reported by Statistics Korea. Data on the mid-year population, as of July 1 of the respective year, were analyzed. For the year 2018, however, we used population data as of December 31, 2017, because mid-2018 resident registration population was not yet available at the time of analysis.

Linear regression models [6] were used to assess time trends and projections. Firstly, we first performed a *Joinpoint* regression analysis on the data available to detect the year

Table 1. Estimated new cancer cases and deaths by sex during 2018 in Korea

Site	Estimated new cases			Estimated deaths		
	Both sexes	Male	Female	Both sexes	Male	Female
All sites	204,909	112,275	92,634	82,155	50,525	31,630
Lip, oral cavity, and pharynx	3,627	2,631	996	1,196	875	321
Esophagus	2,515	2,297	218	1,365	1,212	153
Stomach	25,872	17,103	8,769	7,138	4,624	2,514
Colon and rectum	23,271	13,734	9,537	9,371	5,549	3,822
Liver[a]	15,058	11,343	3,715	10,977	8,016	2,961
Gallbladder[b]	7,327	3,878	3,449	4,562	2,253	2,309
Pancreas	7,539	3,994	3,545	6,362	3,288	3,074
Larynx	1,070	1,040	30	299	298	1
Lung[c]	26,725	19,107	7,618	19,317	14,108	5,209
Breast	21,471	82	21,389	2,709	19	2,690
Cervix uteri	2,910	0	2,910	763	0	763
Corpus uteri	2,741	0	2,741	357	0	357
Ovary	2,709	0	2,709	1,236	0	1,236
Prostate	10,904	10,904	0	2,176	2,176	0
Testis	298	298	0	18	18	0
Kidney	5,244	3,610	1,634	1,186	825	361
Bladder	4,401	3,533	868	1,563	1,173	390
Brain and CNS	1,824	970	854	1,320	674	646
Thyroid	10,129	2,014	8,115	354	101	253
Hodgkin lymphoma	323	205	118	64	39	25
Non-Hodgkin lymphoma	4,960	2,867	2,093	1,966	1,142	824
Multiple myeloma	1,843	991	852	1,102	594	508
Leukemia	3,534	2,019	1,515	1,951	1,132	819
Other and ill defined	18,614	9,655	8,959	4,803	2,409	2,394

CNS, central nervous system. [a]Includes the liver and intrahepatic bile duct, [b]Includes the gallbladder and other/unspecified parts of the biliary tract, [c]Includes the lung and bronchus.

A

	Males 112,275		Females 92,634		
	(%)			(%)	
Lung	17.0			23.1	Breast
Stomach	15.2			10.3	Colon and rectum
Colon and rectum	12.2			9.5	Stomach
Liver	10.1			8.8	Thyroid
Prostate	9.7			8.2	Lung
Pancreas	3.6			4.0	Liver
Kidney	3.5			3.8	Pancreas
Bladder	3.2			3.7	Gallbladder
Gallbladder	3.1			3.1	Cervix uteri
Non-Hodgkin lymphoma	2.6			3.0	Cervix corpus
All sites	100.0			100.0	All sites

B

	Males 50,525		Females 31,630		
	(%)			(%)	
Lung	27.9			16.5	Lung
Liver	15.9			12.1	Colon and rectum
Colon and rectum	11.0			9.7	Pancreas
Stomach	9.2			9.4	Liver
Pancreas	6.5			8.5	Breast
Gallbladder	4.5			7.9	Stomach
Prostate	4.3			7.3	Gallbladder
Esophagus	2.4			3.9	Ovary
Bladder	2.3			2.6	Non-Hodgkin lymphoma
Non-Hodgkin lymphoma	2.3			2.6	Leukemia
All sites	100.0			100.0	All sites

Fig. 1. The 10 leading types of estimated new cancer cases and deaths by sex in 2018. (A) Estimated new cases. (B) Estimated deaths.

when significant changes occurred in cancer 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. 4.3.1; http://surveillance.cancer.gov/joinpoint) from the Surveillance Research Program of the U.S. National Cancer Institute [7].

We chose the number of joinpoint in order to have least four data points between consecutive joinpoints. Secondly, to predict age-specific cancer rates, a linear regression model was fitted to age-specific rates by 5-year age groups against observed years based on observed cancer incidence data of the latest trend. Finally, we multiply the projected age-specific rates by the age-specific population to get the projected

Table 2. Estimated crude and age-standardized cancer incidences by sex during 2018 in Korea

Site	Crude incidence rate per 100,000			Age-standardized incidence rate per 100,000[a]		
	Both sexes	Male	Female	Both sexes	Male	Female
All sites	396.8	433.8	359.7	222.3	255.1	202.7
Lip, oral cavity, and pharynx	7.0	10.2	3.9	4.1	6.1	2.3
Esophagus	4.9	8.9	0.8	2.5	4.9	0.4
Stomach	50.1	66.1	34.0	26.7	38.3	16.7
Colon and rectum	45.1	53.1	37.0	23.1	30.4	16.8
Liver[b]	29.2	43.8	14.4	15.5	25.3	6.6
Gallbladder[c]	14.2	15.0	13.4	6.7	8.3	5.5
Pancreas	14.6	15.4	13.8	7.2	8.7	5.9
Larynx	2.1	4.0	0.1	1.1	2.2	0.1
Lung[d]	51.8	73.8	29.6	25.5	40.8	13.7
Breast	41.6	0.3	83.1	26.4	0.2	52.8
Cervix uteri	5.6	-	11.3	3.6	-	7.1
Corpus uteri	5.3	-	10.6	3.3	-	6.5
Ovary	5.2	-	10.5	3.4	-	6.7
Prostate	21.1	42.1	-	10.5	23.4	-
Testis	0.6	1.2	-	0.6	1.1	-
Kidney	10.2	13.9	6.3	5.9	8.5	3.5
Bladder	8.5	13.7	3.4	4.1	7.6	1.3
Brain and CNS	3.5	3.7	3.3	2.5	2.8	2.3
Thyroid	19.6	7.8	31.5	15.4	5.9	25.5
Hodgkin lymphoma	0.6	0.8	0.5	0.5	0.7	0.4
Non-Hodgkin lymphoma	9.6	11.1	8.1	6.1	7.5	4.9
Multiple myeloma	3.6	3.8	3.3	1.8	2.2	1.6
Leukemia	6.8	7.8	5.9	5.4	6.4	4.5
Other and ill defined	36.0	37.3	34.8	20.3	23.4	17.7

CNS, central nervous system. [a]Age adjusted to the world standard population, [b]Includes the liver and intrahepatic bile duct, [c]Includes the gallbladder and other/unspecified parts of the biliary tract, [d]Includes the lung and bronchus.

cancer cases and deaths of the year 2018.

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 204,909 new cancer cases are anticipated in 2018 (Table 1, Fig. 1), with more male (n=112,275) than female (n=92,634) of cancer patients expected.

The projected CRs per 100,000 of all sites combined in 2018

are projected to be 433.8 and 359.7 in men and women, respectively (Table 2). The projected ASRs per 100,000 of all sites combined are 255.1 and 202.7, respectively. In men, the five leading primary sites of cancer are expected to be the lung (CR, 73.8; ASR, 40.8), stomach (CR, 66.1; ASR, 38.3), colon and rectum (CR, 53.1; ASR, 30.4), liver (CR, 43.8; ASR, 25.3), and prostate (CR, 42.1; ASR, 23.4), accounting for 64.2% of all new cancers in 2018.

In women, the five leading primary sites are expected to be the breast (CR, 83.1; ASR, 52.8), colon and rectum (CR, 37.0; ASR, 16.8), stomach (CR, 34.0; ASR, 16.7), thyroid (CR, 31.5; ASR, 25.5), and lung (CR, 29.6; ASR, 13.7), accounting for 59.9% of all new cancers (Fig. 1).

The five most common cancer sites expected in 2018 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

Table 3. Estimated cancer incidence by age group and sex during 2018 in Korea

Rank	Age group (yr)			
	0-14	15-34	35-64	≥ 65
Male				
1	Leukemia (5.0)	Thyroid (7.9)	Stomach (64.6)	Lung[a)] (433.8)
2	Non-Hodgkin lymphoma (2.9)	Leukemia (3.5)	Liver[a)] (48.7)	Stomach (287.9)
3	Brain and CNS (1.5)	Non-Hodgkin lymphoma (3.0)	Colon and rectum (45.2)	Prostate (266.6)
4	Liver[b)] (0.4)	Testis (2.6)	Lung (43.6)	Colon and rectum (252.9)
5		Colon and rectum (2.5)	Prostate (20.2)	Liver[b)] (166.8)
Female				
1	Leukemia (4.1)	Thyroid (34.9)	Breast (141.3)	Colon and rectum (147.9)
2	Non-Hodgkin lymphoma (1.8)	Breast (10.8)	Thyroid (41.7)	Stomach (119.0)
3	Brain and CNS (1.6)	Cervix uteri (5.4)	Stomach (29.8)	Lung[a)] (116.7)
4	Ovary (0.8)	Ovary (3.2)	Colon and rectum (26.1)	Breast (85.7)
5	Thyroid (0.7)	Cervix corpus (2.4)	Lung[a)] (21.7)	Gallbladder[c)] (63.2)

CNS, central nervous system. [a)]Includes the lung and bronchus, [b)]Includes the liver and intrahepatic bile duct, [c)]Includes the gallbladder and other/unspecified parts of the biliary tract.
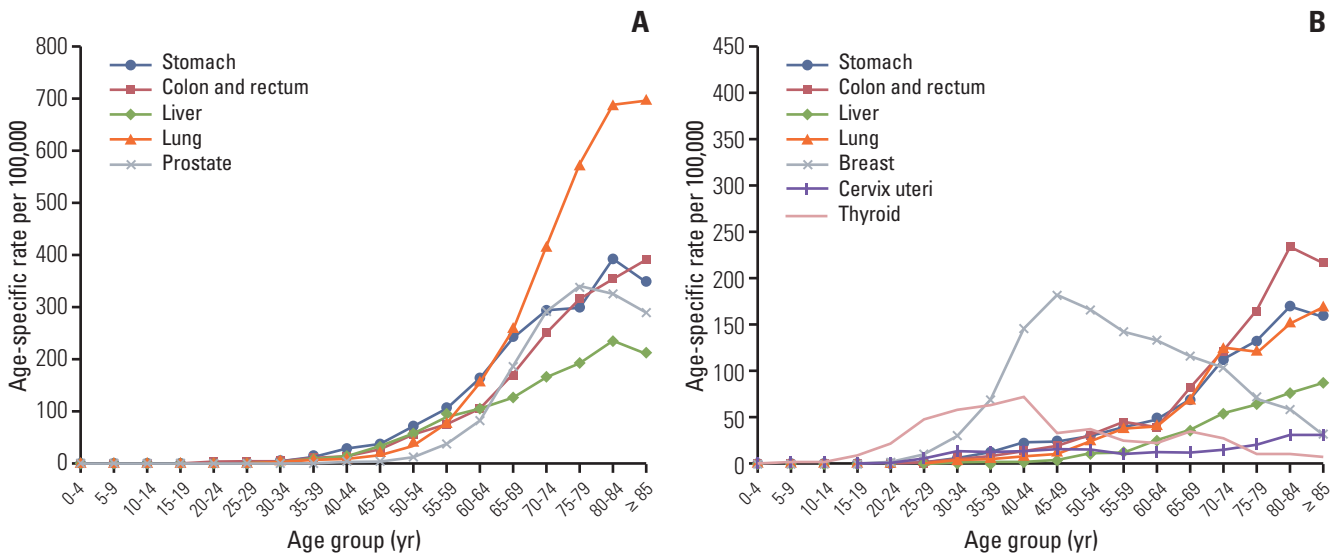
Fig. 2. Projected age-specific incidences of major cancers during 2018 in Korea. (A) Males. (B) Females.

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. Breast 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 (Fig. 2). In women, the age-specific incidence rates of stom-

ach, 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 40s.
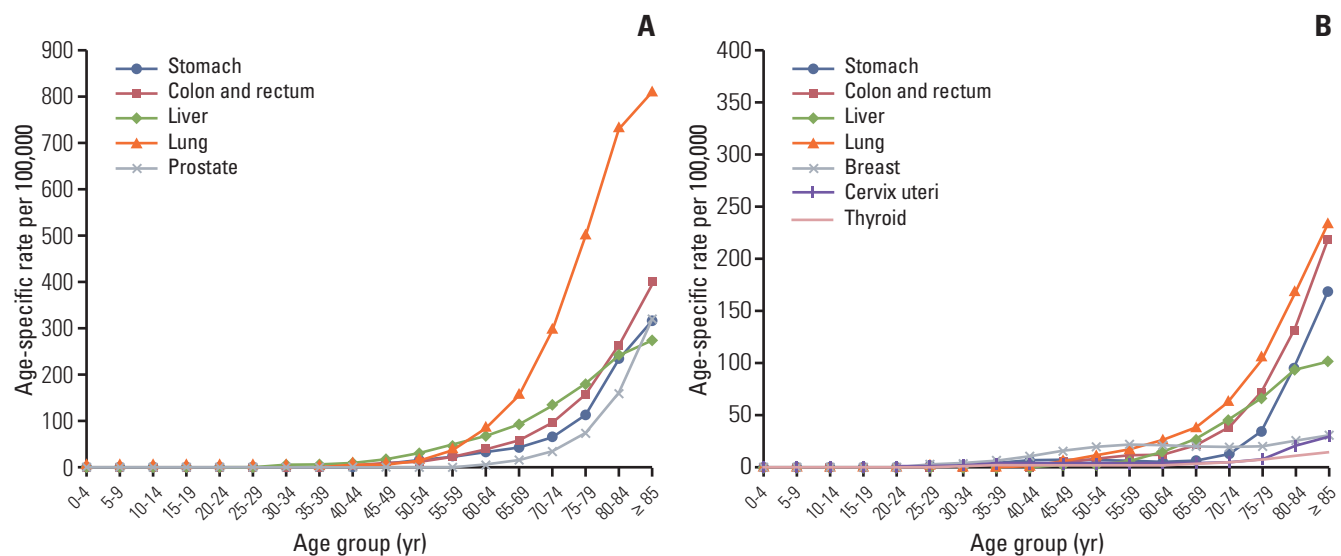
2. Mortality

It is estimated that 82,155 cancer deaths will occur in Korea during 2018 (Table 1, Fig.1). The projected CRs per 100,000

Table 4. Estimated crude and age-standardized cancer mortality rates by sex during 2018 in Korea

Site	Crude mortality rate per 100,000			Age-standardized mortality rate per 100,000[a]		
	Both sexes	Male	Female	Both sexes	Male	Female
All sites	159.1	195.2	122.8	75.0	108.1	51.0
Lip, oral cavity, and pharynx	2.3	3.4	1.2	1.2	1.9	0.5
Esophagus	2.6	4.7	0.6	1.2	2.5	0.2
Stomach	13.8	17.9	9.8	6.4	9.9	3.7
Colon and rectum	18.1	21.4	14.8	8.2	11.8	5.5
Liver[b]	21.3	31.0	11.5	10.5	17.5	4.5
Gallbladder[c]	8.8	8.7	9.0	3.8	4.7	3.1
Pancreas	12.3	12.7	11.9	5.8	7.1	4.7
Larynx	0.6	1.2	0.0	0.3	0.6	0.0
Lung[d]	37.4	54.5	20.2	16.8	29.1	7.8
Breast	5.2	0.1	10.4	3.0	0.0	5.8
Cervix uteri	1.5	-	3.0	0.8	-	1.5
Corpus uteri	0.7	-	1.4	0.4	-	0.7
Ovary	2.4	-	4.8	1.3	-	2.4
Prostate	4.2	8.4	-	1.7	4.5	-
Testis	0.0	0.1	-	0.0	0.1	-
Kidney	2.3	3.2	1.4	1.1	1.8	0.6
Bladder	3.0	4.5	1.5	1.2	2.5	0.5
Brain and CNS	2.6	2.6	2.5	1.6	1.8	1.5
Thyroid	0.7	0.4	1.0	0.3	0.2	0.3
Hodgkin lymphoma	0.1	0.2	0.1	0.1	0.1	0.0
Non-Hodgkin lymphoma	3.8	4.4	3.2	1.8	2.5	1.3
Multiple myeloma	2.1	2.3	2.0	1.0	1.3	0.8
Leukemia	3.8	4.4	3.2	2.1	2.7	1.6
Other and ill defined	9.3	9.3	9.3	4.6	5.5	3.9

CNS, central nervous system. [a]Age adjusted to the world standard population, [b]Includes the liver and intrahepatic bile duct, [c]Includes the gallbladder and other/unspecified parts of the biliary tract, [d]Includes the lung and bronchus.

Fig. 3. Projected age-specific mortality rates of major cancers during 2018 in Korea. (A) Males. (B). Females.

of all sites combined in 2018 for men and women are projected to be 195.2 and 122.8, respectively, whereas the projected ASRs per 100,000 of all sites combined are expected to be 108.1 and 51.0, respectively (Table 4). The predicted five leading cancer sites causing mortality in men are predicted to be lung (CR, 54.5; ASR, 29.1), liver (CR, 31.0; ASR, 17.5), colon and rectum (CR, 21.4; ASR, 11.8), stomach (CR, 17.9; ASR, 9.9), and pancreas (CR, 12.7; ASR, 7.1). During the same period, lung cancer (CR, 20.2; ASR, 7.8) is projected to be the leading cancer cause of death in women, followed by the colon and rectum (CR, 14.8; ASR, 5.5), pancreas (CR, 11.9; ASR, 4.7), liver (CR, 11.5; ASR, 4.5), and breast (CR, 10.4; ASR, 5.8).

The predicted age-specific mortality rates of the selected cancers for males and females in 2018 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.

Conclusion

A total of 204,909 new cancer cases and 82,155 cancer deaths are expected to occur in Korea during 2018. The lung cancer is predicted to the most common cancer among male, followed by stomach, colorectal, liver, and prostate cancers. Lung, liver, colorectal, stomach, and pancreatic cancers are expected to be the most common causes of cancer deaths among men. In women, the five leading primary sites are expected to be the breast, colorectal, stomach, thyroid, and lung cancers are anticipated to be the most prevalent, while lung, colorectal, pancreatic, liver, and breast cancers are projected to be the most common causes of cancer-related deaths.

Cancer is currently one of the foremost public health concerns in Korea. Although cancer rates are anticipated to decrease somewhat, but burden of most of cancers will continue to grow with the aging of its population. The current projections of cancer incidence and mortality for 2018 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. Especially, incidence of some cancers, such as stomach, colorectum and thyroid, started to decrease from early 2010s. So recent trends of those cancers contained only five or six data points, therefore their estimates could be unstable.

Conflicts of Interest

Conflict of interest relevant to this article was not reported.

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