ORIGINAL ARTICLE
Medicine General & Social Medicine

JKMS

http://dx.doi.org/10.3346/jkms.2014.29.12.1597 • J Korean Med Sci 2014; 29: 1597-1603

Trends in the Leading Causes of Death in Korea, 1983-2012

Daroh Lim,[1] Mina Ha,[2,3] and Inmyung Song[4]

[1]Center for Health Industry Information and Statistics, Bureau of Health Industry Policy, Korea Health Industry Development Institute, Cheongju; [2]Department of Health Infrastructure Development, Bureau of Health Technology R&D Planning and Budget Management, Korea Health Industry Development Institute, Cheongju; [3]Department of Preventive Medicine, Dankook University College of Medicine, Cheonan; [4]Department of Pharmaceutical Industry, Bureau of Health Industry Promotion, Korea Health Industry Development Institute, Cheongju, Korea

Received: 31 August 2014
Accepted: 3 November 2014

Address for Correspondence:
Inmyung Song, PhD
Korea University Biomedical Engineering Research Center, 125 Osongsaengmyeong 2-ro, Heungdeock-gu, Cheongju 363-951, Korea
Tel: +82.10-3715-3975, Fax: +82.43-710-0001
E-mail: inmyungs@gmail.com

This study aimed to analyze trends in the 10 leading causes of death in Korea from 1983 to 2012. Death rates were derived from the Korean Statistics Information Service database and age-adjusted to the 2010 population. Joinpoint regression analysis was used to identify the points when statistically significant changes occurred in the trends. Between 1983 and 2012, the age-standardized death rate (ASR) from all causes decreased by 61.6% for men and 51.2% for women. ASRs from malignant neoplasms, diabetes mellitus, and transport accidents increased initially before decreasing. ASRs from hypertensive diseases, heart diseases, cerebrovascular diseases and diseases of the liver showed favorable trends (ASR % change: -94.4%, -53.8%, -76.0%, and -78.9% for men, and -77.1%, -36.5%, -67.8%, and -79.9% for women, respectively). ASRs from pneumonia decreased until the mid-1990s and thereafter increased. ASRs from intentional self-harm increased persistently since around 1990 (ASR % change: 122.0% for men and 217.4% for women). In conclusion, death rates from all causes in Korea decreased significantly in the last three decades except in the late 1990s. Despite the great strides made in the overall mortality, temporal trends varied widely by cause. Mortality trends for malignant neoplasms, diabetes mellitus, pneumonia and intentional self-harm were unfavorable.

Keywords: Mortality; Cause of Death; Trend; Joinpoint; Korea

INTRODUCTION

Mortality has steadily declined in Korea since the mid-1950s (1). Despite the favorable trend in the overall mortality, however, understanding cause-specific death rates and their temporal trends would shed some light on the areas for improvement in developing health care and disease prevention programs. The 10 leading causes of death in Korea accounted for 70.5% of total deaths in 2012 and were malignant neoplasms, heart diseases, cerebrovascular diseases, intentional self-harm, diabetes mellitus, pneumonia, chronic lower respiratory diseases, diseases of the liver, transport accidents, and hypertensive diseases (2). The purpose of this study is to analyze trends in the 10 leading causes of death in Korea from 1983 to 2012 using a joinpoint regression analysis (3-5).

MATERIALS AND METHODS

Data

Death rates in Korea from 1983 to 2012 were derived from the Korean Statistics Information Service (KOSIS) database (6). The causes of death in KOSIS data were classified according to the *International Classification of Diseases, tenth revision, clinical modification* (ICD-10-CM) codes. The ICD-10 codes used for the 10 leading causes of death based on 2012 mortality were C00-C97 for malignant neoplasms, E10-E14 for diabetes mellitus, I00-I13 for hypertensive diseases, I20-I51 for heart diseases, I60-I69 for cerebrovascular diseases, J12-J18 for pneumonia, J40-J47 for chronic lower respiratory diseases, K70-K76 for diseases of the liver, V01-V99 for transport accidents, and X60-X84 for intentional self-harm. The age-standardized death rates (ASR) for all causes and the 10 leading causes of death were calculated to account for the aging of the population using the 2010 Korean standard population (7).

Statistical analysis

To pursue the objective of this study, we adopted joinpoint regression analysis. The joinpoint regression model was developed to identify the occurrence of changes in trends in distinct periods of time rather than a single summary statistic for the whole interval. Joinpoint regression analysis detects when a significant change in trend occurs and thus provides a much clear picture of what is happening during a given period (8). Therefore, we used joinpoint regression analysis to estimate the number of the "joinpoints" where mortality trend changes its slope statistically significantly and to identify the years when the significant changes occurred. Joinpoint regression selects the optimal model using three different methods: the sequence of permutation

pISSN 1011-8934
eISSN 1598-6357

tests, Bayesian information criterion (BIC), and modified BIC which was proposed to improve the performance of the traditional BIC method. As a result, the finally selected model is the most parsimonious model that best fits data (8). The number of joinpoints started from 0 and was increased to test if the addition of joinpoints improved the fitness of model significantly. No maximum number of joinpoints was set. The best-fitting model was estimated separately for men and women. The annual percent rate change (APC) was calculated for each segment of the best-fitting model using generalized linear models that assumed the Poisson distribution. The APC was tested to determine whether it was significantly different from the null hypothesis of no change (0%). The statistical power to determine if an APC is different from 0 is a function of the length of the interval, potentially rendering a short segment rising at a steep rate statistically insignificant. Significance tests were performed using a Monte Carlo permutation technique (two-sided $P < 0.05$). The Joinpoint Regression Program version 4.1.4 (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 as it analyzed the anonymised data made publicly available.

RESULTS

Table 1 summarizes the trends in overall and cause-specific death rates for the 10 leading causes of death of Korean men and women from 1983 to 2012. ASR from all causes combined was 638.8 deaths per 100,000 men and 587.5 per 100,000 women in 2012, representing decreases of 61.6% and 51.2%, respectively, over the 30-yr study period. Only 2 joinpoints were identified for the overall death rates. ASR from all causes combined has steadily and significantly declined in both genders except for the period of 1998-2001.

Temporal trends in ASR for the 10 leading causes of death varied by cause of death and by gender (Tables 2, 3, and Fig. 1). ASRs from malignant neoplasms in both genders increased until 1994 and thereafter declined except for the period of 1998-2002. ASRs from diabetes mellitus increased up to 2003 and 2002 for men and women, respectively, but thereafter declined at a significant

Table 1. Crude and age-standardized death rates for the 10 leading causes of death in Korean men and women, 1983-2012

Causes of death	Men							Women						
	1983			2012			ASR % Change§	1983			2012			ASR % Change§
	Deaths*	CDR†	ASR‡	Deaths*	CDR†	ASR‡		Deaths*	CDR†	ASR‡	Deaths*	CDR†	ASR‡	
All causes	148,101	735.8	1,665.6	147,372	588.6	638.8	-61.6	106,462	538.2	1,203.4	119,849	480.1	587.5	-51.2
Malignant neoplasms	17,789	88.4	187.7	46,462	185.6	170.7	-9.1	10,998	55.6	102.8	27,297	109.3	101.7	-1.1
Diabetes mellitus	1,050	5.2	11.1	5,849	23.4	21.3	91.8	757	3.8	7.5	5,708	22.9	20.8	176.0
Hypertensive diseases	11,561	57.4	138.5	1,620	6.5	7.7	-94.4	7,313	37.0	84.0	3,619	14.5	19.2	-77.1
Heart diseases	10,565	52.5	112.3	13,058	52.1	51.9	-53.8	8,435	42.6	91.7	13,384	53.6	58.3	-36.5
Cerebrovascular diseases	14,749	73.3	186.7	12,380	49.4	44.8	-76.0	12,173	61.5	149.4	13,364	53.5	48.2	-67.8
Pneumonia	2,338	11.6	15.7	5,203	20.8	18.4	16.9	2,093	10.6	12.4	5,111	20.5	17.9	44.2
Chronic lower respiratory diseases	2,262	11.2	32.3	4,844	19.3	17.1	-47.0	1,979	10.0	26.0	2,987	12.0	10.5	-59.5
Diseases of the liver	9,770	48.5	95.9	5,364	21.4	20.2	-78.9	2,793	14.1	26.6	1,429	5.7	5.4	-79.9
Transport accidents	3,524	16.2	21.3	4,785	19.1	18.4	-13.6	1,067	5.4	6.6	1,717	6.9	6.6	-0.6
Intentional self-harm	2,554	12.7	16.7	9,622	38.4	37.1	122.2	917	4.6	5.6	4,538	18.2	17.7	217.4

*Number of deaths; †CDR, crude death rates (per 100,000); ‡ASR, age-standardized death rates adjusted to the 2010 Korean standard population (per 100,000); §The difference between the 2012 and 1983 rates expressed as percentage of the 1983 rate.

Table 2. Trends in age-standardized death rates of the 10 leading causes of death in Korean men according to joinpoint analysis, 1983-2012*

Causes of death	APC 1983-2012	Trend 1		Trend 2		Trend 3		Trend 4		Trend 5		Trend 6	
		Period	APC	Period	APC	Period	APC	Period	APC	Period	APC	Period	APC
All causes	-2.93†	1983-1998	-3.75†	1998-2001	2.37	2001-2012	-3.92†						
Malignant neoplasms	-0.55†	1983-1991	2.00†	1991-1994	4.54†	1994-1998	-2.78†	1998-2002	1.00	2002-2012	-3.06†		
Diabetes mellitus	0.50	1983-1985	18.37	1985-1988	-1.62	1988-1993	15.56†	1993-2003	1.50†	2003-2009	-7.87†	2009-2012	-0.77
Hypertensive diseases	-10.71†	1983-1987	-8.59†	1987-1991	-13.31†	1991-1994	-5.33	1994-1998	-30.59†	1998-2001	12.60	2001-2012	-6.50†
Heart diseases	-2.92†	1983-2004	-3.56†	2004-2012	-0.51								
Cerebrovascular diseases	-4.33†	1983-1991	-4.40†	1991-1994	7.00†	1994-1997	-8.55†	1997-2002	-2.79†	2002-2012	-8.77†		
Pneumonia	1.11†	1983-1995	-4.92†	1995-2000	12.31†	2000-2003	-14.59	2003-2012	7.43†				
Chronic lower respiratory diseases	-1.54†	1983-1990	-5.93†	1990-1994	14.39†	1994-1998	-8.72†	1998-2002	11.99†	2002-2005	-14.38†	2005-2012	-6.20†
Diseases of the liver	-5.38†	1983-1990	-3.18†	1990-1995	-0.82	1995-1998	-8.85†	1998-2003	-5.66†	2003-2006	-12.51†	2006-2012	-5.80†
Transport accidents	-3.10†	1983-1990	15.02†	1990-1996	1.86	1996-2002	-11.04†	2002-2012	-5.48†				
Intentional self-harm	4.39†	1983-1991	-4.84	1991-1998	12.10†	1998-2012	3.32†						

*APC, annual percent rate change of age-standardized death rate; †The annual percent rate change is significantly different from 0 (two-sided $P < 0.05$).

http://dx.doi.org/10.3346/jkms.2014.29.12.1597

Table 3. Trends in age-standardized death rates of the 10 leading causes of death in Korean women according to joinpoint analysis, 1983-2012*

Causes of death	APC 1983-2012	Trend 1		Trend 2		Trend 3		Trend 4		Trend 5		Trend 6	
		Period	APC	Period	APC	Period	APC	Period	APC	Period	APC	Period	APC
All causes	-1.88†	1983-1998	-3.01†	1998-2001	8.60†	2001-2012	-4.52†						
Malignant neoplasms	0.07	1983-1991	1.06†	1991-1994	6.18†	1994-1998	-2.66†	1998-2002	2.16	2002-2012	-2.12†		
Diabetes mellitus	1.07	1983-1988	5.10†	1988-1993	19.45†	1993-2002	3.76†	2002-2006	-6.26†	2006-2009	-10.21†	2009-2012	-0.07
Hypertensive diseases	-5.16†	1983-1991	-6.90†	1991-1994	1.75	1994-1998	-28.00†	1998-2001	31.07†	2001-2012	-4.90†		
Heart diseases	-2.05†	1983-1988	-5.80†	1988-1993	3.32	1993-1996	-10.40	1996-2010	-1.57†	2010-2012	10.55		
Cerebrovascular diseases	-3.37†	1983-1990	-3.34†	1990-1994	8.56†	1994-1997	-8.66†	1997-2002	-1.37	2002-2012	-9.12†		
Pneumonia	2.50†	1983-1993	-5.83†	1993-2007	3.92†	2007-2012	9.44†						
Chronic lower respiratory diseases	-2.49†	1983-1990	-6.54†	1990-1993	20.22	1993-1999	-6.19†	1999-2002	16.38	2002-2005	-21.47†	2005-2012	-6.17†
Diseases of the liver	-5.19†	1983-1990	-6.15†	1990-1993	4.18	1993-2002	-6.01†	2002-2007	-10.10†	2007-2012	-3.13†		
Transport accidents	-2.99†	1983-1990	16.57†	1990-1995	4.14	1995-2012	-8.02†						
Intentional self-harm	5.97†	1983-1989	-2.61	1989-2009	7.71†	2009-2012	-6.46						

*APC, annual percent rate change of age-standardized death rates; †The annual percent rate change is significantly different from 0 (two-sided $P < 0.05$).

rate until they leveled off in 2009. Overall, ASRs from diabetes mellitus increased by 91.8% for men and 176.0% for women over the entire study period.

ASRs from hypertensive diseases, heart diseases, and cerebrovascular diseases decreased by 94.4%, 53.8% and 76.0% for men and by 77.1%, 36.5%, and 67.8% for women, respectively. ASRs from cerebrovascular diseases declined from 1983 to 1990 and after an increase from 1991 to 1994, continued to decrease. Cerebrovascular diseases, which were the first leading cause of death for women and the second one for men in 1983, ranked as the third leading cause of death in both genders in 2012 following malignant neoplasms and heart diseases.

ASRs from diseases of the liver declined significantly and consistently except for the early 1990s, leading to an overall 78.9% and 79.9% decrease in men and women, respectively. ASRs from pneumonia declined until 1995 for men and 1993 for women only to increase again, leading to overall increases of 16.9% and 44.2% for men and women, respectively. Apart from diabetes mellitus, chronic lower respiratory diseases had the greatest number of joinpoints identified for both men and women (n = 5).

ASRs from transport accidents increased significantly at an APC of 15.0% for men and 16.6% for women between 1983 and 1990, but they started to decline significantly in the mid-1990s. The APC in ASRs from intentional self-harm was 12.1% for men in the period of 1991-1998 and 7.7% for women in the period of 1989-2009, contributing to a 122.2% and 217.4% increase, respectively, over the entire study period.

DISCUSSION

Over the last three decades, crude death rates from all causes in Korea declined. The favorable trends in mortality from all causes became more pronounced when ASRs were examined and were shown to be consistent as evidenced by the number of joinpoints identified (n = 2). The consistently favorable trends in the overall death rate may be attributable to a number of factors including advances in diagnostic and medical technologies, improved access to care due to expansion of health insurance coverage, and the rapidly progressed economy that the country witnessed during the study period. By contrast, the increasing, albeit insignificant, trend in the overall death rate in 1998-2001 may have been caused by the 1997 Asian financial crisis that hit Korea hard.

The generally consistent, favorable trends observed in the overall death rate were not replicated in some cause-specific death rates. Malignant neoplasms were the first leading cause by a narrow margin (1%) for men and the second leading cause of death for women in 1983. ASRs from malignant neoplasms increased to a peak in 1994 and thereafter declined except for a brief ascent from 1998 to 2002. Together, ASRs from malignant neoplasms declined by 9.1% for men whereas it remained virtually unchanged for women since 1983. Despite the significantly downward trend since 2002, however, malignant neoplasms was the first leading cause of death by a wide margin in 2012, due in large part to the remarkable progresses made for other major causes of death such as cerebrovascular diseases. Nevertheless, the downward trend in death rates from malignant neoplasms in the last decade is encouraging, given the significant increase in malignant neoplasms incidence in Korea for the corresponding period (9). Decrease of cancer mortality along with increase of cancer incidence in Japan (3) and Italy (8) in the 1990s was mostly attributed to a number of factors including early detection and treatment, and various public health strategies. The recent decline in cancer mortality in Korea may be explained by decreases in stomach, liver and uterine cancer mortality, due at least in part to the nationwide cancer screening program introduced in 1999 and subsequently expanded (10).

ASRs from diabetes mellitus increased since the mid-1980s up to the early 2000s, showing a similar pattern to mortality in the United States (5, 11). Despite the brief decline in 2002-2003, ASRs from diabetes mellitus more than doubled between 1983 and 2012. Consequently, diabetes mellitus was the second highest increasing cause of death among all causes of death examined in this study, surpassed only by intentional self-harm. The

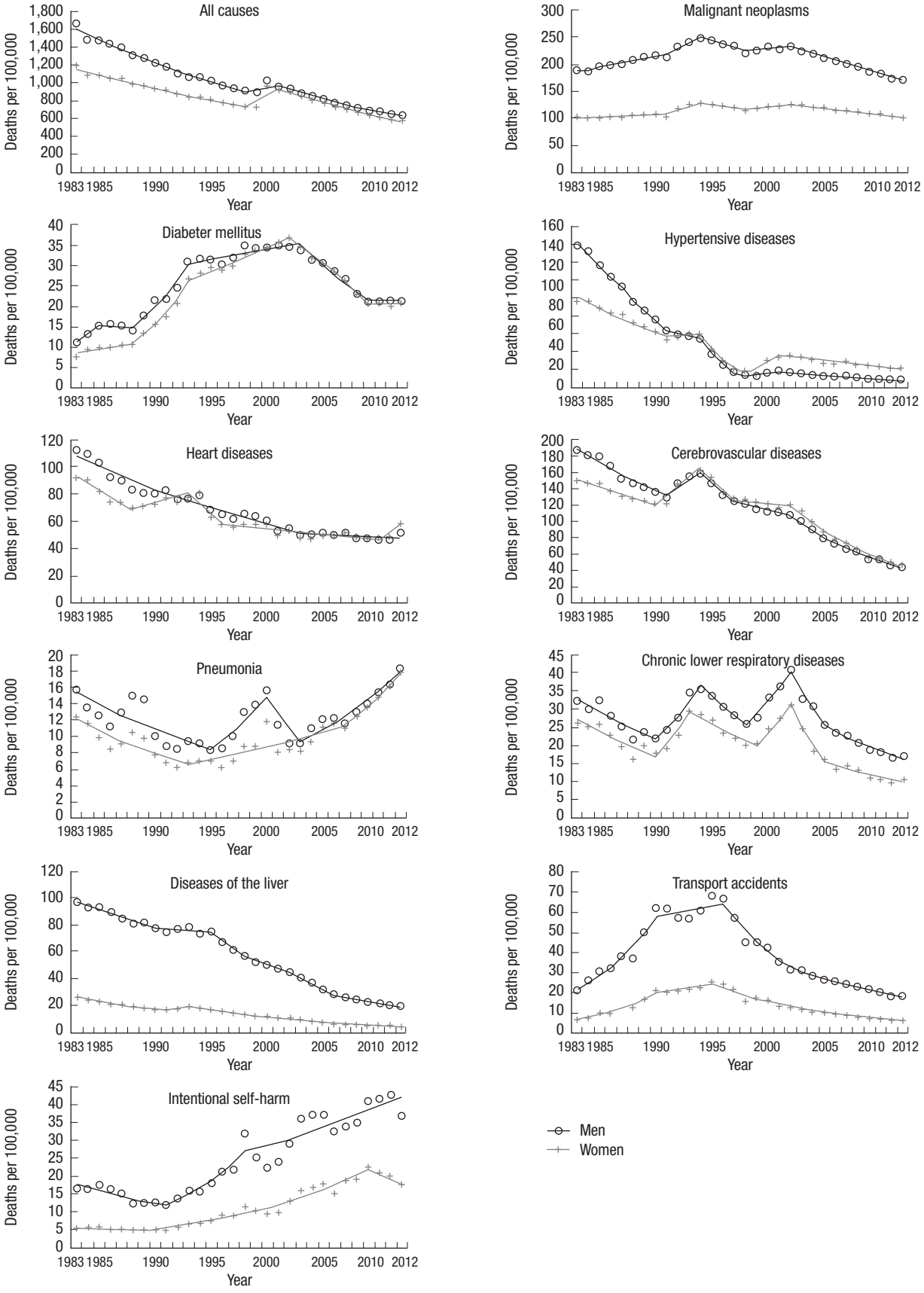

Fig. 1. Trends in age-standardized death rates for the 10 leading causes of death in Korea, 1983-2012. Rates are age-adjusted to the 2010 Korean standard population.

http://dx.doi.org/10.3346/jkms.2014.29.12.1597

steep rise in diabetes mortality may be due to the reported six- to seven- fold increase in the prevalence of diabetes in Korea over the last four decades (12).

ASRs from hypertensive diseases, heart diseases and cerebrovascular diseases decreased significantly during the study period. Especially, ASRs from heart diseases in Korea had been steadily decreasing until recently, except for a spike in women in the mid-1990s. Similarly, a steady and marked decline in death rates from heart diseases was also observed in the United States since 1970 (5, 13), in tandem with continuously improved control of hypertension, a major risk factor for cardiovascular disease (14), and due in part to the use of effective medical and surgical treatments (13). Markedly declining death rates from coronary heart diseases since the 1970s were also observed in Latin America and Europe (14-16). Death rates from cerebrovascular diseases have also decreased consistently and markedly in many countries around the world since the 1960s (14, 16, 17), which was attributed to a decrease in the intake of dietary salt and saturated fat (17).

The most consistently downward trend of death rate was observed in diseases of the liver, resulting in the greatest reduction in mortality among the leading causes of death examined. The favorable trend in mortality from liver diseases in Korea may be ascribed to the declining prevalence of hepatitis B surface antigen (HBsAg) from the 1980s due in no small part to increased hepatitis B vaccination rates (18). Mortality from cirrhosis has shown favorable trends around the world since 1980, due in part to reductions in alcohol consumption and hepatitis B and C virus infections (19, 20). In the United States, however, the favorable trends in death rates from hepatitis B and C virus infections did not continue in the 1990s, although death rates from alcohol-related chronic liver disease declined (21-23). A follow-up analysis of closely investigating the trends in mortality from diseases of the liver by specific cause is needed.

While infectious disease mortality, especially for pneumonia and influenza, was known to fluctuate from year to year, pneumonia remained among the leading causes of illness and death even in the industrialized countries (24, 25). In our analysis, death rates from pneumonia decreased until the mid-1990s and thereafter increased, resulting in overall increases of 16.9% and 44.2% for men and women, respectively. Pneumonia mortality appeared to increase with economic crisis (26). Older people have higher risk of death from infectious diseases including pneumonia than younger people do (25). The resurgence of pneumonia in Korea appears to be attributable to the fact that Korea has the rapidest aging population in the world (27), which distinguishes the country from other countries where ASRs of pneumonia declined in recent decades (28). The finding warrants reinforcement of pneumonia surveillance and control programs in Korea, which could include increasing pneumococcal and influenza vaccination rates as well as a more judicious use of antibiotics (28).

ASRs from chronic lower respiratory diseases declined by around 50% from 1983 to 2012 despite the periodic fluctuations. In the United States, mortality from the diseases has decreased over the last decade although they remained the third leading cause of death in 2010 (29). Moreover, the worldwide death rates from chronic respiratory diseases were projected to decline up to 2020 (30). Chronic lower respiratory diseases are a set of various diseases affecting the lower respiratory tract including asthma, chronic bronchitis, and chronic obstructive pulmonary disease (COPD), suggesting that further research is needed to illuminate the trend. For example, the increasing death rates from COPD in the earlier decades appeared to have stabilized in the 2000s in the United States (5). Death rates from COPD also tended to decline around the world but not in Korea (31, 32).

ASRs from transport accidents in Korea grew at an accelerated pace until the late 1980s and continued to grow, albeit at a slower rate, in the mid-1990s when the rates started to decline. The changing trend may reflect the nation's economic development over the study period. The relationship between economy and transport mortality was reported to be non-linear such that economic development initially would contribute to an increasing number of motor vehicles resulting in more traffic accidents, but further investment in transport infrastructure would decrease deaths from transport accidents (33).

Perhaps, the most alarming mortality trend was observed for intentional self-harm. The rates have increased dramatically and persistently for men since 1991. In fact, the overall percentage increase in the death rates from intentional self-harm for 30 yr was the highest among all the leading causes of death examined. Consequently, suicide mortality now surpasses the death rates from diabetes, pneumonia and liver disease, highlighting urgency with which increasing suicide mortality should be addressed.

Suicide rates were reported to increase in times of economic crisis in respective countries (26, 34). The impact of changes in economy, employment and other socioeconomic factors on suicide rates may have been greater among men in recent decades (35). The 2008 global economic crisis increased suicide rates disproportionately more among men in many countries (36). In the present study, however, from the ASR % change for intentional self-harm over 30 yr was shown to be higher for women while their ASRs stayed consistently lower throughout the period, compared with men. The finding might be a sign that women who had the comparatively low suicide mortality three decades earlier were catching up with men. Similarly, there were substantial differences between genders in death rates from malignant neoplasms, diseases of the liver, and transport accidents, but the disparities tended to narrow in recent years. In other countries, diverging temporal trends between genders were reported for stroke and COPD mortality (37, 38).

To our knowledge, this study is the first to statistically test the long-term trends in the leading causes of death in Korea. Nonetheless, the findings of this study should be interpreted with caution in light of the following limitations. First, the data source used in this study may be subject to potential misclassification of causes of death in official death certificates. A previous study noted that the registered causes of death in Korea may be inaccurate: agreement rates between death certificates and medical charts were 80.4% in malignant neoplasms and 76.6% in circulatory diseases in a regional district in 1998 (39). Second, the accuracy of causes of death on death certificates may have evolved over time due to advances in diagnostic techniques, potentially rendering some mortality data incomparable between different time periods. Third, the ICD-9 coding scheme in KOSIS data was replaced with the ICD-10 in 1995, which may have influenced the trends. Previously, it was suggested that changes in temporal pattern of mortality might reflect changes in documentation and diagnostic coding rather than real improvement in survival (40).

In conclusion, death rates from all causes in Korea decreased significantly in both genders in the last three decades except for a period following the economic crisis in the late 1990s. Despite the great strides made in the overall mortality, temporal trends in cause-specific mortality varied widely by cause. Whereas hypertensive diseases, heart diseases, cerebrovascular diseases and diseases of the liver showed favorable trends, malignant neoplasms, diabetes mellitus, pneumonia and intentional self-harm showed unfavorable trends. The persistently high and increasing causes of death should be addressed with the highest priority, and disease surveillance and control systems targeting the diseases should be implemented.

DISCLOSURE

The authors have no conflicts of interest to disclose.

ORCID

Daroh Lim *http://orcid.org/0000-0001-7016-1983*
Mina Ha *http://orcid.org/0000-0003-1011-9446*
Inmyung Song *http://orcid.org/0000-0001-7772-6617*

REFERENCES

1. Park KA. *Recent trends and patterns of mortality in Korea. Dev Soc 1998; 27: 67-81.*
2. Statistics Korea. *Annual report on the causes of death statistics. Daejon: Statistics Korea, 2012.*
3. Qiu D, Katanoda K, Marugame T, Sobue T. *A Joinpoint regression analysis of long-term trends in cancer mortality in Japan (1958-2004). Int J Cancer 2009; 124: 443-8.*
4. Oliver SE, May MT, Gunnell D. *International trends in prostate-cancer mortality in the "PSA ERA". Int J Cancer 2001; 92: 893-8.*
5. Jemal A, Ward E, Hao Y, Thun M. *Trends in the leading causes of death in the United States, 1970-2002. JAMA 2005; 294: 1255-9.*
6. Korean Statistical Information Service. *KOSIS Statistical Database. Available at http://kosis.kr/eng/statisticsList/statisticsList_01List.jsp?vwcd=MT_ETITLE&parmTabId=M_01_01 [accessed on 15 March 2014].*
7. Statistics Korea. *Population Projections for Korea : 2010-2060. Daejon: Statistics Korea, 2012.*
8. Kim HJ, Fay MP, Feuer EJ, Midthune DN. *Permutation tests for joinpoint regression with applications to cancer rates. Stat Med 2000; 19: 335-51.*
9. Jung KW, Park S, Kong HJ, Won YJ, Boo YK, Shin HR, Park EC, Lee JS. *Cancer statistics in Korea: incidence, mortality and survival in 2006-2007. J Korean Med Sci 2010; 25: 1113-21.*
10. Jung KW, Shin HR, Kong HJ, Park S, Won YJ, Choi KS, Park EC. *Long-term trends in cancer mortality in Korea (1983-2007): a joinpoint regression analysis. Asian Pac J Cancer Prev 2010; 11: 1451-7.*
11. Choi YJ, Cho YM, Park CK, Jang HC, Park KS, Kim SY, Lee HK. *Rapidly increasing diabetes-related mortality with socio-environmental changes in South Korea during the last two decades. Diabetes Res Clin Pract 2006; 74: 295-300.*
12. Kim DJ. *The epidemiology of diabetes in Korea. Diabetes Metab J 2011; 35: 303-8.*
13. Ford ES, Ajani UA, Croft JB, Critchley JA, Labarthe DR, Kottke TE, Giles WH, Capewell S. *Explaining the decrease in U.S. deaths from coronary disease, 1980-2000. N Engl J Med 2007; 356: 2388-98.*
14. T. *R, Malvezzi M, Chatenoud L, Bosetti C, Levi F, Negri E, La Vecchia C. Trends in mortality from coronary heart and cerebrovascular diseases in the Americas: 1970-2000. Heart 2006; 92: 453-60.*
15. Nichols M, Townsend N, Scarborough P, Rayner M. *Trends in age-specific coronary heart disease mortality in the European Union over three decades: 1980-2009. Eur Heart J 2013; 34: 3017-27.*
16. Levi F, Lucchini F, Negri E, La Vecchia C. *Trends in mortality from cardiovascular and cerebrovascular diseases in Europe and other areas of the world. Heart 2002; 88: 119-24.*
17. Sarti C, Rastenyte D, Cepaitis Z, Tuomilehto J. *International trends in mortality from stroke, 1968 to 1994. Stroke 2000; 31: 1588-601.*
18. Lee DH, Kim JH, Nam JJ, Kim HR, Shin HR. *Epidemiological findings of hepatitis B infection based on 1998 National Health and Nutrition Survey in Korea. J Korean Med Sci 2002; 17: 457-62.*
19. Bosetti C, Levi F, Lucchini F, Zatonski WA, Negri E, La Vecchia C. *Worldwide mortality from cirrhosis: an update to 2002. J Hepatol 2007; 46: 827-39.*
20. Perz JF, Armstrong GL, Farrington LA, YJ. *H, Bell BP. The contributions of hepatitis B virus and hepatitis C virus infections to cirrhosis and primary liver cancer worldwide. J Hepatol 2006; 45: 529-38.*
21. Vong S, Bell BP. *Chronic liver disease mortality in the United States, 1990-1998. Hepatology 2004; 39: 476-83.*
22. Ly KN, Xing J, Klevens RM, Jiles RB, Ward JW, Holmberg SD. *The increasing burden of mortality from viral hepatitis in the United States between 1999 and 2007. Ann Intern Med 2012; 156: 271-8.*
23. Wise M, Bialek S, Finelli L, Bell BP, Sorvillo F. *Changing trends in hepatitis C-related mortality in the United States, 1995-2004. Hepatology 2008; 47: 1128-35.*
24. Mokdad AH, Marks JS, Stroup DF, Gerberding JL. *Actual causes of death*

 http://dx.doi.org/10.3346/jkms.2014.29.12.1597

in the United States, 2000. JAMA 2004; 291: 1238-45.
25. Trotter CL, Stuart JM, George R, Miller E. *Increasing hospital admissions for pneumonia, England. Emerg Infect Dis 2008; 14: 727-33.*
26. Khang YH, Lynch JW, Kaplan GA. *Impact of economic crisis on cause-specific mortality in South Korea. Int J Epidemiol 2005; 34: 1291-301.*
27. Howe N, Jackson R, Nakashima K. *The aging of Korea: demographics and retirement policy in the Land of the Morning Calm Washington, DC: Center for Strategic and International Studies, Global Aging Initiative, 2007.*
28. Ruhnke GW, Coca-Perraillon M, Kitch BT, Cutler DM. *Marked reduction in 30-day mortality among elderly patients with community-acquired pneumonia. Am J Med 2011; 124: 171-8.e1.*
29. Murphy SL, Xu J, Kochanek KD. *Deaths: final data for 2010. Natl Vital Stat Rep 2013; 61: 1-117.*
30. Mathers CD, Loncar D. *Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med 2006; 3: e442.*
31. López-Campos JL, Ruiz-Ramos M, Soriano JB. *COPD mortality rates in Andalusia, Spain, 1975-2010: a joinpoint regression analysis. Int J Tuberc Lung Dis 2013; 17: 131-6.*
32. Tan WC, Seale P, Ip M, Shim YS, Chiang CH, Ng TP, Abisheganadan J, Charoenratanakul S, DeGuia T, Mahayiddin A, et al. *Trends in COPD mortality and hospitalizations in countries and regions of Asia-Pacific. Respirology 2009; 14: 90-7.*
33. van Beeck EF, Borsboom GJ, Mackenbach JP. *Economic development and traffic accident mortality in the industrialized world, 1962-1990. Int J Epidemiol 2000; 29: 503-9.*
34. Gunnell D. *Time trends and geographic differences in suicide: implications for prevention. In: Hawton K. editor. Prevention and treatment of suicidal behavior: from science to practice: Oxford, UK: Oxford University Press, 2005.*
35. Chang SS, Gunnell D, Sterne JA, Lu TH, Cheng AT. *Was the economic crisis 1997-1998 responsible for rising suicide rates in East/Southeast Asia? A time-trend analysis for Japan, Hong Kong, South Korea, Taiwan, Singapore and Thailand. Soc Sci Med 2009; 68: 1322-31.*
36. Chang SS, Stuckler D, Yip P, Gunnell D. *Impact of 2008 global economic crisis on suicide: time trend study in 54 countries. BMJ 2013; 347: f5239.*
37. Carandang R, Seshadri S, Beiser A, Kelly-Hayes M, Kase CS, Kannel WB, Wolf PA. *Trends in incidence, lifetime risk, severity, and 30-day mortality of stroke over the past 50 years. JAMA 2006; 296: 2939-46.*
38. Lopez AD, Shibuya K, Rao C, Mathers CD, Hansell AL, Held LS, Schmid V, Buist S. *Chronic obstructive pulmonary disease: current burden and future projections. Eur Respir J 2006; 27: 397-412.*
39. Chung EK, Shin HY, Shin JH, Nam HS, Ryu SY, Im JS, Rhee JA. *Accuracy of the registered cause of death in a county and its related factors. Korean J Prev Med 2002; 35: 153-9.*
40. Lindenauer PK, Lagu T, Shieh MS, Pekow PS, Rothberg MB. *Association of diagnostic coding with trends in hospitalizations and mortality of patients with pneumonia, 2003-2009. JAMA 2012; 307: 1405-13.*