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Prediction of Cancer Incidence and Mortality in Korea, 2016

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Purpose

To estimate of Korea's current cancer burden, this study aimed to report on projected cancer incidence and mortality rates for the year 2016.

Materials and Methods

Cancer incidence data from 1999 to 2013 were obtained from the Korea National Cancer Incidence Database, and cancer mortality data from 1993 to 2014 were acquired from Statistics Korea. Cancer incidence in 2016 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. The *Joinpoint* regression model was used to determine at which year the linear trend changed significantly.

Results

A total of 254,962 new cancer cases and 75,172 cancer deaths are expected to occur in Korea in 2016. The five leading primary cancer incident sites in 2016 were estimated colorectal, stomach, lung, liver and thyroid cancer in men; thyroid, breast, colorectal, stomach, and lung cancer in women.

Conclusion

Currently cancer is one of the foremost public health concerns in Korea. Although cancer rates are anticipated to decrease the nation's cancer burden will continue to increase as the population ages.

Key words
Incidence, Mortality, Neoplasms, Forecasting, Korea, 2016

Introduction

As the leading cause of death in Korea [1], cancer has been the country's main public health concern since 1983. Over 224,000 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 it can provide nationwide cancer statistics within a relatively brief period, a lag time of at least 2 years is required to collect, compile, and analyze the data of 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 2016 based on data from the 1990s through 2014.

Table 1. Estimated new cancer cases and deaths by sex during 2016 in Korea

Site	Estimated new cases			Estimated deaths		
	Both sexes	Male	Female	Both sexes	Male	Female
All sites	254,962	131,224	123,738	75,172	46,155	29,017
Lip, oral cavity, and pharynx	3,236	2,363	873	1,059	775	284
Esophagus	2,335	2,137	198	1,199	1,125	74
Stomach	34,331	23,355	10,976	7,054	4,402	2,652
Colon and rectum	37,968	23,406	14,562	8,715	5,147	3,568
Liver	16,014	11,558	4,456	10,639	7,846	2,793
Gallbladder[a]	5,831	3,029	2,802	3,994	1,927	2,067
Pancreas	6,431	3,428	3,003	5,487	2,863	2,624
Larynx	1,033	1,000	33	342	339	3
Lung	25,052	16,903	8,149	17,505	12,676	4,829
Breast	20,429	73	20,356	2,452	19	2,433
Cervix uteri	3,013	-	3,013	755	-	755
Corpus uteri	2,565	-	2,565	296	-	296
Ovary	2,450	-	2,450	1,097	-	1,097
Prostate	11,062	11,062	-	1,862	1,862	-
Testis	269	269	-	19	19	-
Kidney	4,961	3,456	1,505	1,046	726	320
Bladder	3,824	3,051	773	1,412	1,076	336
Brain and CNS	1,929	1,026	903	1,160	620	540
Thyroid	45,474	11,219	34,255	360	103	257
Hodgkin lymphoma	308	199	109	69	44	25
Non-Hodgkin lymphoma	5,538	3,027	2,511	1,661	955	706
Multiple myeloma	1,555	833	722	921	510	411
Leukemia	3,223	1,822	1,401	1,760	1,015	745
Other and ill defined	16,131	8,008	8,123	4,308	2,106	2,202

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 2013 were obtained from the Korea National Cancer Incidence Database. 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 2014 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-C85, C96), multiple myeloma (C90), leukemia (C91-C95), and others.

Population data from 1993 to 2015 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 2016, however, we used population data as of December 31, 2015, because mid-2015 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, to provide an estimate of the nation's current cancer
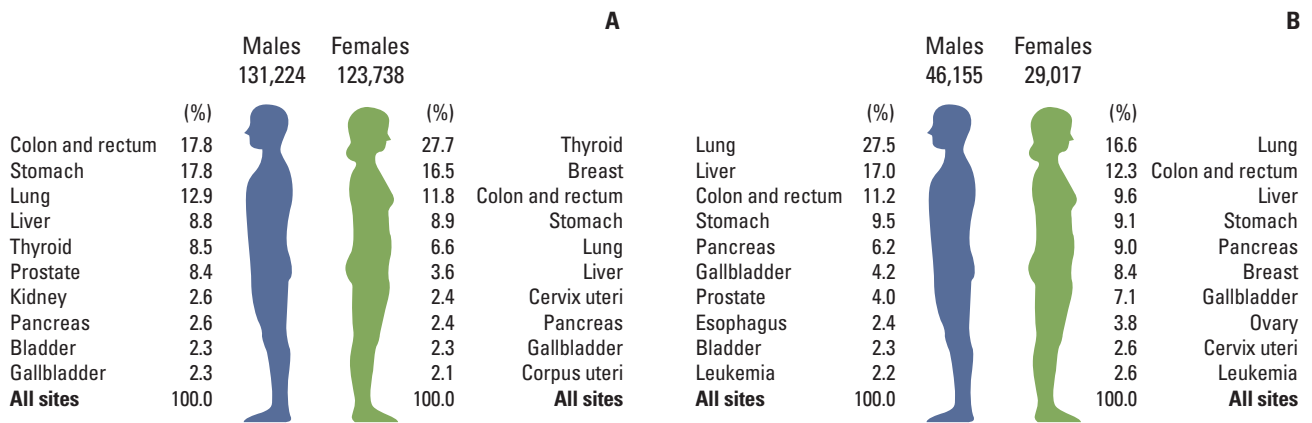
A

Males 131,224   Females 123,738

	(%)				(%)	
Colon and rectum	17.8			27.7		Thyroid
Stomach	17.8			16.5		Breast
Lung	12.9			11.8		Colon and rectum
Liver	8.8			8.9		Stomach
Thyroid	8.5			6.6		Lung
Prostate	8.4			3.6		Liver
Kidney	2.6			2.4		Cervix uteri
Pancreas	2.6			2.4		Pancreas
Bladder	2.3			2.3		Gallbladder
Gallbladder	2.3			2.1		Corpus uteri
All sites	**100.0**			**100.0**		**All sites**

B

Males 46,155   Females 29,017

	(%)				(%)	
Lung	27.5			16.6		Lung
Liver	17.0			12.3		Colon and rectum
Colon and rectum	11.2			9.6		Liver
Stomach	9.5			9.1		Stomach
Pancreas	6.2			9.0		Pancreas
Gallbladder	4.2			8.4		Breast
Prostate	4.0			7.1		Gallbladder
Esophagus	2.4			3.8		Ovary
Bladder	2.3			2.6		Cervix uteri
Leukemia	2.2			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 2016. (A) Estimated new cases. (B) Estimated deaths.

Table 2. Estimated crude and age-standardized cancer incidences by sex during 2016 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	496.7	511.2	482.3	311.0	340.0	298.8
Lip, oral cavity, and pharynx	6.3	9.2	3.4	4.0	6.1	2.1
Esophagus	4.6	8.3	0.8	2.6	5.4	0.4
Stomach	66.9	91.0	42.8	39.8	59.0	23.5
Colon and rectum	74.0	91.2	56.8	43.9	59.6	30.5
Liver	31.2	45.0	17.4	18.5	29.1	9.1
Gallbladder[b]	11.4	11.8	10.9	6.2	7.6	5.0
Pancreas	12.5	13.4	11.7	7.0	8.6	5.7
Larynx	2.0	3.9	0.1	1.2	2.5	0.1
Lung	48.8	65.9	31.8	27.3	42.3	16.0
Breast	39.8	0.3	79.3	26.2	0.2	52.2
Cervix uteri	5.9	-	11.7	3.9	-	7.5
Corpus uteri	5.0	-	10.0	3.2	-	6.4
Ovary	4.8	-	9.6	3.2	-	6.4
Prostate	21.6	43.1	-	12.4	28.0	-
Testis	0.5	1.1	-	0.5	1.0	-
Kidney	9.7	13.5	5.9	6.1	8.9	3.5
Bladder	7.5	11.9	3.0	4.1	7.7	1.3
Brain and CNS	3.8	4.0	3.5	3.0	3.4	2.7
Thyroid	88.6	43.7	133.5	63.3	31.1	96.2
Hodgkin lymphoma	0.6	0.8	0.4	0.5	0.7	0.4
Non-Hodgkin lymphoma	10.8	11.8	9.8	7.4	8.6	6.3
Multiple myeloma	3.0	3.3	2.8	1.8	2.1	1.5
Leukemia	6.3	7.1	5.5	5.3	6.2	4.4
Other and ill defined	31.4	31.2	31.7	19.6	22.0	17.6

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

Table 3. Estimated cancer incidence by age group and sex during 2016 in Korea

Rank	Age group (yr)			
	0-14	15-34	35-64	≥ 65
Male				
1	Leukemia (5.0)	Thyroid (23.5)	Stomach (98.7)	Lung (434.3)
2	Non-Hodgkin lymphoma (2.6)	Colon and rectum (3.6)	Colon and rectum (96.6)	Colon and rectum (425.6)
3	Brain and CNS (2.4)	Leukemia (3.4)	Thyroid (70.1)	Stomach (418.8)
4	Liver (0.5)	Non-Hodgkin lymphoma (3.3)	Liver (54.4)	Prostate (303.5)
5	Thyroid (0.4)	Stomach (2.0)	Lung (41.9)	Liver (182.2)
Female				
1	Leukemia (4.0)	Thyroid (79.7)	Thyroid (216.8)	Colon and rectum (214.6)
2	Brain and CNS (2.0)	Breast (12.0)	Breast (141.8)	Stomach (152.0)
3	Non-Hodgkin lymphoma (1.5)	Cervix uteri (5.5)	Colon and rectum (53.2)	Lung (137.0)
4	Ovary (0.8)	Stomach (3.4)	Stomach (42.5)	Thyroid (93.3)
5	Thyroid (0.7)	Ovary (3.1)	Lung (24.8)	Breast (77.7)

CNS, central nervous system.
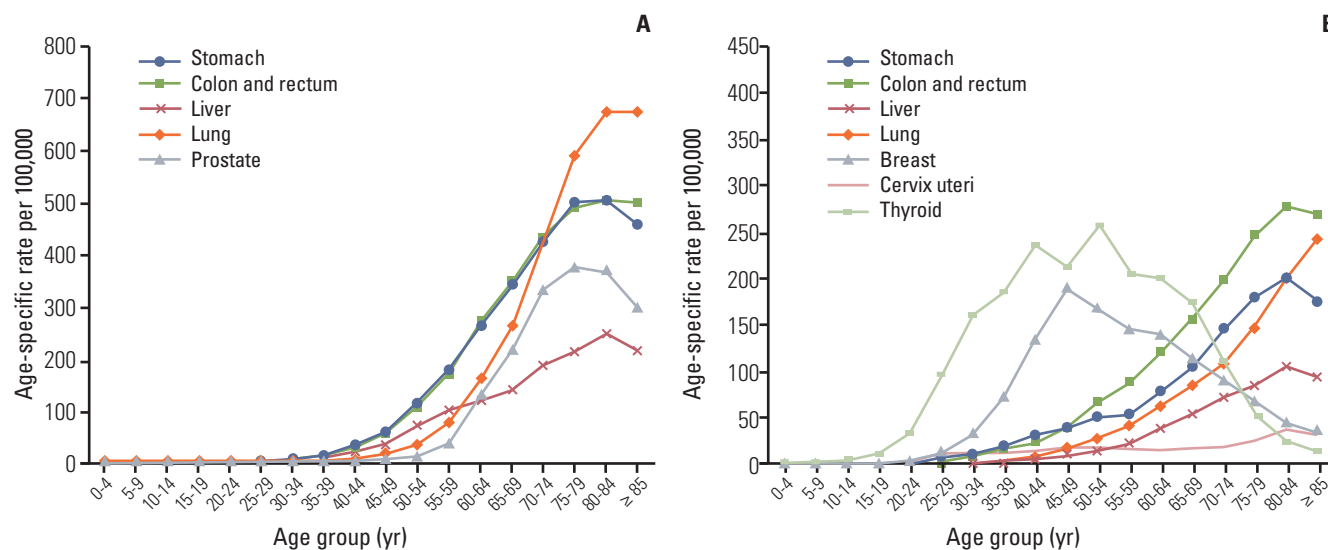
Fig. 2. Projected age-specific incidences of major cancers during 2016 in Korea. (A) Male. (B) Female.

burden, we attempted to project, the expected number of new cancer cases and deaths in Korea for 2016. Linear regression models [6] were used to assess the time trends and projections. A simple linear or log-linear model of age-specific rates provide a good fit to the data, and it gives accurate predictions over a short time span [7]. Based on observed cancer incidence data from 1999 to 2013, a linear regression model was fitted to the age-specific rates by 5-year age groups against the observed years.

To predict the cancer incidence and mortality in 2016, we

first performed a *Joinpoint* regression analysis on the data available to detect the year 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. 4.0.1, http://surveillance.cancer.gov/joinpoint) from the Surveillance Research Program of the US National Cancer Institute [8]. We chose the number of joinpoints to ensure that there would be at least five data points between

Table 4. Estimated crude and age-standardized cancer mortality rates by sex during 2016 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	146.5	179.8	113.1	79.3	116.2	53.1
Lip, oral cavity, and pharynx	2.1	3.0	1.1	1.2	1.9	0.5
Esophagus	2.3	4.4	0.3	1.3	2.8	0.1
Stomach	13.7	17.1	10.3	7.2	11.0	4.5
Colon and rectum	17.0	20.1	13.9	8.9	13.0	6.0
Liver	20.7	30.6	10.9	11.8	19.7	5.0
Gallbladder[b)]	7.8	7.5	8.1	3.9	4.8	3.3
Pancreas	10.7	11.2	10.2	5.8	7.2	4.6
Larynx	0.7	1.3	0.0	0.3	0.8	0.0
Lung	34.1	49.4	18.8	17.8	31.2	8.3
Breast	4.8	0.1	9.5	2.9	0.0	5.7
Cervix uteri	1.5	-	2.9	0.8	-	1.6
Corpus uteri	0.6	-	1.2	0.3	-	0.7
Ovary	2.1	-	4.3	1.3	-	2.4
Prostate	3.6	7.3	-	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	2.8	4.2	1.3	1.3	2.8	0.5
Brain and CNS	2.3	2.4	2.1	1.6	1.8	1.3
Thyroid	0.7	0.4	1.0	0.3	0.3	0.4
Hodgkin lymphoma	0.1	0.2	0.1	0.1	0.1	0.1
Non-Hodgkin lymphoma	3.2	3.7	2.8	1.8	2.4	1.3
Multiple myeloma	1.8	2.0	1.6	1.0	1.3	0.8
Leukemia	3.4	4.0	2.9	2.2	2.8	1.7
Other and ill defined	8.4	8.2	8.6	4.7	5.6	4.0

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

consecutive joinpoints. However, for thyroid cancer, which has recently shown significant decreasing trends, we selected three joinpoints, although the last segment had only three data points.

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 [9] and expressed as rates per 100,000 persons.

Results

1. Incidence

A total of 254,962 new cancer cases are anticipated in 2016

(Table 1, Fig. 1), with more male (n=131,224) than female (n=123,738) cancer patients expected in the coming year.

The projected CRs per 100,000 of all sites combined in 2016 are projected to be 511.2 and 482.3 in men and women, respectively. The projected ASRs per 100,000 of all sites combined are 340.0 and 298.8, respectively (Table 2). In men, the five leading primary sites of cancer are expected to be the colon and rectum (CR, 91.2; ASR, 59.6), stomach (CR, 91.0; ASR, 59.0), lung (CR, 65.9; ASR, 42.3), liver (CR, 45.0; ASR, 29.1), and thyroid (CR, 43.7; ASR, 31.1), accounting for 65.9% of all new cancers in 2016.

In women, the five leading primary sites are expected to be the thyroid (CR, 133.5; ASR, 96.2), breast (CR, 79.3; ASR, 52.2), colon and rectum (CR, 56.8; ASR, 30.5), stomach (CR, 42.8; ASR, 23.5), and lung (CR, 31.8; ASR, 16.0), accounting for 71.4% of all new cancers (Fig. 1). Thyroid cancer alone is projected to account for approximately 27.7% (34,255 cases)
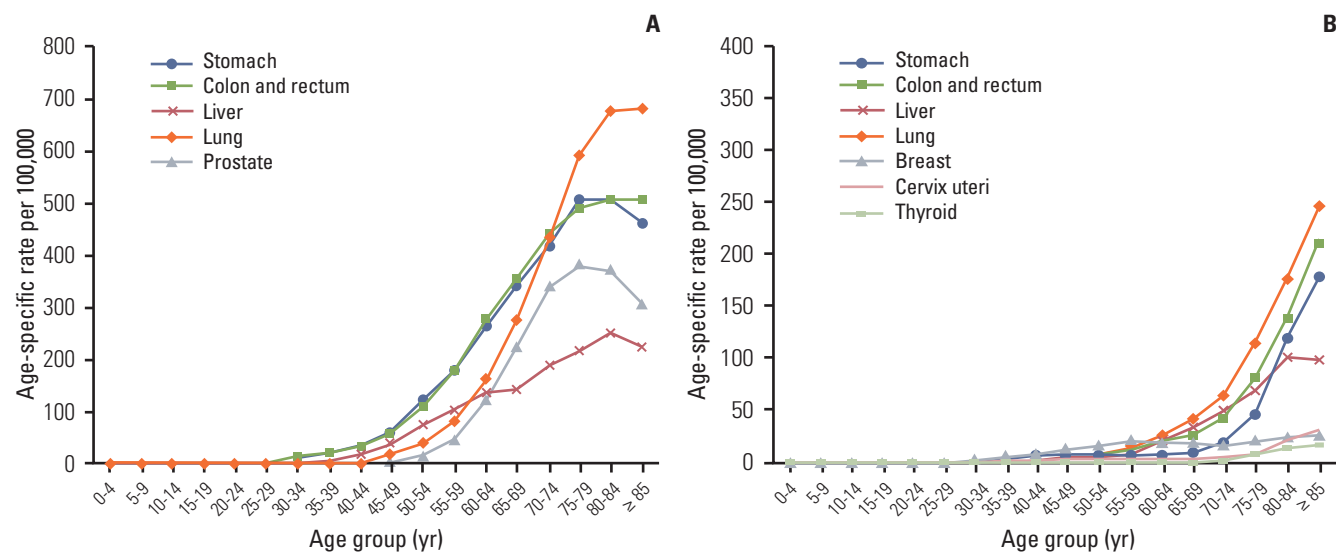
Fig. 3. Projected age-specific mortality rates of major cancers during 2016 in Korea. (A) Male. (B) Female.

of incident cases in women in 2016.

The five most common cancer sites expected in 2016 by sex and age group are shown in Table 3. Leukemia and thyroid cancer are expected to be the most common types 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 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 75,172 cancer deaths will occur in Korea in 2016 (Table 1, Fig. 1). The projected CRs per 100,000 of all sites combined in 2016 for men and women are projected to be 179.8 and 113.1, respectively, whereas the projected ASRs per 100,000 of all sites combined are expected to be 116.2 and 53.1, respectively (Table 4). The predicted five leading cancer sites causing mortality in men are predicted to be lung (CR, 49.4; ASR, 31.2), liver (CR, 30.6; ASR, 19.7), colon and rectum (CR, 20.1; ASR, 13.0), stomach (CR, 17.1; ASR, 11.0), and pan-

creas (CR, 11.2; ASR, 7.2). During the same period, lung cancer (CR, 18.8; ASR, 8.3) is projected to be the leading cancer site in women, causing mortality, followed by the colon and rectum (CR,13.9; ASR, 6.0), liver (CR, 10.9; ASR, 5.0), stomach (CR, 10.3; ASR, 4.5), and pancreas (CR, 10.2; ASR, 4.6).

The predicted age-specific mortality rates of the selected cancers for males and females in 2016 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 254,962 new cancer cases and 74,096 cancer deaths are expected to occur in Korea during 2016. The colorectal cancer is predicted to the most common cancer among male for the first time, followed by stomach, lung, liver, and thyroid 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 thyroid, breast, colorectal, stomach, and lung cancers are anticipated to be the most prevalent, while lung, colorectal, liver, stomach, and pancreatic 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 cancer burden will continue to increase with the aging of its population. The current projections of cancer incidence and mortality for 2016 represent an important resource for planning and evaluating 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.

Acknowledgments

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