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Prediction of Cancer Incidence and Mortality in Korea, 2013

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Purpose

To estimate the current cancer burden in Korea, cancer incidence and mortality rates were projected for the year 2013.

Materials and Methods

Cancer incidence data from 1999 to 2010 were obtained from the Korea National Cancer Incidence Database, and cancer mortality data from 1993 to 2011 were obtained from Statistics Korea. Cancer incidence in 2013 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 used, except that a *Joinpoint* regression model was used to determine at which year the linear trend changed significantly.

Results

In total, 247,732 new cancer cases and 74,179 cancer deaths are projected to occur in Korea in 2013. For all sites combined, the crude incidence rates are projected to be 489.8 and 492.2, and the age-standardized incidences to be 350.4 and 318.4 per 100,000 for males and females, respectively.

Conclusion

Cancer has become an important public health concern in Korea, and as the Korean population ages, the cancer burden will continue to increase.

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Introduction

Since 1983, as the leading cause of death [1], cancer has become a major public health concern in Korea. Annually, over 200,000 patients are newly diagnosed with cancer in Korea, and one in four deaths is due to cancer [2,3]. Although the cancer registration system in Korea is very efficient and can provide nationwide cancer statistics within a relatively short time, an at least 2-year lag for accurate data collection and compilation is necessary. To plan and apply a cancer control program, it is important to assess the number of new cases and deaths that are expected to occur during the current year. In this report, we provide the projected cancer incidence and mortality rate based on data up to 2010.

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 details of the history, objectives, and activities of the KCCR have been documented elsewhere [4]. Incidence data from 1999 to 2010 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 to 2011 were obtained from Statistics Korea [1]. The cause of death was coded and classified according to ICD-10.

The cancer sites included in this report are 1) all cancers combined and 2) the 24 most 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 all others.

Population data were obtained from the resident registration population, reported by Statistics Korea. The mid-year population, on July 1 of the respective year, was used when computing the incidence and deaths.

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

Linear regression models [7] were used to assess time trends 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 observed years. From the projected age-specific rates in 2013, the estimated number of cancer cases was calculated by multiplying the rates by the projected 2013 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 estimate the number of cancer deaths in 2013, we first ran a *Joinpoint* regression model on the data for 1993-2011 to detect the year of significant changes in the trends in cancer mortality by 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; http://surveillance.cancer.gov/joinpoint) from the Surveillance Research Program of the US National Cancer Institute [8]. After identifying the year of significant trend changes using *Joinpoint* regression analysis, a simple linear regression model was fitted to the last line segment to estimate age-specific cancer mortality rates in 2013. 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 2013's projected age-specific population.

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

Results

1. Incidence

Table 1 presents the estimated number of new cancer cases and deaths during 2013 in Korea by sex and cancer site. It is projected that 247,732 cancer incidence cases will occur in 2013.

Table 2 presents the estimated CRs and ASRs of cancer incidence in 2013 by sex and cancer site. The CRs of all sites combined in males and females in 2013 are projected to be 489.8 and 492.2, respectively, per 100,000, and the ASRs of all sites combined are projected to be 350.4 and 318.4, respectively, per 100,000. In males, the five leading primary sites of cancer are expected to be the stomach (CR, 89.1; ASR, 62.6), colon and rectum (CR, 82.2; ASR, 58.1), lung (CR, 65.3; ASR, 46.1), liver (CR, 49.4; ASR, 34.4), and prostate (CR, 48.3; ASR, 34.5), accounting for 68.2% of all newly diagnosed cancers in 2013. In females, the five leading primary sites are expected to be thyroid (CR, 174.4; ASR, 124.1), breast (CR, 67.6; ASR, 45.8), colon and rectum (CR, 51.7; ASR, 29.8), stomach (CR, 42.1; ASR, 24.6), and lung (CR, 28.0; ASR, 15.0), accounting for 73.9% of all newly diagnosed cancers (Fig. 1). Thyroid cancer alone is projected to account for 35.4% (43,973 cases) of incident cases in females in 2013.

Table 3 presents the most common cancer sites expected in 2013 by sex and age group. Leukemia and thyroid cancer are projected to be the most common forms of cancer in both sexes for the 0-14 and 15-34 age groups. Gastric cancer is predicted to be the most common cancer in males 35-64 years

Table 1. Estimated new cancer cases and deaths by sex during 2013 in Korea

Site	Estimated new cases			Estimated deaths		
	Both	Male	Female	Both	Male	Female
All sites	247,732	123,610	124,122	74,179	46,610	27,569
Lip, oral cavity, and pharynx	2,897	2,142	755	1,007	739	268
Esophagus	2,273	2,089	184	1,242	1,158	84
Stomach	33,118	22,495	10,623	8,292	5,346	2,946
Colon and rectum	33,789	20,745	13,044	9,221	5,620	3,601
Liver	16,845	12,456	4,389	10,734	8,005	2,729
Gallbladder[a]	5,637	2,823	2,814	3,918	1,893	2,025
Pancreas	5,581	2,986	2,595	5,037	2,732	2,305
Larynx	1,072	1,032	40	211	200	11
Lung	23,543	16,479	7,064	16,448	11,963	4,485
Breast	17,104	67	17,037	2,207	18	2,189
Cervix uteri	3,240	-	3,240	825	-	825
Corpus uteri	2,174	-	2,174	262	-	262
Ovary	2,199	-	2,199	1,003	-	1,003
Prostate	12,180	12,180	-	1,620	1,620	-
Testis	221	221	-	19	19	-
Kidney	4,549	3,139	1,410	894	596	298
Bladder	4,043	3,255	788	1,087	780	307
Brain and CNS	1,872	999	873	1,112	608	504
Thyroid	52,485	8,512	43,973	372	104	268
Hodgkin lymphoma	267	173	94	52	30	22
Non-Hodgkin lymphoma	4,684	2,580	2,104	1,521	876	645
Multiple myeloma	1,312	689	623	965	515	450
Leukemia	2,936	1,657	1,279	1,690	977	713
Other and ill defined	13,711	6,891	6,820	4,440	2,811	1,629

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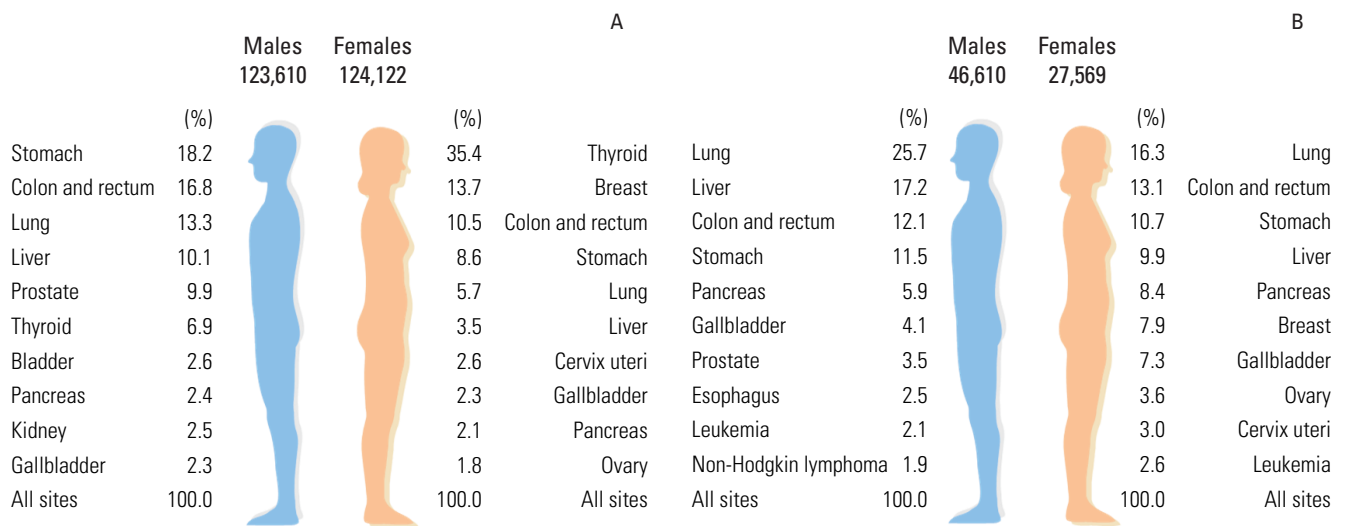

Fig. 1. The 10 leading types of estimated new cancer cases and deaths by sex in 2013. (A) Estimated new cases. (B) Estimated deaths.

Table 2. Estimated crude and age-standardized cancer incidences by sex during 2013 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	491.0	489.8	492.2	324.2	350.4	318.4
Lip, oral cavity, and pharynx	5.7	8.5	3.0	3.9	6.0	2.0
Esophagus	4.5	8.3	0.7	2.8	5.9	0.4
Stomach	65.6	89.1	42.1	41.9	62.6	24.6
Colon and rectum	67.0	82.2	51.7	42.7	58.1	29.8
Liver	33.4	49.4	17.4	21.4	34.4	9.8
Gallbladder[b]	11.2	11.2	11.2	6.7	8.0	5.6
Pancreas	11.1	11.8	10.3	6.7	8.4	5.3
Larynx	2.1	4.1	0.2	1.3	2.9	0.1
Lung	46.7	65.3	28.0	28.2	46.1	15.0
Breast	33.9	0.3	67.6	23.1	0.2	45.8
Cervix uteri	6.4	-	12.9	4.3	-	8.4
Corpus uteri	4.3	-	8.6	2.9	-	5.7
Ovary	4.4	-	8.7	3.0	-	6.0
Prostate	24.1	48.3	-	15.0	34.5	-
Testis	0.4	0.9	-	0.5	0.9	-
Kidney	9.0	12.4	5.6	6.1	8.9	3.6
Bladder	8.0	12.9	3.1	4.8	9.1	1.6
Brain and CNS	3.7	4.0	3.5	3.1	3.5	2.7
Thyroid	104.0	33.7	174.4	73.7	24.0	124.1
Hodgkin lymphoma	0.5	0.7	0.4	0.5	0.6	0.3
Non-Hodgkin lymphoma	9.3	10.2	8.3	6.6	7.8	5.6
Multiple myeloma	2.6	2.7	2.5	1.6	1.9	1.4
Leukemia	5.8	6.6	5.1	5.2	6.1	4.4
Other and ill defined	27.2	27.3	27.0	18.3	20.7	16.4

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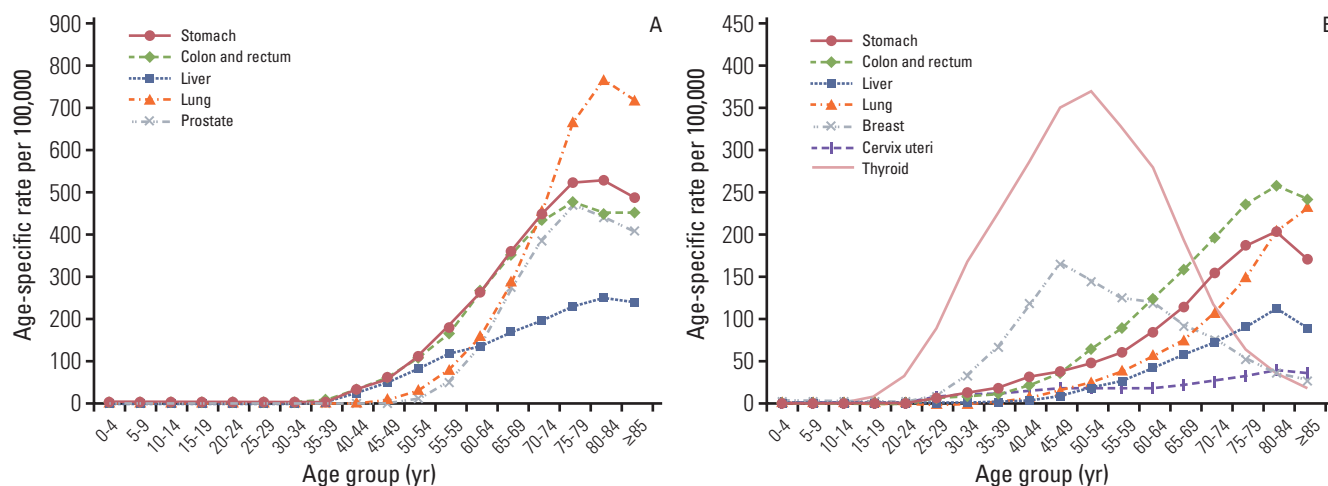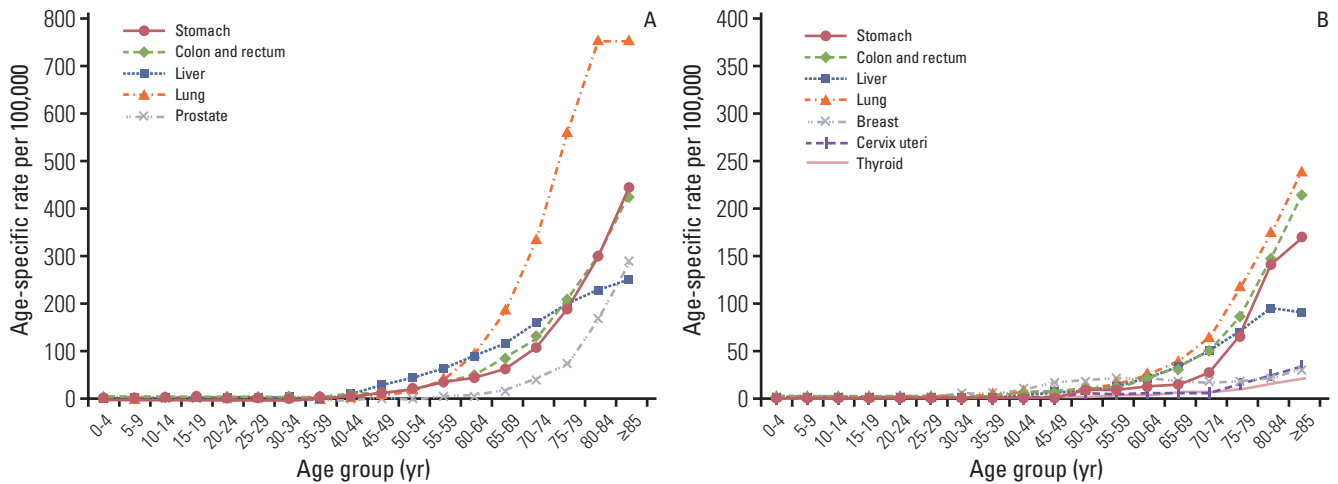

Fig. 2. Projected age-specific incidences of major cancers during 2013 in Korea. (A) Male. (B) Female.

Table 3. Estimated cancer incidence by age group and sex during 2013 in Korea

Rank	Age group (yr)			
	0-14	15-34	35-64	≥65
Male				
1	Leukemia	Thyroid	Stomach	Lung
	(5.1)	(14.6)	(99.9)	(478.9)
2	Brain and CNS	Leukemia	Colon and rectum	Stomach
	(2.6)	(3.3)	(90.9)	(445.5)
3	Non-Hodgkin lymphoma	Colon and rectum	Liver	Colon and rectum
	(2.0)	(3.0)	(64.5)	(414.0)
4	Kidney	Non-Hodgkin lymphoma	Thyroid	Prostate
	(0.6)	(3.0)	(57.4)	(374.0)
5	Testis	Stomach	Lung	Liver
	(0.4)	(2.3)	(41.7)	(202.9)
Female				
1	Leukemia	Thyroid	Thyroid	Colon and rectum
	(4.0)	(79.3)	(307.8)	(204.9)
2	Brain and CNS	Breast	Breast	Stomach
	(2.0)	(11.4)	(123.8)	(157.0)
3	Non-Hodgkin lymphoma	Cervix uteri	Colon and rectum	Lung
	(1.0)	(5.2)	(50.8)	(131.4)
4	Ovary	Stomach	Stomach	Thyroid
	(0.8)	(4.2)	(43.2)	(108.0)
5	Thyroid	Ovary	Lung	Liver
	(0.6)	(2.8)	(21.7)	(78.2)

CNS, central nervous system.

Fig. 3. Projected age-specific mortality rates of major cancers during 2013 in Korea. (A) Male. (B) Female.

of age, while lung cancer is predicted to be more frequent in males ≥65 years of age. Thyroid cancer is predicted to be the most common cancer in females 35-64 years of age, whereas colorectal cancer is predicted to be the most common cancer in females ≥65 years of age. Fig. 2 shows the age-specific incidence rates of the selected cancers for males and females

in 2013. The projection indicates that the incidences of gastric, lung, liver, and colorectal cancers will increase gradually with age. In women, the age-specific incidence rates of breast and thyroid cancer will increase with age until 50 years of age, and then level off.

Table 4. Estimated crude and age-standardized cancer mortality rates by sex during 2013 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	147.0	184.7	109.3	87.7	131.8	56.3
Lip, oral cavity, and pharynx	2.0	2.9	1.1	1.2	2.0	0.6
Esophagus	2.5	4.6	0.3	1.5	3.2	0.1
Stomach	16.4	21.2	11.7	9.6	15.1	5.7
Colon and rectum	18.3	22.3	14.3	10.7	16.0	7.0
Liver	21.3	31.7	10.8	13.3	22.3	5.6
Gallbladder[b]	7.8	7.5	8.0	4.4	5.4	3.7
Pancreas	10.0	10.8	9.1	5.9	7.7	4.5
Larynx	0.4	0.8	0.0	0.2	0.6	0.0
Lung	32.6	47.4	17.8	18.9	33.4	8.6
Breast	4.4	0.1	8.7	2.9	0.1	5.5
Cervix uteri	1.6	-	3.3	1.0	-	1.8
Corpus uteri	0.5	-	1.0	0.3	-	0.6
Ovary	2.0	-	4.0	1.2	-	2.3
Prostate	3.2	6.4	-	1.7	4.8	-
Testis	0.0	0.1	-	0.0	0.1	-
Kidney	1.8	2.4	1.2	1.1	1.7	0.6
Bladder	2.2	3.1	1.2	1.2	2.3	0.5
Brain and CNS	2.2	2.4	2.0	1.6	1.9	1.3
Thyroid	0.7	0.4	1.1	0.4	0.3	0.5
Hodgkin lymphoma	0.1	0.1	0.1	0.1	0.1	0.1
Non-Hodgkin lymphoma	3.0	3.5	2.6	1.8	2.5	1.3
Multiple myeloma	1.9	2.0	1.8	1.2	1.4	1.0
Leukemia	3.4	3.9	2.8	2.3	3.0	1.8
Other and ill defined	8.8	11.1	6.5	5.3	8.1	3.3

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

2. Mortality

It is estimated that 74,179 cancer deaths will occur in Korea during 2013 (Table 1, Fig. 2). The CRs of all sites combined in 2013 for males and females are projected to be 184.7 and 109.3, respectively, per 100,000, and the ASRs of all sites combined are expected to be 131.8 and 56.3, respectively, per 100,000 (Table 4).

In 2013, the five leading cancer sites causing mortality in males are predicted to be lung (CR, 47.4; ASR, 33.4), liver (CR, 31.7; ASR, 22.3), colon and rectum (CR, 22.3; ASR 16.0), stomach (CR, 21.2; ASR, 15.1), and pancreas (CR, 10.8; ASR, 7.7). During the same time period, in females, lung cancer (CR, 17.8; ASR, 8.6) is projected to be the leading cancer site causing mortality, followed by cancers of the colon and rectum (CR, 14.3; ASR, 7.0), stomach (CR, 11.7; ASR, 5.7), liver (CR, 10.8; ASR, 5.6), and pancreas (CR, 9.1; ASR, 4.5).

Fig. 3 shows the age-specific predicted mortality rates of the selected cancers for males and females in 2013. When examined by age, Korean males ≥60 years of age are expected to have the highest mortality rates from lung cancer. In contrast, Korean females ≥55 years of age are expected to have the highest mortality rates from breast cancer, followed by lung cancer.

Conclusion

This report provides estimated nationwide cancer incidence and mortality in Korea for the current year. In total, 247,732 new cancer cases and 74,179 cancer deaths are expected in Korea during 2013. In Korean males, gastric, colorectal, lung, liver, and prostate cancers are estimated to have the highest incidences, while lung, liver, colorectal,

gastric, and pancreatic cancers are estimated to be the most common causes of cancer-related deaths. In Korean females, thyroid, breast, colorectal, gastric, and lung cancer are estimated to have the highest incidences, while lung, colorectal, gastric, liver, and pancreatic cancers are estimated to be the most common causes of cancer-related deaths.

Cancer has become an important public health concern in Korea, and as the population continues to age, the cancer burden will continue to increase. The estimated cancer statistics for the current year given in this report represent an important resource for planning and evaluating cancer-control programs. The estimates in this report, however, are projected numbers based on statistical models and 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.

Acknowledgments

References

1. Statistics Korea [Internet]. Daejeon: Statistics Korea; 2013 [cited 2013 Jan 4]. Available from: http://kostat.go.kr.
2. Ministry of Health and Welfare. 2010 Annual report of cancer statistics in Korea. Seoul: Ministry of Health and Welfare; 2012.
3. Jung KW, Park S, Kong HJ, Won YJ, Lee JY, Seo HG, et al. Cancer statistics in Korea: incidence, mortality, survival, and prevalence in 2009. Cancer Res Treat. 2012;44:11-24.
4. Shin HR, Won YJ, Jung KW, Kong HJ, Yim SH, Lee JK, et al. Nationwide cancer incidence in Korea, 1999~2001; first result using the national cancer incidence database. Cancer Res Treat. 2005;37:325-31.
5. Fritz A, Percy C, Jack A, Shanmugaratnam K, Sobin L, Parkin DM, et al. International classification of diseases for oncology. 3rd ed. Geneva: World Health Organization; 2000.
6. World Health Organiztion. International statistical calssification of diseases and related health problems. 10th rev. Geneva: World Health Organization; 1994.
7. Boyle P, Parkin DM. Statistical methods for registries. In: Jensen OM, Parkin DM, MacLennan R, Muir CS, Skeet RG, editors. Cancer registration: principles and methods. No. 95. Lyon: IARC; 1991. p. 126-58.
8. National Cancer Institute. Joinpoint regression program, version 4.0 [Internet]. Bethesda, MD: National Cancer Institute; 2013 [cited 2013 Jan 4]. Available from: http://surveillance.cancer.gov/joinpoint/.
9. Segi M. Cancer mortality for selected sites in 24 countries (1950-1957). Sendai: Tohoku University School of Medicine; 1960.