



Trends in major cancer mortality in Korea, 1983–2012, with a joinpoint analysis



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ABSTRACT

Background: Cancer is the leading cause of death in Korea. This study aims to examine changes in temporal trends in major cancer mortality.

Materials and methods: Mortality data for 1993–2012 were obtained from the Korean Statistics Information Service (KOSIS) database and age-standardized to the 2000 Korean population. Joinpoint analysis was used to identify significant changes in trends over time. The annual percentage rate change (APC) was computed for each segment of the trends.

Results: The age-standardized mortality rates (ASR) for all cancer sites combined decreased by 9.1% and 1.1% in men and women, respectively, from 1983 to 2012. ASRs from cancers of esophagus, stomach, and liver decreased substantially, whereas ASRs from cancer for all other sites increased markedly. ASRs for all cancer sites combined increased until 1994 and thereafter decreased significantly in both genders except for the period of 1998–2002 (APC: −5.5% for men [$p < 0.05$] and 0.07% for women). ASRs for esophagus and liver cancers increased until the early 1990s and thereafter declined, leading to significant decreases [$p < 0.05$] for esophagus cancer (APC: −1.85% for men and −3.82% for women) and liver cancer (APC: −1.55% for men and −0.56% for women) in 1983–2012. ASRs for stomach cancer declined (APC: −4.06% for men and −4.07% for women) except for 1990–1994. ASRs for uterine cancer peaked in 2003 and then declined (APC: 2.85%). ASRs increased significantly until 2002 for colorectal cancer in men (APC: 7.52%) and lung cancer in both genders. The most consistently upward trend was observed for non-Hodgkin's lymphoma (APC: 3.55% for men and 5.29% for women; number of joinpoints = 0). The greatest ASR increase was seen for prostate cancer for which mortality increased until 2002 at an APC of 12.56%.

Conclusion: While mortality decreased significantly for esophagus, stomach and liver cancers in recent decades in Korea, challenges still remain for many other cancers, especially pancreatic, breast, and prostate cancers and non-Hodgkin's lymphoma. Surveillance of cancer mortality trends can lend valuable insights as to the prevention and control of cancer. Public health promotion efforts to control cancer such as lowering smoking rate and obesity could reduce the burden of cancer in many sites.

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1. Introduction

Cancer is a major public health problem in Korea as in many other parts of the world [1]. The top three leading causes of death in Korea in 2012 were heart diseases, cerebrovascular diseases, and cancer, with cancer causing more deaths than heart and cerebrovascular diseases combined [2]. Cancer has been the

leading cause of death in Korea since 1983, and claimed 73,757 deaths in 2012, which accounted for one in three deaths for men and one in four deaths for women [3]. A previous study examined trends in cancer mortality in Korean men and women who were of target age for the national cancer screening programs using data for 1983–2007 (over 30 years for cervix, over 40 years for stomach, liver, and breast, and over 50 years for colon and rectum) [4]. Therefore, longer-term trends in cancer mortality in the entire Korean population using data for three decades merit investigation. This study aims to analyze temporal trends in major cancer mortality rates in Korea from 1983 to 2012.

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2. Material and methods

2.1. Data

Mortality data for 1983–2012 were obtained from the *Korean Statistics Information Service (KOSIS)* database [5]. The causes of death in the KOSIS database were coded and classified according to the *International Classification of Diseases, tenth revision (ICD-10)* codes. 13 major causes of cancer death were identified based on 2012 mortality statistics. The ICD-10 codes used for the causes of cancer death were C15 for esophageal cancer, C16 for stomach cancer, C18–C21 for colon and rectum cancer, C22 for liver cancer, C25 for pancreatic cancer, C33–C34 for lung and bronchus (lung) cancer, C50 for breast cancer, C53–C55 for uterine cancer, C61 for prostate cancer, C67 for urinary bladder cancer, C71 for brain cancer, C82–C85 for non-Hodgkin's lymphoma, and C91–C95 for leukemia. Overall cancer was defined as cancer at any site (C00–C97). Crude cancer mortality rates were computed and age-standardized to account for the aging of the population using the 2010 Korean population as the standard population [6].

In Korea, the death certificate is mostly issued by a licensed physician [7]. The immediate cause of death is a direct injury or complication, and the underlying cause of death is the disease having a medically causal relationship with the immediate cause of death. For example, if a person dies with esophageal varix bleeding complicated by liver cancer, the immediate cause of death is esophageal varix bleeding and the underlying cause of death is liver cancer.

2.2. Statistical analysis

We used joinpoint regression analysis to identify the years when there were significant changes in the age-standardized mortality rates. Joinpoint regression analysis fits a series of joined straight lines to the age-standardized mortality rates on a logarithmic scale [8]. Straight line segments are joined at “joinpoints” where mortality trend changes its slope statistically significantly. The number of joinpoints started from 0 and was increased to test if the addition of joinpoints improved the fitness of model significantly. Analysis started with 0 and tested for model fit with a maximum of 5 joinpoints. The slope of each line segment of the best-fitting model was expressed as the annual percentage rate change (APC) in the age-standardized mortality rate (ASR).

Significance tests were performed using the Monte Carlo permutation technique (two-sided $P < 0.05$). The best-fitting model was estimated separately for men and women. The Joinpoint Regression Program version 4.1.0 (US National Cancer Institute, Bethesda, MD, USA) was used for the statistical analysis. Approval from the institutional review board was not required for this study.

3. Results

Table 1 describes the number of deaths, crude death rates, and ASRs for major cancer sites in men and women in 1983–2012. The overall cancer mortality rates for all sites combined decreased by 9.1% and 1.1% in men and women, respectively, from 1983 to 2012. ASR % change, however, differed by site. ASRs from cancers of esophagus, stomach, and liver decreased substantially, whereas ASRs from cancer for all other sites increased markedly from 1983 to 2012. The highest increase in ASRs was observed for prostate cancer at 1053.3%. Colorectal cancer, pancreatic cancer, and non-Hodgkin's lymphoma all had over 200% increases in ASRs in both men and women. The lowest increase in ASRs was observed for leukemia at 30% and 38.1% for women and men, respectively.

Tables 2 and 3 summarize the results of joinpoint analyses for men and women, respectively. ASRs for all cancers sites combined increased until 1994 and thereafter decreased significantly in both genders except for the period of 1998–2002 (APC: –5.5% for men and 0.07% for women). In particular, ASRs from esophagus cancer increased from 1983 to 1993 among men and thereafter decreased significantly. Similarly, ASRs from liver cancer also showed an upward trend from 1983 to 1994 followed by significant declines except for the period of 1998–2002 (APC: –1.55% for men and –0.56% for women). ASRs from stomach cancer showed downward trends from 1983 to 2012 except for 1991–1994 in men and for 1990–1993 in women. ASRs from colorectal cancer, on the other hand, increased until 2002 in men and until 2004 in women and leveled off (APC: 4.25% for men and 4.01% for women). ASRs from pancreatic cancer also increased at a marked rate from 1983 to 1994 (APC until 1994: 9.82% for men and 12.57% for women), but the rate of increase slowed thereafter. ASRs from lung cancer increased at a rapid rate until 1993 in men and until 1994 in women (APC: 9.83% for men and 8.98% for women) and then at a slower rate until 2002 when they started to decrease.

ASRs from prostate cancer increased at an APC of 12.56% from 1983 to 2002 and thereafter leveled off. ASRs from breast cancer

Table 1
Crude and age-standardized death rates for major cancers in Korean men and women, 1983–2012.

Site	Men							Women						
	1983			2012				1983			2012			
	Deaths ^a	CDR ^b	ASR ^c	Deaths ^a	CDR ^b	ASR ^c	ASR % Change ^d	Deaths ^a	CDR ^b	ASR ^c	Deaths ^a	CDR ^b	ASR ^c	ASR % Change ^d
All sites	17,789	88.4	187.7	46,462	185.6	170.7	–9.1	10,998	55.6	102.78	27,297	109.3	101.7	–1.1
Esophagus	559	2.8	6.4	1,278	5.1	4.7	–26.8	121	0.6	1.19	120	0.5	0.4	–63.0
Stomach	7,566	37.6	83.5	6,090	24.3	22.4	–73.2	4,579	23.1	45.32	3,252	13.0	12.1	–73.3
Colon & Rectum	340	17.0	3.6	4,692	18.7	17.6	371.4	326	1.6	3.21	3,506	14.0	12.9	302.2
Liver	4,801	23.9	48.6	8,494	33.9	34.0	–30.0	1,583	8.0	15.13	2,841	11.4	12.6	–16.8
Pancreas	236	1.2	2.5	2,616	10.4	9.6	287.1	160	0.8	1.61	2,162	8.7	8.0	398.1
Lung	1,659	8.2	18.4	12,171	48.6	44.4	142.1	684	3.5	6.52	4,476	17.9	16.5	153.4
Breast	–	–	–	–	–	–	–	408	2.1	3.51	1,993	8.0	7.6	117.4
Uterine	–	–	–	–	–	–	–	1421	7.2	12.4	1219	4.9	5.4	–56.8
Prostate	29	0.1	0.5	1,460	5.8	5.2	1053.3	–	–	–	–	–	–	–
Bladder	120	0.6	1.5	918	3.7	3.3	125.3	36	0.2	0.36	303	1.2	1.1	202.8
Brain	130	0.6	1.0	588	2.3	2.3	134.0	84	0.4	0.6	545	2.2	2.3	314.3
Non-Hodgkin's lymphoma	139	0.7	1.2	927	3.7	3.8	221.8	75	0.4	0.6	598	2.4	2.7	339.3
Leukemia	489	2.4	2.5	919	3.7	3.5	38.1	428	2.2	2.20	747	3.0	2.9	30.0

^a Number of deaths.

^b Crude death rates (per 100,000).

^c Age-standardized death rates adjusted to the 2010 Korean standard population (per 100,000).

^d Percentage of the 1983 rate.

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