Introduction

Statistics Korea has published an annual report on the cause-of-death statistics of the Korean population since 1982. The first report, published in 1982, dealt with causes of death in 1980. Analyses of the cause-of-death data from 2003 to 2014 are available at the homepage of Statistics Korea [1]. Although this resource is easily accessible to the public, it is difficult to cite the data since the report is in Korean, making it difficult for foreigners to access. Therefore, the editor of the Journal of the Korean Medical Association and the corresponding staff of Statistics Korea discussed the publication of these data in the journal in December 2015, and agreed to jointly author an article in English drawing on the cause-of-death data from 2014, which was made available on the journal’s website on February 11, 2016.

This article presents recent trends and statistical indicators related to mortality in the Republic of Korea by analyzing the 2014 cause-of-death statistics. Specifically, we assessed the number of deaths, the crude death rate, the ranking of causes of death, and trends in the death rate from the major causes of death. Causes of death were classified according to the International Statistical Classification of Diseases and Related Health Problems, 10th revision, as recommended by the World Health Organization. In order to determine the ranking of causes of death, Statistics Korea used the selection list of 56 causes of death from the 80 causes of death list for tabulation mortality statistics recommended by World Health Organization to better fit the Korean situation. The 10 leading causes of death were, in order, cancer, heart disease, cerebrovascular disease, suicide, pneumonia, diabetes mellitus, chronic lower respiratory disease, liver disease, transport accidents, and hypertensive diseases. The top 10 causes of death accounted for 70.5% of all Korean deaths. The ranking of cancer types as causes of death was lung, liver, stomach, colon, and pancreatic cancer. Death rates for heart disease increased from the third in 2013 to the second leading cause in 2014 and the rank of pneumonia moved up from the sixth in 2013 to the fifth in 2014. The mortality rate due to stomach cancer has decreased continuously over time. This finding may reflect changes in Korean society involving population structure, epidemiological patterns, and lifestyles, including dietary habits.

Key Words: Neoplasms; Cardiovascular diseases; Cause of death; Heart diseases; Korea
publically available in September 2015. This is the first effort between these two organizations to facilitate the wider propagation of this valuable information.

The annual reporting of cause-of-death statistics is a duty of the governments of World Health Organization (WHO) member countries, and the Korean government has fulfilled this duty. These statistics are important because they can provide a basis for national demographic and health care policies by identifying the number, causes, and geographical distribution of deaths. The distribution of causes of death in the Korean population is of interest not only for members researchers, and the government, but also for policymakers and researchers worldwide, because Korea is undergoing economic and demographic changes at an unusually rapid rate. Examining the corresponding changes in the causes of death in the Korean population may provide some insights regarding how to cope with issues of public health and welfare in developing countries as well as in other Organization for Economic Co-operation and Development countries.

Beginning in 2000, cause of death statistics has provided regional figures along with nation-wide data. However, in this article, only nation-wide data are presented and discussed. This article presents the recent trends and statistical indicators related to death by analyzing the cause-of-death statistics in 2014. In particular, we analyzed the number of deaths, the crude death rate, the ranking of causes of death, and trends in the death rate from the major causes of death.

Methods

Cause-of-death statistics were collected based on the Statistics Act and Act on the Registration, etc. of Family Relationships (http://elaw.klri.re.kr). Statistics Korea collected data from death certificates issued for deaths in 2014 filed in local administration offices. When death occurs, family should submit the death report form with death medical certificate issued by physicians to local offices. The present data reflect an analysis of death certificates issued up to April 30, 2015 for deaths from January 1, 2014 to December 31, 2014 [1]. In order to compare the data internationally, the causes of death were classified according to the International Statistical Classification of Diseases and Related Health Problems, 10th revision, as recommended by the WHO, as well as the KCD-6 (Korean Standard Classification of Diseases and Causes of Death), which has been modified to fit circumstances in Korea [2,3]. In order to determine the ranking of causes of death, Statistics Korea used the selection list of 56 causes of death from the 80 causes of death list for tabulation mortality statistics recommended by WHO to better fit the Korean situation. A variety of cancers (malignant neoplasms) were integrated into the single item of cancer [1]. Descriptive analysis was performed.

Results

1. Number of deaths and crude death rate

The total number of deaths was 267,692, which was an increase of 1,435 (0.5%) from 2013. The number of deaths has continually increased over the last 20 years (Figure 1, Table 1). The number of deaths among men was 147,321, which was an increase of 722 (0.5%) from 2013. The number of deaths among women was 120,371, which was an increase of 713 (0.6%) from 2013. More precise information on the death rate is available in Supplementary Tables 1 and 2.

The crude death rate (number of deaths per 100,000 population) was 527.3, which was an increase of 0.7 (0.1%) compared to the crude death rate observed in 2013 (Table 1). The crude death rate among men was 580.6, which was
The crude death rate among women was 474.1, which was an increase of 0.7 (0.1%) from 2013. The crude death rate among men was 1.22 times higher than among women, and this discrepancy did not change from 2013 (Table 2).

When death numbers were analyzed according to age, increases were observed in the over 80-year-old group (4.4%) and in the 10- to 19-year-old group (2.3%) (Table 2). Deaths in people over 80 years of age accounted for 38.8% of all deaths. In most age groups, the number of deaths in both sexes decreased compared to 2013. However, increases were observed in males aged 0 year (2.4%), men in their fifties (0.2%), men in their eighties or older (5.6%), females aged 10 to 19 years (12.5%), and women in their eighties or older (3.8%). The male-to-female death ratio was 2.88 for people in their fifties, 2.51 for people in their sixties, and 2.37 times for people in their forties.

The death rate according to years of age decreased in all age groups except the 10- to 19-year-old groups (Table 3) due to tragic water transport accident happened in 2014. The male death rate showed the greatest decrease in the 1- to 9-year-old group (-24.0%) and in individuals in their twenties (-6.7%). The female death rate exhibited the greatest decrease among individuals in their twenties (-9.1%) and the 1- to 9-year-old group (-6.4%).

The death rate was higher in men, and in particular, the death rate among men in their fifties was 2.85 times higher than that of women in their fifties. The death rate of women increased with age up to women in their fifties, but then decreased slowly afterwards.
Table 2. Trends of number of deaths of Korean people by sex and age in 2004, 2013, and 2014

| Age (yr) | Total | 0-1 | 1-9 | 10-19 | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 | 80≤ |
|----------|-------|-----|-----|-------|-------|-------|-------|-------|-------|-------|-----|
| Total 2004 | 244,217 | 2,228 | 1,375 | 1,526 | 3,961 | 8,613 | 20,649 | 26,080 | 47,578 | 61,943 | 70,255 |
| 2013 | 266,257 | 1,305 | 595 | 1,084 | 2,782 | 6,273 | 15,270 | 29,754 | 35,696 | 74,130 | 99,332 |
| 2014 | 267,692 | 1,305 | 493 | 1,109 | 2,580 | 5,940 | 14,111 | 29,795 | 35,409 | 72,660 | 103,748 |
| From 2013 Change Percentage change | 1,435 | 0 | -102 | 25 | -202 | -333 | -659 | 41 | -287 | -1,470 | 4,416 |
| 2004 | 135,218 | 1,221 | 814 | 1,021 | 2,667 | 5,927 | 15,319 | 19,510 | 32,470 | 32,273 | 23,994 |
| 2013 | 146,599 | 698 | 352 | 733 | 1,850 | 4,083 | 10,833 | 22,068 | 25,329 | 44,484 | 36,159 |
| 2014 | 147,321 | 715 | 266 | 714 | 1,735 | 3,843 | 10,278 | 22,123 | 25,324 | 44,135 | 38,167 |
| From 2013 Change Percentage change | 722 | 17 | -86 | -19 | -115 | -240 | -555 | 55 | -349 | 2,008 | 5,6 |
| Male 2004 | 108,999 | 1,007 | 561 | 505 | 1,294 | 2,686 | 5,330 | 6,570 | 15,108 | 29,670 | 46,261 |
| 2013 | 119,658 | 607 | 243 | 351 | 932 | 2,190 | 4,437 | 7,686 | 10,367 | 29,646 | 63,173 |
| 2014 | 120,371 | 590 | 227 | 395 | 845 | 2,097 | 4,333 | 7,672 | 10,085 | 28,525 | 65,581 |
| From 2013 Change Percentage change | 713 | -17 | -16 | 44 | -87 | -93 | -104 | -14 | -282 | -1,121 | 2,408 |
| Sex ratio (male/female) 2004 | 1.24 | 1.21 | 1.45 | 2.02 | 2.06 | 2.21 | 2.87 | 2.97 | 2.15 | 1.09 | 0.52 |
| 2013 | 1.23 | 1.15 | 1.45 | 2.09 | 1.98 | 1.86 | 2.44 | 2.87 | 2.44 | 1.50 | 0.57 |
| 2014 | 1.22 | 1.21 | 1.17 | 1.81 | 2.05 | 1.83 | 2.37 | 2.88 | 2.51 | 1.55 | 0.58 |

Unit: person

Table 3. Trends of death rates of Korean people by sex and age in 2004, 2013, and 2014

| Age (yr) | Total | 0-1 | 1-9 | 10-19 | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 | 80≤ |
|----------|-------|-----|-----|-------|-------|-------|-------|-------|-------|-------|-----|
| Total 2004 | 503.7 | 484.1 | 24.4 | 23.1 | 50.3 | 96.8 | 252.1 | 545.0 | 1,306.8 | 3,506.6 | 5,199.5 |
| 2013 | 526.6 | 294.6 | 14.2 | 17.1 | 42.3 | 78.2 | 174.4 | 382.1 | 821.8 | 2,475.5 | 8,906.2 |
| 2014 | 527.3 | 310.2 | 11.8 | 18.2 | 39.2 | 75.7 | 165.8 | 372.4 | 781.7 | 2,358.0 | 8,597.5 |
| From 2013 Change Percentage change | 0.7 | 15.6 | -2.4 | 1.1 | -3.1 | -2.5 | -8.6 | -9.7 | -40.2 | -117.5 | -305.1 |
| 2004 | 556.1 | 510.2 | 27.6 | 29.3 | 66.1 | 130.6 | 367.3 | 817.1 | 1,945.3 | 4,912.6 | 13,134.3 |
| 2013 | 579.8 | 306.9 | 16.2 | 22.1 | 53.8 | 99.9 | 243.3 | 564.5 | 1,209.1 | 3,534.4 | 11,044.8 |
| 2014 | 580.6 | 331.4 | 12.3 | 22.4 | 50.2 | 96.1 | 229.7 | 550.2 | 1,154.1 | 3,380.9 | 10,680.9 |
| From 2013 Change Percentage change | 0.8 | 24.5 | -3.9 | 0.3 | -3.6 | -3.9 | -13.6 | -14.3 | -55.0 | -153.5 | -436.8 |
| Female 2004 | 451.0 | 455.9 | 21.0 | 16.1 | 33.7 | 61.6 | 132.6 | 274.0 | 762.2 | 2,674.1 | 10,404.6 |
| 2013 | 473.4 | 281.7 | 11.9 | 11.7 | 29.7 | 55.7 | 103.1 | 198.2 | 461.1 | 1,707.8 | 8,013.0 |
| 2014 | 474.1 | 287.9 | 11.2 | 13.6 | 27.0 | 54.5 | 99.9 | 192.8 | 431.8 | 1,666.1 | 7,743.3 |
| From 2013 Change Percentage change | 0.7 | 6.3 | -0.8 | 1.9 | -2.7 | -1.2 | -3.2 | -5.5 | -29.3 | -101.6 | -269.6 |
| Sex ratio (male/female) 2004 | 1.23 | 1.12 | 1.32 | 1.81 | 1.96 | 2.12 | 2.77 | 2.98 | 2.54 | 1.84 | 1.26 |
| 2013 | 1.22 | 1.09 | 1.36 | 1.89 | 1.81 | 1.79 | 2.36 | 2.85 | 2.62 | 2.07 | 1.38 |
| 2014 | 1.22 | 1.15 | 1.10 | 1.64 | 1.86 | 1.76 | 2.30 | 2.85 | 2.67 | 2.10 | 1.37 |

Unit: per 100,000 population, %

2. Ranking of causes of death

The mortality rates of the three top causes of death per 100,000 people were 150.9 for cancer, 52.4 for heart disease, and 48.2 for cerebrovascular disease (Table 4). These
three major causes of death (cancer, heart disease, and cerebrovascular disease) accounted for 47.7% of the total mortality rate, which was an increase of 0.3%p from 2013. Within the 10 top causes of death, the rankings of heart disease and pneumonia increased; while those of cerebrovascular disease and diabetes fell. In comparison to 10 years ago (2004), increases were found in the ranking of heart disease (third to second place), suicide (fifth to fourth place), and pneumonia (tenth to fifth place), while decreases were observed in the ranking of cerebrovascular disease (second to third place), diabetes (fourth to sixth place), liver disease (sixth to eighth place), traffic/transit accidents (eighth to ninth place), and hypertensive disorders (ninth to tenth).

The top-ranking cause of death for men was the same as in 2013. In women, rises in the ranking of heart disease (third to second place), pneumonia (fifth to fourth place), and liver disease (eleventh to tenth place) were observed (Figure 2). In both sexes, cancer was the top-ranking cause of death. The mortality rate of men due to cancer was 1.67 times higher than that of women. The top-ranked causes of death were cancer in the 1- to 9-year-old group and the forties or older, transport accidents in the 10- to 19-year-old group, and suicide in individuals in their thirties (Table 5). More detailed information is presented in Supplementary Tables 3 and 4.

3. Trends in the top two causes of death

1) Cancer mortality rate

The mortality rate due to cancer was found to have
increased to 150.9 out of 100,000, which was an increase of 1.9 (1.3%) compared to 2013. The greatest contributions to the mortality rate due to cancer were made by lung cancer (34.4), liver cancer (22.8), and stomach cancer (17.6). The mortality rate of men due to cancer (188.7) was 1.67-fold higher than that of women (113.2) (Table 5).
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Compared to the previous year, mortality due to lung cancer (1.1%) and liver cancer (1.0%) increased, while mortality due to gastric cancer (-3.3 %) decreased (Figure 3). The mortality rate increased by 2.4 in men (1.3%) and 1.4 (1.3%) in women compared to 2013. The major types of cancer among men were lung cancer (50.4), liver cancer (34.0), and stomach cancer (22.7), in comparison to lung cancer (18.3), colo-rectal cancer (14.2), and stomach cancer (12.4) in women. Differences in mortality between men and women were highest in esophageal cancer (10.58 times), liver cancer (2.92 times), and lung cancer (2.75 times).

Individuals in their thirties showed a high mortality rate due to stomach cancer, while individuals in their forties and fifties showed high mortality rates due to liver cancer, and lung cancer took an especially high toll among
Figure 4. (Continuing)
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Age-specific mortality rate trends due to cancers of the stomach, colon, liver, lung, breast, cervix, and prostate are shown in Figure 4. The age-specific mortality rate due to cancer decreased in all age groups in comparison to the rates observed in 2013 except among individuals in their eighties or older.

2) Mortality rates due to circulatory system diseases

The mortality rate due to circulatory system diseases was 113.9 out of 100,000 and this category consisted of heart disease (52.4), cerebrovascular disease (48.2), and hypertensive disorders (10.0). Women (119.4) had a higher mortality rate than men (108.4) (Table 8).

### Table 8. Trends of death rate of Korean people due to disease of the circulatory system by sex in 2004, 2013, and 2014

| Disease of the circulatory system | Heart disease | Cerebrovascular disease |
|----------------------------------|--------------|-------------------------|
| Total                            |              |                         |
| 2004                             | 119.9        | 10.4                    | 36.7    | 26.2 | 10.5 | 70.1 |
| 2013                             | 113.9        | 10.8                    | 35.2    | 26.8 | 23.3 | 50.3 |
| 2014                             | 113.9        | 6.7                     | 32.4    | 27.9 | 24.4 | 48.2 |

|          | Change Percentage change |          |          |          |        |          |
|----------|--------------------------|----------|----------|----------|--------|----------|
| Male     |                          |          |          |          |        |          |
| 2004     | 0.8                      | 0.2      | 2.2      | 1.1      | 1.1    | -2.1     |
| 2013     | 0.7                      | 0.2      | 2.4      | 1.2      | 1.3    | -1.2     |
| 2014     | 0.7                      | 0.2      | 2.6      | 1.2      | 1.3    | -1.2     |

| Female   |                          |          |          |          |        |          |
| 2004     | 125.1                    | 13.8     | 34.9     | 24.5     | 10.3   | 73.8     |
| 2013     | 119.0                    | 12.8     | 30.4     | 25.4     | 25.1   | 52.8     |
| 2014     | 119.4                    | 14.0     | 32.4     | 26.4     | 26.0   | 49.9     |

| Sex ratio (male/female) |          |          |          |          |        |          |
| 2004                 | 0.92      | 0.50     | 1.0      | 1.14     | 1.02   | 0.90     |
| 2013                 | 0.90      | 0.46     | 0.79     | 1.11     | 0.86   | 0.91     |
| 2014                 | 0.91      | 0.43     | 1.0      | 1.12     | 0.88   | 0.93     |

Unit: per 100,000 population, %

*a) Myocardial infarction and angina were included in ischemic heart disease; b) Heart failure and endocarditis, etc. were included in other heart disease.
Within the category of heart disease, ischemic heart disease (27.9) caused the most mortality. The mortality rate of women (119.4 people) due to circulatory system diseases was higher than that of men (108.4 people). The mortality rates due to circulatory system diseases increased by 1.2 (1.1%) in men and 0.4 (0.3%) in women in comparison to 2013. The mortality rate of women due to hypertensive disorders (14.0) was higher than that of men (6.0). The mortality rate of men due to ischemic heart disease (29.5) was higher than that of women (26.4).

The mortality rate due to circulatory system diseases decreased in all age groups except in individuals in their thirties (Table 9). Mortality due to circulatory system diseases showed a tendency to increase with increasing age. In particular, age-specific mortality rates soared after age 70. The highest death rate due to diseases of the circulatory system was due to heart disease in most age groups, except for participants in their seventies, in whom the mortality rate due to cerebrovascular disease (248.5) was higher than that due to heart disease (234.6). Within the category of heart disease, other heart disease was the most common cause of death in individuals less than 50 years of age, whereas ischemic heart disease was the most common cause of death in this category in individuals 50 years of age or older.

### Discussion

The total number of deaths of in the Korean population was 267,692 in 2014. This number has continued to grow as the proportion of the aging population has increased; however, the mortality rate has remained at a similar level, exhibiting an increase of 0.5%. The ten leading causes of death, in order, were cancer, heart disease, cerebrovascular disease, suicide, pneumonia, diabetes mellitus, chronic lower respiratory disease, liver disease, traffic/transit accidents, and hyper-tensive diseases. The most remarkable change from the 2013 data was the increase in heart disease and decrease in cerebrovascular disease, such that heart disease increased from being the third most common cause of death to the second most common cause of death. This reflects changes in the prevalence of diseases corresponding to changes in dietary and exercise habits. Another remarkable change was the increase in pneumonia as a cause of death from sixth place in 2013 (21.4 persons out of 100,000 people) to fifth place in 2014 (23.7). This most likely reflects the increased proportion of elderly people in the population. In fact, pneumonia is expected to increase continuously if the population structure of Korea does not change. The mortality rate due to diabetes decreased compared to 2013, from 21.5 to 20.7. This is a good sign regarding the nationwide control of diabetes. Diabetes and pre-diabetes have been found to be epidemic in Korea, as reflected by an
estimated prevalence of diabetes and prediabetes of 12.4% and 38.3%, respectively, based on both hemoglobin A1c levels and fasting plasma glucose levels [4].

The cancers associated with the highest mortality rates were lung, liver, stomach, colon, and pancreatic cancer, in descending order. Mortality due to lung cancer has increased continuously from 2000 to the present. The mortality rate due to liver cancer has been consistent over recent years. However, the number of deaths due to liver cancer is expected to decrease soon in response to control of hepatitis B virus infections with antiviral drugs and improved sanitation. Stomach cancer is the only one of the five leading cancers to exhibit a continuously decreasing mortality rate since 2000. This is due to early detection and treatment, although stomach cancer remains the second most prevalent cancer, after thyroid cancer [5]. Mortality rates due to colon and pancreatic cancer have increased continuously from 2000. Colon cancer will increase further due to the increased preference for meat consumption exhibited by the Korean population.

The mortality rate of circulatory system diseases included heart disease (52.4), cerebrovascular disease (48.2), and hypertensive disorders (10.0). The mortality rate due to circulatory system diseases in women was higher than in men. Although the mortality rate of women (26.4) due to ischemic heart disease was lower than that of men (29.5), the mortality rates due to hypertensive diseases (14.0) and other heart diseases (26.0) were higher than those observed in men (6.0 and 22.8). It is estimated that heart disease will remain the leading cause of death in this category into the medium- to long-term future.

**Conclusion**

We summarized the annual report on the cause-of-death statistics of the Korean population. We also identified changes in the ranking of leading causes of death in the Korean population from 2013 to 2014. Such findings are evidence of the dynamic changes that Korean society is currently undergoing from the perspective of population structure, disease patterns, and lifestyles, including dietary habits. Further analysis of supplementary raw data from Statistics Korea [1] may facilitate further valuable analyses with the goal of promoting the health of the Korean population.

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**Supplementary materials**

Supplementary tables are available from online only.

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Peer Reviewers’ Commentary

The cause of death statistics of Korean people is one of the most important statistical data not only for the establishment of health policy by Korean Government, but also for the approach to patients care by medical health personnel. This article is a memorable one since this cause of death statistics is first exposed from the journal through agreement between editorial board of the Journal of the Korean Medical Association and Vital Statistics Division of the Statistics Korea. Korea is known to be one of the most dynamic countries in the world. The change of the cause of death may reflect the change of the Korean society from the perspective of economics, medical health, and social behavior. Especially the heart diseases became the 2nd ranking cause of death in 2014, surpassing cerebrovascular diseases. It may be originated from the increased uptake of meat and fatty diet. It is anticipated that this article to be read and cited by the researchers from both Korea and abroad. Articles on the health statistics of Korea will be published continuously with a variety of topics or more intensive analysis of each cause of death statistics.

[정리: 편집위원 회]