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Changing trends in suicide rates in South Korea from 1993 to 2016

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Changing trends in suicide rates in South Korea from 1993 to 2016

Running title: Trends in suicide in South Korea

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Abstract

Objectives: South Korean government has recently implemented policies to prevent suicide. However, there were few studies examining the recent changing trend in suicide rates. This study aims to examine the changing trend in suicide rates by time and age group.

Design: A descriptive study using nationwide mortality rates

Setting: Data on the nationwide cause of death from 1993 to 2016 were obtained from the Statistics Korea.

Participants: People living in the South Korea

Interventions: Implementation of national suicide prevention policies (1st: 2004 year, 2nd: 2009 year)

Primary outcome measures: Suicide was defined as “X60-X84” code according to the ICD-10 code. Age-standardized suicide rates were estimated, and a Joinpoint regression model was applied to describe the trends in suicide rate.

Results: Since 2010, the suicide rates in South Korea have been decreasing by 5.5% (95% CI: -10.3% to -0.5%) annually. In terms of sex, the suicide rate for men had increased by 5.0% (95% CI: 3.6% to 6.4%) annually until 2010. However, there has been no statistically significant change since 2010. For women, the suicide rate had increased by 7.5% (95% CI: 6.3% to 8.7%) annually until 2009, but since 2009, the suicide rate has been significantly decreasing by 6.1% (95% CI: -9.1% to -3.0%) annually. In terms of the age group, the suicide rates among women of almost all age groups have been decreasing since 2010; however, the suicide rates of men aged between 30 and 49 years showed continuously increasing trends.

Conclusion: Our results showed that there were differences in the changing trends in suicide rate by sex and age groups. It was closely related to the timing of the implementation of national suicide prevention policies. Further specific suicide prevention programs targeting

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middle-aged men are required.

Keywords: Suicide; Mortality; Social and political issues; Prevention; Republic of Korea

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Article Summary

Strengths and limitations of this study

- Our findings show that efforts to reduce suicide at the national level can actually lead to a decline in suicide rates through natural experiment.
- Another finding of our study is that suicide rates in middle-age men are continuing to increase, suggesting that a different suicide prevention strategy may be necessary in South Korea.
- Because this study is a descriptive epidemiologic study, it is difficult to know exactly which policies have reduced suicide rates in which age group.
- Improved accuracy of statistics on the causes of death may affect to changes in suicide rates.

Introduction

Suicide is a major public health issue, with an estimated 788,000 deaths every year according to the World Health Organization (WHO) statistics.¹ The WHO established the Mental Health Action 2013-2020 plan to implement a national, multi-sectorial promotion and prevention program for promoting mental health and reducing suicide rates of each country by 10% until 2020.² Especially, the developed countries in East Asia have relatively high mortality rates due to suicide.³ Among these countries, suicide in South Korea is a serious health problem because the suicide rate in South Korea in 2013 (28.5 per 100,000 person-years) was 2.4 times higher than the average suicide rates of other Organization for Economic Co-operation and Development (OECD) countries and South Korea has been ranked top among the OECD countries in terms of suicide rates in the last 10 years.⁴ In addition, suicide was the most common cause of death in young people aged between 10 and 39 years, and it was the second-most common cause of death among middle-aged adults aged 40-59 years in 2016 in South Korea.⁵

South Korea implemented the national suicide prevention program in the early 2000s.⁶ This national suicide prevention program includes both high-risk group-oriented monitoring and prevention of suicide and suicide prevention program for general population such as media campaign.⁷ However, there was a few studies to examine the trends in suicide rates by sex and age group with regard to the national suicide prevention policies in South Korea. Therefore, this study aimed to describe the changing trends in suicide rate by sex and age group in South Korea and exploring the potential effects of implementation of the national suicide prevention policies.

Method

Study participants

The cause of death statistics is a reliable source of data on how the causes of death have changed because of socioeconomic changes and public health developments; it also provides comprehensive information to plan and prioritize health care policies. The number of deaths due to suicide and the corresponding mid-year population counts from 1993 to 2016 were obtained from Statistic Korea (Available from <http://kosis.kr/>). The Statistic Korea used the estimated population as the denominator for mortality rates before year 1993. After 1993, Statistic Korea used the mid-year population based on resident registration number as the denominator for mortality rates. In addition, the cause of death data before 1993 is less accurate, therefore, we selected the suicide rates from 1993 to 2016. The code assigned to the cause of death due to suicide was “X60-X84” according to the ICD-10 code.

National suicide prevention program

Information regarding the timing and implementation of the national suicide prevention policy in South Korea were obtained from relevant government data and expert consultants. Initially, the timing and details of the national suicide prevention policy were obtained from the national knowledge information system (<https://nkis.re.kr:4445/main.do>) and publications from Korea Suicide Prevention Center.⁷⁻¹⁰ The contents and details obtained from these websites were confirmed after review by the experts and staffs of Korea Suicide Prevention Center.⁶⁻¹²

Ethics statement

The study protocol was reviewed by the Institutional Review Board of Kyung Hee University (IRB No.KHSIRB-17-086). Our study was exempted from review because it was

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4 not an experimental trial, which required contacting the patients, and our study did not
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6 include personal identifiable information.
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10 *Statistical analysis*

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12 To describe the baseline characteristics of people who die due to suicide, the number of
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14 deaths was presented for each 6-year period (1993-1998/1999-2004/2005-2010/2011-2016)
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16 from 1993 to 2016. Chi-square test was used to test the differences in the distribution of death
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18 due to suicide by sex and age groups. To describe the changes in suicide rates by time period,
19
20 the age-standardized suicide rates of suicide were calculated. The mid-year Korean
21
22 population in 2005 was used as the standard population for age-standardized suicide rates.
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24 Age-specific suicide rates were applied to the corresponding 5-year age group of the standard
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26 population. The sum of expected deaths for each 5-year age group was calculated, and the
27
28 age-standardized suicide rates were calculated by dividing the sum of expected deaths by the
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30 total number of standard population. Joinpoint regression modelling was used to test the
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32 trends in age-standardized suicide rates for suicide and detect significant changes over time to
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34 fit a better multi-segmented model compared to a simple linear model.¹³ The trends in rates
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36 were summarized as annual percentage changes (APCs) and their 95% confidence intervals
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38 (CIs).
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43 *P* values <0.05 were considered statistically significant. We used SPSS (version 23.0,
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45 Armonk, NY: IBM Corp., USA) and R software (version 3.1.1, Vienna, Austria) and
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47 Joinpoint Regression Program software (Version 4.1.1, Statistical Methodology and
48
49 Applications Branch, Surveillance Research Program, National Cancer Institute, Bethesda,
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51 MD, USA).
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Results

Baseline characteristics

The total number of deaths in South Korea from 1993 to 2016 was 6,007,678 (Table 1). Of these, the total number of deaths due to suicide was 249,085 (4.1%). Of the deaths due to suicide, 169,963 (68.2%) were men, and 79,122 (31.8%) were women. In terms of the time period, South Korea had the highest number of deaths from suicide (n=15,906) and the highest age-standardized suicide rate from suicide (29.1 per 100,000 person-year) in 2011 (Supplementary Table 1). After 2011, the number of deaths and suicide rates due to suicide decreased until 2016. The number of deaths due to suicide in 2011-2016 was 2.5 times higher than that in 1993-1998. According to the age groups, the proportion of deaths due to suicide in children and adolescents aged between 0 and 19 years had decreased from 1993-1998 to 2011-2016, whereas the proportion of elderly aged more than 70 years had increased during the same time period ($p<0.01$).

Trends in suicide rates

According to the joinpoint regression model, the mortality rate from suicide had increased by 5.6% (95% CI: 4.4% to 6.9%) annually from 1993 to 2010 (Figure 1). After 2010, the suicide rate had declined by 5.5% (95% CI: -10.3% to -0.5%) annually until 2016. In terms of sex, suicide rate for men had increased by 5.0% (95% CI: 3.6% to 6.4%) annually from 1993 to 2010. After 2010, suicide rate for men shown decreasing trends (APC=-4.3%, 95% CI: -9.8% to 1.6%), although it was not statistically significant ($p=0.14$). Similarly, the suicide rates for women had increased by 7.5% (95% CI: 6.3% to 8.7%) annually from 1993 to 2009.

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4 Following that, suicide rates for women showed a significant decreasing trend (APC=-6.1%,
5 (95% CI: -9.1% to -3.0%)).
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10 ***Trends in suicide rates for men by age group***

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12 Joinpoint regression analysis was performed by sex and age group. Suicide rates for men
13 increased with age (Table 2). The suicide rate of adolescents aged 10-19 years is relatively
14 low, ranging from 3 to 7 people per 100,000 persons. The suicide rate of adolescents aged 10-
15 19 years has been increasing annually by 2.8% since 2001. Although there was no statistically
16 significant change in suicide rate of young adults aged 20-29 years, the rates showed
17 increasing trends from 2006 to 2010, and it has tended to decrease since 2010. The suicide
18 rate of men aged 30-39 years showed a significant annual increase of 3.1% from 1993 to
19 2016. For men aged 40-49 years, the suicide rate dramatically increased by 15.6% annually
20 from 1993 to 1998. Since 1998, the increasing trend in the suicide rate has attenuated among
21 men aged 40-49 years (APC=1.9% (95% CI: 0.9% to 2.9%)). The suicide rate for men aged
22 50-59 years has increased by 8.0% from 1993 to 2004. However, there has been no
23 significant increase since 2004. For men aged 60-69 years, there was a statistically significant
24 increase in suicide rate by 10.7% increase each year between 1993 and 2005; however, there
25 has been a decreasing trend since 2005. The suicide rate for men aged 70-79 years had
26 increased by 12.9% annually from 1993 to 2004 but has been decreasing by 7.5% annually
27 since 2011. For men aged 80 years and above, the suicide rate had increased by 9.2%
28 annually between 1993 and 2000. There was no significant change in the suicide rate for men
29 from 2000 to 2010. Since 2010, the suicide rate has been decreasing by 6.2% annually.
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53 ***Trends in suicide rates for women by age group***

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4 Table 3 shows the suicide rate for women by age group. The suicide rate of adolescents
5 aged 10-19 years is relatively low, and the trends of suicide rates are similar to that in the
6 twenties. Suicide rates in women aged 20-29 years had increased by 20.0% annually from
7 2001 to 2008. Since 2008, suicide rate for women aged 20-29 years has decreased by 9.5%
8 annually. The suicide rate of women aged 30-39 years showed a significant annual increase of
9 5.0% from 1993 to 2006, whereas the suicide rates tended to decrease by 5.9% annually from
10 2009 to 2016. For women aged 40-49 years, the suicide rate had increased by 6.5% annually
11 from 1993 to 2010. Since 2010, there was no significant change in the suicide rate. The
12 suicide rate for women aged 50-59 years had increased by 6.6% from 1993 to 2010. After
13 2010, the suicide rates for women aged 50-59 years showed a decreasing trend (APC=-5.5%
14 (95% CI: -8.6% to 0.0%)). For women aged 60-69 years, there was a statistically significant
15 increase in the suicide rate with 9.4% increase each year from 1993 to 2005; however, there
16 has been a significant decreasing trend since 2010 (APC=-8.7% (95% CI: -11.9% to -5.5%)).
17 The suicide rate for women aged 70-79 years increased by 13.5% annually from 1993 to 2004
18 but has decreased significantly by 9.9% annually since 2011. For women aged 80 years and
19 above, the suicide rates had dramatically increased by 18.0% annually from 1993 to 2004.
20 There was no significant change from 2004 to 2011. Since 2011, suicide rate has decreased
21 by 11.5% annually.
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The implementation of the National Suicide Prevention Program in South Korea

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47 The first step of the national suicide prevention program was the establishment of the first
48 5-year National Strategy for Suicide Prevention in 2004 (Figure 2). Based on this, a suicide
49 prevention program was introduced in 2005 at regional mental health centres which were
50 public community infrastructures for mental health. Following this, the second 5-year
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4 National Strategy for Suicide Prevention was implemented in 2009. Based on this program, a
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6 separate budget was newly proposed and executed. In 2010, the government established the
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8 integrated welfare system to reduce redundant welfare services and expand the basic living
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10 subsidies. Indeed, the welfare budget in South Korea was increased by 72%, welfare
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12 receivers were increased by 157.6%, and additional 7,000 welfare officers of local
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14 government had increased from 2006 to 2011. In 2010, a screen door was expanded to
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16 prevent suicide on the subway. In 2011, the Act for the Prevention of Suicide was passed, the
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18 Korea Suicide Prevention Center was established, and the sales of paraquat pesticides were
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20 prohibited. The Act for the Prevention of Suicide was enforced in 2012, and the Korean
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22 gatekeeper training program for suicide prevention entitled '*watch, listen, and speak*' was
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24 introduced to the general population in South Korea. In 2013, an emergency department-
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26 based suicide attempt survivor management program was implemented, and the Korea
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28 Suicide Prevention Center along with Journalists Association of Korea announced the
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30 recommendation for media reporting of suicide. In addition, the government authenticated the
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32 private suicide prevention program to disseminate the evidence-based suicide prevention
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34 program. In 2014, the government collaborated with religious organizations to increase the
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36 participation rates of general population in the national suicide program. The Korea
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38 Psychological Autopsy Center was established to understand the causes of suicide deaths
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40 better. In 2015, the '*Are you okay*' media campaign as one of the suicide prevention programs
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42 was conducted. In 2016, a comprehensive plan for mental health was established by the
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44 cooperation of many Ministries of government, and an '*Air Kiss*' campaign, in which famous
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46 celebrities participated, was conducted through social network services.
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Discussion

This study aimed to examine the trends of suicide rate in South Korea by sex and age group and explore these suicide rate changes according to the timing of suicide prevention policies implemented by the Korean government. This study found that the overall suicide rate in South Korea had tended to decline since 2010. However, when analysed by sex and age, the suicide rate trends showed differences according to the sex and age groups. While women's suicide rate has decreased in all age groups since 2010, the suicide rate of middle-aged men aged between 30 and 49 years is still on the rise. Our findings were consistent with the study findings of Matsubayashi et al.¹⁴ They showed that a national level of suicide prevention intervention was effective way to reduce suicide rate except for working-age adults in 21 OECD countries.¹⁴

Trend in suicide rate after 2004/2005

From 1993 to 2016, the suicide rates tended to change at two points in time. First, this study found that the suicide rate changed before and after 2004 and 2005. It was revealed that after 2004, an increase in the suicide rate of men and women aged 60 years or older had changed. After 2005, the suicide rate of men in their 60s decreased by 3.6% each year and that of women in their 60s, which had risen sharply up until 2005, no longer showed a statistically significant increase from 2005 to 2010.

During this period, Korea's 1st national suicide prevention initiative was implemented in 2004, which included various programs such as mental health improvement and suicide prevention, suicide prevention counseling calls, the development of a culture that respects life, treatment and post-suicide attempt management for those who attempt suicide, and suicide prevention research.¹² In addition, the Mental Health Welfare Center, a national mental health

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4 system, also implemented a regional suicide prevention program in 2005, and the Seoul
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6 Suicide Prevention Center was first established.¹⁵ To identify the reason for the changes in
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8 the suicide rate being observed mainly among those aged 60 years or older since the 1st
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10 suicide prevention initiative was put into practice, the following should be considered. To
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12 begin with, the government did not earmark funding for the 1st suicide prevention initiative.¹⁶
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14 For this reason, it is difficult to find the data that can precisely identify the programs that
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16 were actually implemented among various other programs. Nonetheless, a suicide prevention
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18 program implemented by the Mental Health Welfare Center mainly focused on management
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20 via phone calls, and it has been applied since 2005 without additional funding. Previous
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22 studies reported that interventions and management based on phone calls were effective for
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24 the suicide prevention of the elderly,^{17,18} and in this regard, changes in the suicide rate mostly
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26 found among those aged 60 years or older can be attributed to the effect of phone-based
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28 interventions.¹⁹ These changes in the suicide rate, however, were found to be not a
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30 statistically significant decline in the suicide rate overall but a change in the increasing trend
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32 of the suicide rate.
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38 ***Trend in suicide rate after 2008/2009***

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40 Second, the suicide rate began to decline from 2008 to 2011. As of 2008 and 2009, the
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42 suicide rate for females aged 10 to 39 years, which had increased before, began to decrease.
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44 As of 2010 and 2011, the suicide rate of women aged 40 years or older also began to decline.
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46 Furthermore, the suicide rates of men in their 20s and those aged 70 years or older tended to
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48 decline since 2010 and 2011, respectively. In contrast, the suicide rate of men aged 30-49
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50 years had not decreased significantly from 1993 to 2016; instead, it continued to rise during
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52 this period.
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4 To begin with, the 2nd national suicide prevention initiative was enacted in 2009, which
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6 consisted of the research and development of suicide prevention policy, development of a
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8 culture that respects life, suicide prevention training and nurturing of specialists, online
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10 counselling and harmful suicide information monitoring, and public-private partnerships for
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12 suicide prevention.¹² The importance of the 2nd suicide prevention initiative is that the
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14 national budget was allocated for suicide prevention unlike the 1st suicide prevention
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16 initiative. While this initiative could be effective in reducing the suicide rate of young
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18 females in their 10s to 30s, it would be more reasonable to consider that a series of specific
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20 events contributed to a surge in the suicide rate of young women in 2008 and 2009. The
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22 effect of a celebrity's suicide on the suicide rate is well-known,^{20, 21} and there were incidents
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24 of suicides among very high-profile celebrities in 2008 and 2009 in South Korea, which were
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26 reported across the country.⁷ Furthermore, it was reported that the effect of a celebrity's
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28 suicide in Korea was five times higher among young women.²² Considering these results, it is
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30 a reasonable interpretation to view a reduction in the suicide rate of young women after 2009
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32 as a decline in the suicide rate surged previously due to the effect of a series of specific
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34 events—celebrity suicides.
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38 While it did not directly address suicide prevention, one of the programs implemented in
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40 2010 was the establishment of an integrated welfare system to increase the number of
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42 recipients eligible for National Basic Livelihood Security, and the access to welfare programs
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44 was expanded in 2011 by increasing the number of welfare service worker.¹¹ Economically
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46 vulnerable groups have been known to be at a high risk of suicide,²³ and more notably, the
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48 poverty rate of the elderly in Korea was reported to be particularly high.²⁴ From this
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50 perspective, it is suggested that the expansion of the welfare system would have had a
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52 positive effect on reducing the suicide rate. In addition, some important national suicide
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4 prevention activities were carried out during the same period, such as the installation of more
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6 screen doors to prevent people from throwing themselves into the subway train²⁵ and
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8 Enactment of Act for the Prevention of Suicide and a ban on the sale of paraquat pesticides.²⁶
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10 Such government-led suicide prevention interventions may have contributed to the changes in
11
12 the suicide rate of men in their 20s, men aged 70 years or older, and women aged 40 years or
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14 older in 2010 and 2011. Moreover, a continuous decrease in the suicide rate since 2011
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16 indicates that the reduction of suicide rates was attributable to the government intervention
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18 efforts. Following this, the Korean government launched a Korean gatekeeper training
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20 program (*'watch, listen, and speak'*) in 2012,⁶ which trained people in Korea about being a
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22 suicide gatekeeper; in 2013, the government implemented an emergency department-based
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24 suicide attempt survivor management program, announced the recommendation for media
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26 reporting of suicide, and established a suicide prevention certification system for a more
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28 efficient implementation of suicide prevention programs.⁷ In 2014, the government
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30 introduced suicide prevention programs in cooperation with the religious community and
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32 established the Korea Psychological Autopsy Center to better identify the cause of suicide.⁸
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34 In 2015, the government launched the *'Are You Okay'* campaign to raise public awareness
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36 across the country.⁹ In 2016, not just the Ministry of Health and Welfare but all Ministries in
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38 Korea cooperated and established the Comprehensive Plan for Mental Health and promoted
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40 the *'Air Kiss'* campaign, which included celebrities.¹⁰
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47 ***Increase in suicide rate of middle-aged men***

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49 Nevertheless, it was found that the suicide rate of middle-aged men in their 30s and 40s
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51 had continued to increase significantly from 1993 to 2016. While there was a slight
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53 slowdown in the increase of their suicide rate due to suicide prevention programs
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4 implemented by the government, it did not result in a decrease in the suicide rate. This might
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6 suggest that the currently implemented suicide prevention programs are not effective for men
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8 in their 30s and 40s. However, in Korea, suicide prevention policies focused on middle-aged
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10 men have not been implemented until now. In previous studies, men were reported to have a
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12 higher risk of suicide due to financial reasons than women do,²³ and the risk of suicide among
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14 men arising due to the unemployment rate and economic crisis was also shown to be higher.²⁷
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17 ²⁸ In Japan, a loan system for financial independence was implemented by suicide prevention
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19 policy, and the suicide rate of males in their 30s and 40s has decreased.^{12, 29} It may be
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21 considered to be as a result of the policy. However, the current suicide prevention policies
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23 only included the development of an office worker gatekeeper program for men in their 30s
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25 and 40s. In this regard, to fundamentally address the issue of suicide among men in their 30s
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27 and 40s, the Korean government should implement multi ministry-driven policies that include
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29 social and financial bases such as social security system and unemployment-related
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31 assistance system with various suicide prevention policies.
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36 ***Strengths and Limitations of this study***

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38 When interpreting the findings of this study, the following limitations need to be
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40 considered. This study did not take account of the individual effect of a suicide prevention
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42 program; it instead interpreted the changes in suicide rates at each point in time when such
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44 programs were implemented. However, we cannot confirm when exactly the effect of policy
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46 was seen. This was because the data on the outcome of each individual suicide prevention
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48 program were not available as Korea did not have a monitoring system for each individual
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50 program, even though it implemented suicide prevention programs quite extensively. In this
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52 regard, a monitoring system needs to be established in order to identify the policy effect on
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4 the changes in the suicide rate in Korea more accurately, and a follow-up study needs to be
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6 conducted using this system. Furthermore, the accuracy of the cause of death statistics had
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8 continued to improve, so there is a chance that an increase in the number of deaths due to
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10 suicide would have been affected by the improved accuracy of statistics on the causes of
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12 death. Despite these limitations, this study has the following strengths. This study presented
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14 the trends in the suicide rates in Korea based on statistical analysis of a 24-year period. In
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16 addition, it showed that the point in time wherein such changes in the suicide rate occurred
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18 coincided with that wherein the government-led suicide prevention programs were
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20 implemented. Accordingly, further government-level investments and interventions should be
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22 considered to reduce the suicide rate.
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27 **Conclusion**

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29 This study showed that the suicide rate among Korean men and women has decreased
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31 since 2010, based on the causes of death statistics, which could represent the general
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33 population of South Korea. Our findings also showed that there were significant changes in
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35 trends Korea's suicide rate after 2004 to 2005 and 2008 to 2011. These changes in suicide
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37 rate coincided with those when the 1st suicide prevention initiative was implemented in 2004
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39 and the 2nd suicide prevention initiative enacted in 2009. In this regard, it is considered that
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41 government-level suicide prevention interventions had a potential effect on decreasing the
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43 suicide rate, and national-level efforts are still needed in the future to reduce the increasing
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45 suicide rate of middle-aged men in their 30s and 40s.
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50 **Author contributions**

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4 S-U Lee obtained, analysed the data and wrote the manuscript and J-I P, S Lee, I-H Oh and
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6 J-M Choi interpreted the data and contributed to revise the manuscript. C-M Oh made the
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8 research design and revised the manuscript.
9

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13
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16 20170835).
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19 20 21 **Conflicts of interests**

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23 On behalf of all the authors, the corresponding author declares that there are no conflicts of
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25 interests.
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28 29 30 **Patient consent**

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32 This study was a descriptive epidemiologic study using the cause of death database that
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34 could not identify individuals. Therefore, patient consent form was exempted from IRB.
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37 38 39 **Acknowledgments**

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41 All authors participated in the design, execution, and analysis of the results and have read
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43 and approved the final version. We are especially thankful for the advice and help of the
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45 staffs and colleagues of the Korea Suicide Prevention Center.
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48 49 50 **Ethical Standards**

51
52 The study protocol was reviewed and approved by Institutional Review Board of Kyung
53
54 Hee University (IRB No. KHSIRB-17-086).
55

Data sharing statement

All data used in this study can be obtained from Homepage of Statistic Korea (<http://kosis.kr/eng/>).

REFERENCES

1. World Health Organisation. Suicide Data.
http://www.who.int/mental_health/prevention/suicide. (Accessed on 14 September 2017).
2. World Health Organisation. Mental health action plan 2013–2020.
http://www.who.int/mental_health/publications/action_plan/en/. (Accessed on 14 September 2017).
3. Hendin H, Phillips MR, Vijayakumar L, Pirkis J, Wang H, Yip P, Wasserman D, Bertolote JM, Fleischmann A. Suicide and suicide prevention in Asia. World Health Organization: Geneva, 2018.
4. Organization for Economic Co-operation and Development. OECD health data 2016.
<https://data.oecd.org/healthstat/suicide-rates.htm>. (Accessed on 14 September 2017).
5. Statistics Korea. Cause-of-Death Statistics 2017. <http://kosis.kr/en>. (Accessed on 14 September 2017).
6. Paik JW, Jo SJ, Lee S, Ong JY, Park JI. The Effect of Korean Standardized Suicide

- 1
2
3
4 Prevention Program on Intervention by Gatekeepers. J Korean Neuropsychiatr Assoc
5
6 2014;53:358-363. [In Korean].
7
- 8 7. Korea Suicide Prevention Center. Suicide White Book. Seoul: Ministry of Health and
9
10 Welfare, 2014 [In Korean].
11
- 12 8. Korea Suicide Prevention Center. Suicide White Book. Seoul: Ministry of Health and
13
14 Welfare, 2015 [In Korean].
15
- 16 9. Korea Suicide Prevention Center. Suicide White Book. Seoul: Ministry of Health and
17
18 Welfare, 2016 [In Korean].
19
- 20 10. Korea Suicide Prevention Center Suicide White Book. Seoul: Ministry of Health and
21
22 Welfare, 2017 [In Korean].
23
- 24 11. Kang HG. Social Welfare Delivery Reform: Achievements and Beyond, Health and
25
26 Welfare Policy Forum 2012;4:35-49
27
- 28 12. Lee SY. Policy options for the improvement of suicide prevention programs. Health and
29
30 Welfare Policy Forum 2015;4:34-49.
31
- 32 13. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with
33
34 applications to cancer rates. Stat Med 2000;19:335-351.
35
- 36 14. Matsubayashi T, Ueda M. The effect of national suicide prevention programs on suicide
37
38 rates in 21 OECD nations. Soc Sci Med 2011;73:1395-400.
39
- 40 15. National Mental Health and Welfare Commission. Guidelines for mental health services,
41
42 Seoul: Ministry of Health and Welfare 2005 [In Korean].
43
- 44 16. Park JI, Nam YY, Lee HK, Park JY, Lee MS, Lee SJ. National suicide prevention plan.
45
46 Seoul: Ministry of Health and Welfare, 2011 [In Korean].
47
- 48 17. De Leo D, Buono MD, Dwyer J. Suicide among the elderly: the long-term impact of a
49
50 telephone support and assessment intervention in northern Italy. Br J Psychiatry
51
52
53
54

- 2002;181: 226-9.
18. De Leo D, Carollo G, Buono MD. Lower suicide rates associated with a Tele-Help/Tele-Check service for the elderly at home. *Am J Psychiatry* 1995;152: 632-4.
19. Sun HJ. Suicide prevention efforts for the elderly in Korea. *Perspect Public Health* 2016;136:269-70.
20. Jeong J, Shin SD, Kim H, Hong YC, Hwang SS, Lee EJ. The effects of celebrity suicide on copycat suicide attempt: a multi-center observational study. *Soc Psychiatry Psychiatr Epidemiol* 2012;47:957-65.
21. Niederkrotenthaler T, Fu KW, Yip PS, Fong DY, Stack S, Cheng Q, Pirkis J. Changes in suicide rates following media reports on celebrity suicide: a meta-analysis. *J Epidemiol Community Health* 2012;66:1037-42.
22. Ju Ji N, Young Lee W, Seok Noh M, Yip PS. The impact of indiscriminate media coverage of a celebrity suicide on a society with a high suicide rate: epidemiological findings on copycat suicides from South Korea. *J Affect Disord* 2014;156:56-61.
23. Lee SU, Oh IH, Jeon HJ, Roh S. Suicide rates across income levels: Retrospective cohort data on 1 million participants collected between 2003 and 2013 in South Korea. *J Epidemiol* 2017;27:258-64.
24. Jin JM., Kim SY, Moon KJ. A Study on The Poverty and The Effect of Income Transfer of Elderly-Headed Households in Korea: Focused on Poverty Rate, Poverty Gap and Income Transfer. *Social Welfare Policy* 2014;41:239-58.
25. Chung YW, Kang SJ, Matsubayashi T, Sawada Y, Ueda M. The effectiveness of platform screen doors for the prevention of subway suicides in South Korea. *J Affect Disord*. 2016 ;194:80-3.
26. Cha ES, Chang SS, Gunnell D, Eddleston M, Khang YH, Lee WJ. Impact of paraquat

- 1
2
3
4 regulation on suicide in South Korea. *Int J Epidemiol* 2015;45:470-9.
5
6 27. Chang SS, Gunnell D, Sterne JA, Lu TH, Cheng AT. Was the economic crisis 1997–1998
7
8 responsible for rising suicide rates in East/Southeast Asia? A time–trend analysis for
9
10 Japan, Hong Kong, South Korea, Taiwan, Singapore and Thailand. *Soc Sci Med.*
11
12 2009;68:1322-31.
13
14 28. Hawton K, Arensman E, Wasserman D, Hulten A, Bille-Brahe U, Bjerke T, Crepet P,
15
16 Deisenhammer E, Kerkhof A, De Leo D, Michel K, Ostamo A, Philippe A, Querejeta I,
17
18 Salander-Renberg E, Schmidtke A, Temesváry B. Relation between attempted suicide
19
20 and suicide rates among young people in Europe. *J Epidemiol Community Health*
21
22 1998;52:191-4
23
24
25 29. Takeshima T, Yamauchi T, Inagaki M, Kodaka M, Matsumoto T, Kawano K, Katsumata
26
27 Y, Fujimori M, Hisanaga A, Takahashi Y. Suicide prevention strategies in Japan: A 15-
28
29 year review (1998–2013). *J Public Health Policy* 2015;36:52-66.
30
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Table 1. Baseline characteristics of suicide by sex and age group

Characteristics	Overall	Year				<i>p</i> -value [†]
		1993-1998	1999-2004	2005-2010	2011-2016	
Total number of deaths*	6,007,678	1,445,819	1,467,088	1,479,483	1,615,288	
Number of deaths due to suicide	249,085 (4.15%)	34,064 (2.36%)	51,413 (3.50%)	78,674 (5.32%)	84,934 (5.26%)	
Sex						<0.01
Men	169,963 (68.23%)	23,733 (69.67%)	35,619 (69.28%)	51,525 (65.49%)	59,086 (69.57%)	
Women	79,122 (31.77%)	10,331 (30.33%)	15,794 (30.72%)	27,149 (34.51%)	25,848 (30.43%)	
Age group						<0.01
0-19 years	7,767 (3.2%)	2,362 (6.9%)	1,649 (3.2%)	1,944 (2.5%)	1,812 (2.1%)	
20-29 years	29,988 (12.0%)	7,108 (20.9%)	6,306 (12.3%)	9,097 (11.6%)	7,477 (8.8%)	
30-39 years	43,015 (17.3%)	7,800 (22.9%)	9,654 (18.8%)	12,575 (16.0%)	12,986 (15.3%)	
40-49 years	47,796 (19.2%)	5,815 (17.1%)	10,468 (20.4%)	14,938 (19.0%)	16,575 (19.5%)	
50-59 years	41,960 (16.8%)	4,701 (13.8%)	7,705 (15.0%)	12,593 (16.0%)	16,961 (20.0%)	
60-69 years	33,214 (13.3%)	3,259 (9.6%)	7,441 (14.5%)	11,615 (14.8%)	10,899 (12.8%)	
70-79 years	29,654 (11.9%)	2,142 (6.3%)	5,389 (10.5%)	10,337 (13.1%)	11,786 (13.9%)	
≥80 years	15,661 (6.3%)	873 (2.6%)	2,800 (5.5%)	5,557 (7.1%)	6,431 (7.6%)	

*Total number of deaths present the overall cause of deaths.

[†]Chi-square test was used to test the differences in the number of deaths by sex and age group
Data was obtained from Statistics Korea (Available from: <http://kosis.kr/>)

Table 2. Joinpoint regression analysis for suicide rate from 1993 to 2016 in Korean men by age group

Categories	Suicide rate		Trend 1		Trend 2		Trend 3		Trend 4	
	1993	2016	Years	APC (95% CI)	Years	APC (95% CI)	Years	APC (95% CI)	Years	APC (95% CI)
Men										
10-19 years old	5.35	5.57	1993-1998	4.8% (-5.2% to 16.0%)	1998-2001	-14.7% (-48.4% to 40.9%)	2001-2016	2.8% (0.5% to 5.2%)*		
20-29 years old	14.44	19.91	1993-2006	0.5% (-1.6% to 2.7%)	2006-2010	12.1% (-7.3% to 35.6%)	2010-2016	-5.8% (-11.7% to 0.5%)		
30-39 years old	15.53	31.32	1993-2016	3.0% (2.1% to 4.0%)*						
40-49 years old	18.39	42.34	1993-1998	15.6% (3.0% to 29.8%)*	1998-2016	1.9% (0.8% to 2.9%)*				
50-59 years old	23.92	48.32	1993-2004	8.0% (4.6% to 11.5%)*	2004-2016	-0.2% (-1.9% to 1.6%)				
60-69 years old	26.58	55.74	1993-2005	10.7% (7.8% to 13.7%)*	2005-2016	-3.6% (-5.5% to -1.7%)*				
70-79 years old	34.38	90.32	1993-2004	12.9% (9.9% to 16.0%)*	2004-2011	1.2% (-2.2% to 4.7%)	2011-2016	-7.5% (-11.2% to -3.5%)*		
≥80 years old	41.74	150.52	1993-2000	9.2% (2.3% to 16.7%)*	2000-2003	29.7% (-3.3% to 74.0%)	2003-2010	0.9% (-2.4% to 4.3%)	2010-2016	-6.2% (-8.8% to -3.6%)*

Joinpoint regression model is used to test that age-standardized rates have significantly changed. The trends in suicide mortality rates were summarized as APC (annual percentage change).

Age-standardized rates were expressed per 100,000 men and Korean mid-year population in year 2005 was used for age-standardization.

APC: annual percentage change, CI: confidence interval.

*p-value <0.05

Table 3. Joinpoint regression analysis for suicide rate from 1993 to 2016 in Korean women by age group

Categories	Suicide rate		Trend 1		Trend 2		Trend 3		Trend 4	
	1993	2016	Years	APC (95% CI)	Years	APC (95% CI)	Years	APC (95% CI)	Years	APC (95% CI)
Women										
10-19 years old	3.01	4.15	1993-1998	14.4% (5.2% to 24.3%)*	1998-2001	-21.4% (-47.0% to 16.6%)	2001-2009	8.0% (2.3% to 14.0%)*	2009-2016	-5.1% (-10.0% to -0.0%)*
20-29 years old	6.97	12.46	1993-1998	10.0% (-1.3% to 22.5%)*	1998-2001	-14.8% (-47.7% to 38.8%)	2001-2008	19.9% (12.0% to 28.5%)*	2008-2016	-9.5% (-13.3% to -5.6%)*
30-39 years old	8.07	17.65	1993-2006	5.0% (3.2% to 6.8%)*	2006-2009	20.8% (-4.4% to 52.5%)	2009-2016	-5.9% (-8.9% to -2.8%)*		
40-49 years old	7.57	16.47	1993-2010	6.5% (5.4% to 7.7%)*	2010-2016	-3.3% (-6.8% to 0.3%)				
50-59 years old	5.47	16.35	1993-2010	6.6% (5.0% to 8.2%)*	2010-2016	-5.5% (-8.6% to 0.0%)				
60-69 years old	9.10	14.65	1993-2005	9.4% (7.5% to 11.4%)*	2005-2010	0.7% (-5.4% to 7.3%)	2010-2016	-8.7% (-11.9% to -5.5%)*		
70-79 years old	12.19	26.50	1993-2004	13.5% (11.0% to 16.1%)*	2004-2011	-1.5% (-4.6% to 1.7%)	2011-2016	-9.9% (-13.9% to -5.8%)*		
≥80 years old	17.21	45.73	1993-2004	18.0% (14.3% to 21.8%)*	2004-2011	-1.3% (-5.1% to 2.5%)	2011-2016	-11.5% (-15.8% to -6.9%)*		

Joinpoint regression model is used to test that age-standardized rates have significantly changed. The trends in suicide mortality rates were summarized as APC (annual percentage change). Age-standardized rates were expressed per 100,000 women and Korean mid-year population in year 2005 was used for age-standardization.

APC: annual percentage change, CI: confidence interval.

**p*-value <0.05

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5 **Figure legends**
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8 **Figure 1.** Trends in age-standardized suicide rates in South Korea, 1993-2016
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10 Footnotes:

11 APC=Annual percent change

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13 The age-standardized suicide rates are presented as suicide death cases per 100,000 people using Korean mid-year population in 2005 as
14 standard population.
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16 Joinpoint regression analysis was used to determine whether there were significant changes in trends in age-standardized suicide rates for the
17 period between 1993 and 2016.
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19 *p<0.05
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24 **Figure 2.** Implementation of National Suicide Prevention Program and Plan
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26 Footnotes:

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28 The age-standardized suicide rates are presented as connected line from 1993 to 2016.
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30 Each number represents the year in which the major events related to national suicide prevention program or plan were occurred.
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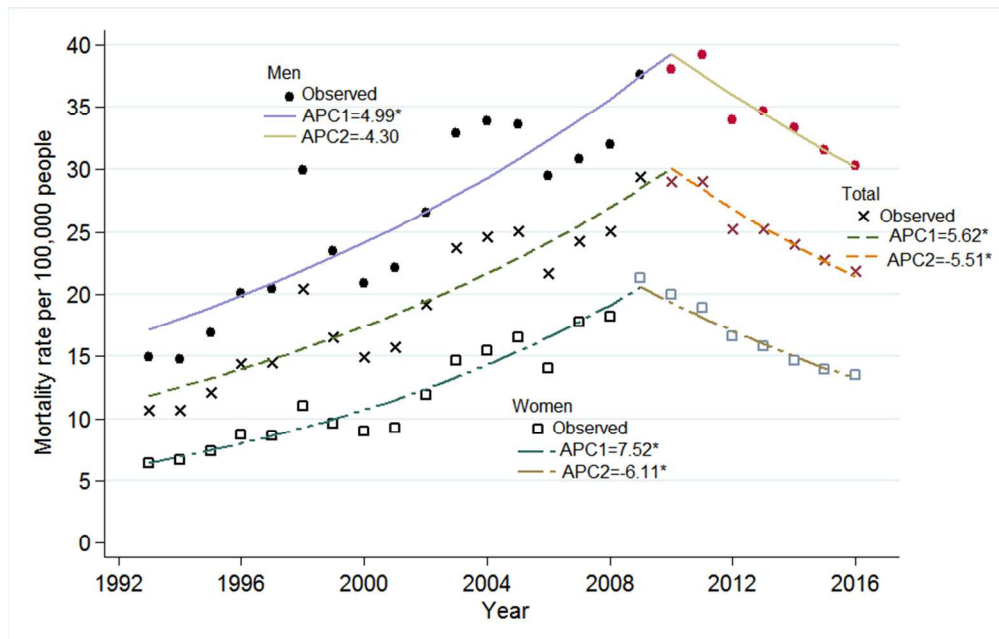
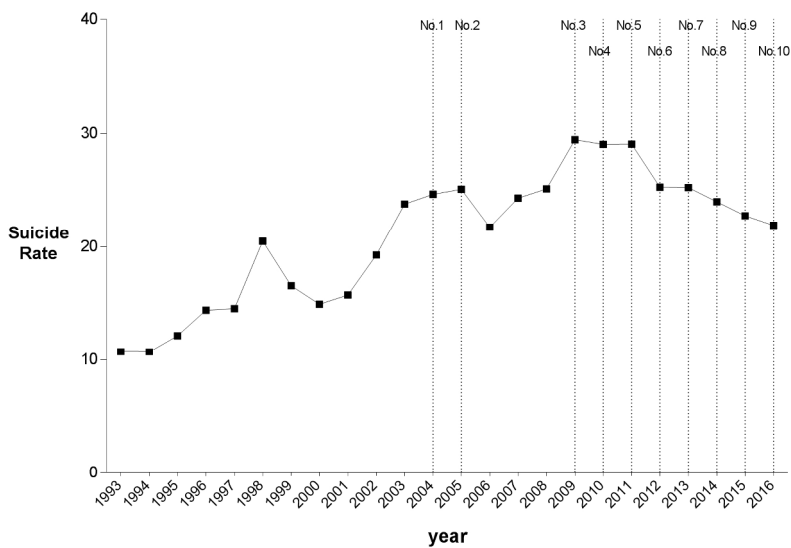


Figure 1. Trends in age-standardized suicide rates in South Korea, 1993-2016

318x202mm (72 x 72 DPI)



No.	Year	National suicide prevention program or plan
1	2004	The establishment of the first 5-year National Strategy for Suicide Prevention
2	2005	Suicide prevention program was introduced into regional mental welfare centers
3	2009	The establishment of the second 5-year National Strategy for Suicide Prevention
4	2010	The establishment of integrated welfare system The expansion of the basic living subsidies The increase in the number of welfare officers
5	2011	The enactment of the Act on Preventing Suicide The inhibition of sales of paraquat pesticides
6	2012	The enforcement of the Act on Preventing Suicide The introduction of the Korean gatekeeper program for suicide prevention entitled "Look and Listening and Say"
7	2013	The introduction of management of emergency department based suicide attempts The certification of private suicide prevention
8	2014	The collaboration the government with religious organizations The establishment of the Korea Psychological Autopsy Center
9	2015	The expansion of screen door on the subway "Are you okay" campaign
10	2016	The establishment of the comprehensive national mental health care strategy "Air kiss" campaign

Figure 2. Implementation of National Suicide Prevention Program and Plan

275x400mm (195 x 195 DPI)

Supplementary table 1. The number of death from suicide, suicide mortality rates from 1993 to 2016 in South Korea

Year	Population	Number of suicide death	Age-standardized suicide mortality rate
1993	44,752,157	4,208	10.7
1994	45,208,726	4,277	10.7
1995	45,637,184	4,930	12.1
1996	46,062,143	5,959	14.4
1997	46,475,163	6,068	14.5
1998	46,837,620	8,622	20.4
1999	47,163,425	7,056	16.5
2000	47,534,117	6,444	14.9
2001	47,877,049	6,911	15.7
2002	48,125,745	8,612	19.2
2003	48,308,386	10,898	23.7
2004	48,485,314	11,492	24.6
2005	48,683,040	12,011	25.1
2006	48,887,027	10,653	21.7
2007	49,130,354	12,174	24.3
2008	49,404,648	12,858	25.1
2009	49,656,756	15,412	29.5
2010	49,879,812	15,566	29.1
2011	50,111,476	15,906	29.1
2012	50,345,325	14,160	25.3
2013	50,558,952	14,427	25.3
2014	50,763,158	13,836	24.0
2015	50,951,719	13,513	22.8
2016	51,112,972	13,092	21.9

Data was obtained from Statistics Korea (Available from: <http://kosis.kr/>)

Age-standardized rates were expressed per 100,000 people and Korean mid-year population in year 2005 was used for age-standardization.

STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	p.2 p.2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p.5
Objectives	3	State specific objectives, including any prespecified hypotheses	p.5 line 15-22
Methods			
Study design	4	Present key elements of study design early in the paper	p.1,7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p.6 Line 1-11
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (b) For matched studies, give matching criteria and number of exposed and unexposed	p.6 Line 1-11 -
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p.6 Line 10-11, 13-20
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	p.6 Line 10-11
Bias	9	Describe any efforts to address potential sources of bias	p.16 Line 10-21
Study size	10	Explain how the study size was arrived at	p.8 Line 3-8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p.7 Line 5-7
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, explain how loss to follow-up was addressed (e) Describe any sensitivity analyses	p.7 Line 7-21 p.7 Line 5-7 - - -
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	p.8 Line 3-8 - -
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	p.8 Line 2-

		(b) Indicate number of participants with missing data for each variable of interest	13 -
		(c) Summarise follow-up time (eg, average and total amount)	p.8 Line 3
Outcome data	15*	Report numbers of outcome events or summary measures over time	p.8 Line 3-8
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	p.8 Line 15-24 p.7 Line 5-7 Supplementary table 1
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	p.11 Line 23- p.12 Line 5
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p.16 Line 10-21
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p.12 Line 9- p.16 Line 7
Generalisability	21	Discuss the generalisability (external validity) of the study results	p.12 Line 5-7 p.16 Line 22- p.17 Line 2
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p.17 Line 20-22

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.

BMJ Open

Changing trends in suicide rates in South Korea from 1993 to 2016: A descriptive study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-023144.R1
Article Type:	Research
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Primary Subject Heading:	Mental health
Secondary Subject Heading:	Epidemiology, Health policy, Public health
Keywords:	Suicide & self-harm < PSYCHIATRY, Mortality, Social and political issues, Prevention, Republic of Korea

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4 **Changing trends in suicide rates in South Korea from 1993 to**
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7 **2016: A descriptive study**
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11 Running title: Trends in suicide in South Korea
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16 Sang-Uk Lee^{1,2}, Jong-Ik Park³, Soojung Lee⁴, In-Hwan Oh², Joong-Myung Choi², Chang-Mo
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53 **Word count:** 3,518
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Abstract

Objectives: South Korean government has recently implemented policies to prevent suicide. However, there were few studies examining the recent changing trend in suicide rates. This study aims to examine the changing trend in suicide rates by time and age group.

Design: A descriptive study using nationwide mortality rates

Setting: Data on the nationwide cause of death from 1993 to 2016 were obtained from the Statistics Korea.

Participants: People living in the South Korea

Interventions: Implementation of national suicide prevention policies (1st: 2004 year, 2nd: 2009 year)

Primary outcome measures: Suicide was defined as “X60-X84” code according to the ICD-10 code. Age-standardized suicide rates were estimated, and a Joinpoint regression model was applied to describe the trends in suicide rate.

Results: From 2010 to 2016, the suicide rates in South Korea have been decreasing by 5.5% (95% CI: -10.3% to -0.5%) annually. In terms of sex, the suicide rate for men had increased by 5.0% (95% CI: 3.6% to 6.4%) annually from 1993 to 2010. However, there has been no statistically significant change from 2010 to 2016. For women, the suicide rate had increased by 7.5% (95% CI: 6.3% to 8.7%) annually from 1993 to 2009, but since 2009, the suicide rate has been significantly decreasing by 6.1% (95% CI: -9.1% to -3.0%) annually until 2016. In terms of the age group, the suicide rates among women of almost all age groups have been decreasing since 2010; however, the suicide rates of men aged between 30 and 49 years showed continuously increasing trends.

Conclusion: Our results showed that there were differences in the changing trends in suicide rate by sex and age groups. Our finding suggests that there was a possible relationship

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between implementation of second national suicide prevention policies and a decline in suicide rate.

Keywords: Suicide; Mortality; Social and political issues; Prevention; Republic of Korea

For peer review only

Article Summary

Strengths and limitations of this study

- Our findings show that efforts to reduce suicide at the national level may lead to a decline in suicide rates through natural experiment.
- Another finding of our study is that suicide rates in men in their 30s and 40s are continuing to increase, suggesting that a different suicide prevention strategy may be necessary in South Korea.
- Because this study is a descriptive epidemiologic study, it is difficult to know exactly which policies have reduced suicide rates in which age group.
- Improved accuracy of statistics on the causes of death may affect to changes in suicide rates.

Introduction

Suicide is a major public health issue, with an estimated 788,000 deaths every year according to the World Health Organization (WHO) statistics.¹ The WHO established the Mental Health Action 2013-2020 plan to implement a national, multi-sectorial promotion and prevention program for promoting mental health and reducing suicide rates of each country by 10% until 2020.² Especially, the developed countries in East Asia have relatively high mortality rates due to suicide.³ Among these countries, suicide in South Korea is a serious health problem because the suicide rate in South Korea in 2013 (28.5 per 100,000 person-years) was 2.4 times higher than the average suicide rates of other Organization for Economic Co-operation and Development (OECD) countries and South Korea has been ranked top among the OECD countries in terms of suicide rates in the last 10 years.⁴ In addition, suicide was the most common cause of death in young people aged between 10 and 39 years, and it was the second-most common cause of death among adults aged 40-59 years in 2016 in South Korea.⁵

South Korea implemented the national suicide prevention program in the early 2000s.⁶ This national suicide prevention program includes both high-risk group-oriented monitoring and prevention of suicide and suicide prevention program for general population such as media campaign.⁷ However, there was a few studies to examine the trends in suicide rates by sex and age group with regard to the national suicide prevention policies in South Korea. Therefore, this study aimed to describe the changing trends in suicide rate by sex and age group in South Korea and exploring the potential effects of implementation of the national suicide prevention policies.

Method

Study participants

The cause of death statistics is a reliable source of data on how the causes of death have changed because of socioeconomic changes and public health developments; it also provides comprehensive information to plan and prioritize health care policies. The number of deaths due to suicide and the corresponding mid-year population counts from 1993 to 2016 were obtained from Statistic Korea (Available from <http://kosis.kr/>). The Statistic Korea used the estimated population as the denominator for mortality rates before year 1993. After 1993, Statistic Korea used the mid-year population based on resident registration number as the denominator for mortality rates. In addition, the cause of death data before 1993 is less accurate, therefore, we selected the suicide rates from 1993 to 2016. The code assigned to the cause of death due to suicide was “X60-X84” according to the ICD-10 code.

Patient and Public Involvement

We did not contact with patients and our study was not directly associated with patients, because we used the administrative secondary data – the cause of death data from Statistic Korea. There was no role or participation of patients in our study.

National suicide prevention program

Information regarding the timing and implementation of the national suicide prevention policy in South Korea were obtained from relevant government data and expert consultants. Initially, the timing and details of the national suicide prevention policy were obtained from the national knowledge information system (<https://nkis.re.kr:4445/main.do>) and publications from Korea Suicide Prevention Center.⁷⁻¹⁰ The contents and details obtained from these

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4 websites were confirmed after review by the experts and staffs of Korea Suicide Prevention
5 Center.⁶⁻¹²
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10 ***Ethics statement***

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12 The study protocol was reviewed by the Institutional Review Board of Kyung Hee
13 University (IRB No.KHSIRB-17-086). Our study was exempted from review because it was
14 not an experimental trial, which required contacting the patients, and our study did not
15 include personal identifiable information.
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23 ***Statistical analysis***

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25 To describe the baseline characteristics of people who die due to suicide, the number of
26 deaths was presented for each 6-year period (1993-1998/1999-2004/2005-2010/2011-2016)
27 from 1993 to 2016. Chi-square test was used to test the differences in the distribution of death
28 due to suicide by sex and age groups. To describe the changes in suicide rates by time period,
29 the age-standardized suicide rates of suicide were calculated. The mid-year Korean
30 population in 2005 was used as the standard population for age-standardized suicide rates.
31 Age-specific suicide rates were applied to the corresponding 5-year age group of the standard
32 population. The sum of expected deaths for each 5-year age group was calculated, and the
33 age-standardized suicide rates were calculated by dividing the sum of expected deaths by the
34 total number of standard population. We used Joinpoint regression program to know whether
35 there were changes in trends in mortality rates. Joinpoint statistical software was developed
36 by the National Cancer Institute in the United States. Joinpoint regression modelling was
37 used to test the trends in age-standardized suicide rates for suicide and detect significant
38 changes over time to fit a better multi-segmented model compared to a simple linear model
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4 using a Monte Carlo permutation method.¹³ Further, it could detect point where significant
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6 change in rates over time. The trends in rates were summarized as annual percentage changes
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8 (APCs) and their 95% confidence intervals (CIs).
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10 *P* values <0.05 were considered statistically significant. We used SPSS (version 23.0,
11 Armonk, NY: IBM Corp., USA) and R software (version 3.1.1, Vienna, Austria) and
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13 Joinpoint Regression Program software (Version 4.1.1, Statistical Methodology and
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15 Applications Branch, Surveillance Research Program, National Cancer Institute, Bethesda,
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17 MD, USA).
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26 **Results**

27 *Baseline characteristics*

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30 The total number of deaths in South Korea from 1993 to 2016 was 6,007,678 (Table 1). Of
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32 these, the total number of deaths due to suicide was 249,085 (4.1%). Of the deaths due to
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34 suicide, 169,963 (68.2%) were men, and 79,122 (31.8%) were women. In terms of the time
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36 period, South Korea had the highest number of deaths from suicide (n=15,906) and the
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38 highest age-standardized suicide rate from suicide (29.1 per 100,000 person-year) in 2011
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40 (Table 2). After 2011, the number of deaths and age-standardized suicide rates due to suicide
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42 decreased until 2016. The number of deaths due to suicide in 2011-2016 was 2.5 times higher
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44 than that in 1993-1998. According to the age groups, the proportion of deaths due to suicide
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46 in children and adolescents aged between 10 and 19 years had decreased from 1993-1998 to
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48 2011-2016, whereas the proportion of elderly aged more than 70 years had increased during
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50 the same time period (p<0.0001).
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Trends in suicide rates

According to the joinpoint regression model, the mortality rate from suicide had increased by 5.6% (95% CI: 4.4% to 6.9%) annually from 1993 to 2010 (Figure 1). After 2010, the suicide rate had declined by 5.5% (95% CI: -10.3% to -0.5%) annually until 2016. In terms of sex, suicide rate for men had increased by 5.0% (95% CI: 3.6% to 6.4%) annually from 1993 to 2010. After 2010, suicide rate for men shown decreasing trends (APC=-4.3%, 95% CI: -9.8% to 1.6%), although it was not statistically significant ($p=0.14$). Similarly, the suicide rates for women had increased by 7.5% (95% CI: 6.3% to 8.7%) annually from 1993 to 2009. Following that, suicide rates for women showed a significant decreasing trend (APC=-6.1%, (95% CI: -9.1% to -3.0%)).

Trends in suicide rates for men by age group

Joinpoint regression analysis was performed by sex and age group. Suicide rates for men increased with age (Table 3). The suicide rate of adolescents aged 10-19 years is relatively low, ranging from 3 to 7 people per 100,000 persons. The suicide rate of adolescents aged 10-19 years has been increasing annually by 2.8% since 2001. Although there was no statistically significant change in suicide rate of young adults aged 20-29 years, the rates showed increasing trends from 2006 to 2010, and it has tended to decrease since 2010. The suicide rate of men aged 30-39 years showed a significant annual increase of 3.1% from 1993 to 2016. For men aged 40-49 years, the suicide rate dramatically increased by 15.6% annually from 1993 to 1998. Since 1998, the increasing trend in the suicide rate has attenuated among men aged 40-49 years (APC=1.9% (95% CI: 0.9% to 2.9%)). The suicide rate for men aged 50-59 years has increased by 8.0% from 1993 to 2004. However, there has been no

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4 significant increase since 2004. For men aged 60-69 years, there was a statistically significant
5 increase in suicide rate by 10.7% increase each year between 1993 and 2005; however, there
6 has been a decreasing trend since 2005. The suicide rate for men aged 70-79 years had
7 increased by 12.9% annually from 1993 to 2004 but has been decreasing by 7.5% annually
8 since 2011. For men aged 80 years and above, the suicide rate had increased by 9.2%
9 annually between 1993 and 2000. There was no significant change in the suicide rate for men
10 from 2000 to 2010. Since 2010, the suicide rate has been decreasing by 6.2% annually.
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21 ***Trends in suicide rates for women by age group***

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23 Table 3 shows the suicide rate for women by age group. The suicide rate of adolescents
24 aged 10-19 years is relatively low, and the trends of suicide rates are similar to that in the
25 twenties. Suicide rates in women aged 20-29 years had increased by 20.0% annually from
26 2001 to 2008. Since 2008, suicide rate for women aged 20-29 years has decreased by 9.5%
27 annually. The suicide rate of women aged 30-39 years showed a significant annual increase of
28 5.0% from 1993 to 2006, whereas the suicide rates tended to decrease by 5.9% annually from
29 2009 to 2016. For women aged 40-49 years, the suicide rate had increased by 6.5% annually
30 from 1993 to 2010. Since 2010, there was no significant change in the suicide rate. The
31 suicide rate for women aged 50-59 years had increased by 6.6% from 1993 to 2010. After
32 2010, the suicide rates for women aged 50-59 years showed a decreasing trend (APC=-5.5%
33 (95% CI: -8.6% to 0.0%)). For women aged 60-69 years, there was a statistically significant
34 increase in the suicide rate with 9.4% increase each year from 1993 to 2005; however, there
35 has been a significant decreasing trend since 2010 (APC=-8.7% (95% CI: -11.9% to -5.5%)).
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37 The suicide rate for women aged 70-79 years increased by 13.5% annually from 1993 to 2004
38 but has decreased significantly by 9.9% annually since 2011. For women aged 80 years and
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4 above, the suicide rates had dramatically increased by 18.0% annually from 1993 to 2004.
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6 There was no significant change from 2004 to 2011. Since 2011, suicide rate has decreased
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8 by 11.5% annually.
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12 ***The implementation of the National Suicide Prevention Program in South Korea***

14 The first step of the national suicide prevention program was the establishment of the first
15 5-year National Strategy for Suicide Prevention in 2004 (Figure 2). Based on this, a suicide
16 prevention program was introduced in 2005 at regional mental health centres which were
17 public community infrastructures for mental health. Following this, the second 5-year
18 National Strategy for Suicide Prevention was implemented in 2009. Based on this program, a
19 separate budget was newly proposed and executed. In 2010, a screen door was expanded to
20 prevent suicide on the subway. In 2011, the Act for the Prevention of Suicide was passed, the
21 Korea Suicide Prevention Center was established, and the sales of paraquat pesticides were
22 prohibited. The Act for the Prevention of Suicide was enforced in 2012, and the Korean
23 gatekeeper training program for suicide prevention entitled '*Look and Listening and Say*' was
24 introduced to the general population in South Korea. In 2013, an emergency department-
25 based suicide attempt survivor management program was implemented, and the Korea
26 Suicide Prevention Center along with Journalists Association of Korea announced the
27 recommendation for media reporting of suicide. In addition, the government authenticated the
28 private suicide prevention program to disseminate the evidence-based suicide prevention
29 program. In 2014, the government collaborated with religious organizations to increase the
30 participation rates of general population in the national suicide program. The Korea
31 Psychological Autopsy Center was established to understand the causes of suicide deaths
32 better.
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Discussion

This study aimed to examine the trends of suicide rate in South Korea by sex and age group and explore these suicide rate changes according to the timing of suicide prevention policies implemented by the Korean government. This study found that the overall suicide rate in South Korea had tended to decline since 2010. However, when analysed by sex and age, the suicide rate trends showed differences according to the sex and age groups. While women's suicide rate has decreased in all age groups since 2010, the suicide rate of men aged between 30 and 49 years is still on the rise. Our findings were consistent with the study findings of Matsubayashi et al.¹⁴ They showed that a national level of suicide prevention intervention was effective way to reduce suicide rate except for working-age adults in 21 OECD countries.¹⁴

Trend in suicide rate after 2004/2005

From 1993 to 2016, the suicide rates tended to change at two points in time. First, this study found that the suicide rate changed before and after 2004 and 2005. It was revealed that after 2004, an increase in the suicide rate of men and women aged 60 years or older had changed. After 2005, the suicide rate of men in their 60s decreased by 3.6% each year and that of women in their 60s, which had risen sharply up until 2005, no longer showed a statistically significant increase from 2005 to 2010.

During this period, Korea's 1st national suicide prevention initiative was implemented in 2004, which included various programs such as mental health improvement and suicide prevention, suicide prevention counseling calls, the development of a culture that respects life,

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4 treatment and post-suicide attempt management for those who attempt suicide, and suicide
5 prevention research.¹² In addition, the Mental Health Welfare Center, a national mental health
6 system, also implemented a regional suicide prevention program in 2005, and the Seoul
7 Suicide Prevention Center was first established.¹⁵ Although the 1st suicide prevention
8 initiative was implemented in 2004, the government did not earmark funding for the 1st
9 suicide prevention initiative.¹⁶ For this reason, it is difficult to find the data that can precisely
10 identify the programs that were actually implemented among various other programs.
11 Nonetheless, a suicide prevention program implemented by the Mental Health Welfare
12 Center mainly focused on management via phone calls, and it has been applied since 2005
13 without additional funding. Previous studies reported that interventions and management
14 based on phone calls were effective for the suicide prevention of the elderly,^{17,18} and in this
15 regard, changes in the suicide rate mostly found among those aged 60 years or older can be
16 attributed to the effect of phone-based interventions.¹⁹ These changes in the suicide rate,
17 however, were found to be not a statistically significant decline in the suicide rate overall but
18 a change in the increasing trend of the suicide rate.

Trend in suicide rate after 2008/2009

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Second, the suicide rate began to decline from 2008 to 2011. As of 2008 and 2009, the
suicide rate for females aged 10 to 39 years, which had increased before, began to decrease.
As of 2010 and 2011, the suicide rate of women aged 40 years or older also began to decline.
Furthermore, the suicide rates of men in their 20s and those aged 70 years or older tended to
decline since 2010 and 2011, respectively. In contrast, the suicide rate of men aged 30-49
years had not decreased significantly from 1993 to 2016; instead, it continued to rise during
this period.

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4 To begin with, the 2nd national suicide prevention initiative was enacted in 2009, which
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6 consisted of the research and development of suicide prevention policy, development of a
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8 culture that respects life, suicide prevention training and nurturing of specialists, online
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10 counselling and harmful suicide information monitoring, and public-private partnerships for
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12 suicide prevention.¹² The importance of the 2nd suicide prevention initiative is that the
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14 national budget was allocated for suicide prevention unlike the 1st suicide prevention
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16 initiative. While this initiative could be effective in reducing the suicide rate of young
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18 females in their 10s to 30s, it would be more reasonable to consider that a series of specific
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20 events contributed to a surge in the suicide rate of young women in 2008 and 2009. The
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22 effect of a celebrity's suicide on the suicide rate is well-known,^{20, 21} and there were incidents
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24 of suicides among very high-profile celebrities in 2008 and 2009 in South Korea, which were
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26 reported across the country.⁷ Furthermore, it was reported that the effect of a celebrity's
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28 suicide in Korea was five times higher among young women.²² Considering these results, it is
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30 a reasonable interpretation to view a reduction in the suicide rate of young women after 2009
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32 as a decline in the suicide rate surged previously due to the effect of a series of specific
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34 events—celebrity suicides.
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38 Some important national suicide prevention activities were carried out during the 2nd
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40 suicide prevention initiative, such as the installation of more screen doors to prevent people
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42 from throwing themselves into the subway train²³ and a ban on the sale of paraquat
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44 pesticides.²⁴ The one of the most effective suicide prevention intervention is to restrict of
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46 assessment to lethal methods.²⁵ Such government-led suicide prevention interventions may
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48 have contributed to the changes in the suicide rate of men in their 20s, men aged 70 years or
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50 older, and women aged 40 years or older in 2010 and 2011. Moreover, a continuous decrease
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52 in the suicide rate since 2011 indicates that the reduction of suicide rates was attributable to
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4 the government intervention efforts. After the introduction of the national suicide prevention
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6 initiative in 2009, the community mental health center has endeavoured to register and
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8 manage more people with severe mental disorder and people with alcoholism. Indeed, the
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10 mental health service utilization rates among people with alcoholism has increased from 8.1%
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12 in 2008 to 12.1% in 2015.²⁶ The registration and management rate for patients with severe
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14 mental disorder in the community mental health center has also increased from 19.2% in
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16 2008 to 26.4% in 2016. In addition, the government implemented an emergency department-
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18 based suicide attempt survivor management program, announced the recommendation for
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20 media reporting of suicide in 2013.⁷
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25 ***Increase in suicide rate of men in their 30s and 40s***

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27 Nevertheless, it was found that the suicide rate of men in their 30s and 40s had continued
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29 to increase significantly from 1993 to 2016. While there was a slight slowdown in the
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31 increase of their suicide rate due to suicide prevention programs implemented by the
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33 government, it did not result in a decrease in the suicide rate. This might suggest that the
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35 currently implemented suicide prevention programs are not effective for men in their 30s and
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37 40s. However, in Korea, suicide prevention policies focused on men in their 30s and 40s have
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39 not been implemented until now. In previous studies, men were reported to have a higher risk
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41 of suicide due to financial reasons than women do,²⁷ and the risk of suicide among men
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43 arising due to the unemployment rate and economic crisis was also shown to be higher.^{28,29}
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45 However, the current suicide prevention policies only included the development of an office
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47 worker gatekeeper program for men in their 30s and 40s.
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53 ***Strengths and Limitations of this study***

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4 When interpreting the findings of this study, the following limitations need to be
5 considered. This study did not take account of the individual effect of a suicide prevention
6 program; it instead interpreted the changes in suicide rates at each point in time when such
7 programs were implemented. However, we cannot confirm when exactly the effect of policy
8 was seen. This was because the data on the outcome of each individual suicide prevention
9 program were not available as Korea did not have a monitoring system for each individual
10 program, even though it implemented suicide prevention programs quite extensively. In this
11 regard, a monitoring system needs to be established in order to identify the policy effect on
12 the changes in the suicide rate in Korea more accurately, and a follow-up study needs to be
13 conducted using this system. Furthermore, the accuracy of the cause of death statistics had
14 continued to improve, so there is a chance that an increase in the number of deaths due to
15 suicide would have been affected by the improved accuracy of statistics on the causes of
16 death. Despite these limitations, this study has the following strengths. This study presented
17 the trends in the suicide rates in Korea based on statistical analysis of a 24-year period. In
18 addition, it showed that the point in time wherein such changes in the suicide rate occurred
19 coincided with that wherein the government-led suicide prevention programs were
20 implemented. Accordingly, further government-level investments and interventions should be
21 considered to reduce the suicide rate.
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45 **Conclusion**

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47 This study showed that the suicide rate among Korean men and women has decreased
48 since 2010, based on the causes of death statistics, which could represent the general
49 population of South Korea. Our findings also showed that there were significant changes in
50 trends Korea's suicide rate after 2004 to 2005 and 2008 to 2011. These changes in suicide
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4 rate coincided with those when the 2nd suicide prevention initiative enacted in 2009. In this
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6 regard, it is considered that government-level suicide prevention interventions had a potential
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8 effect on decreasing the suicide rate, and national-level efforts are still needed in the future to
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10 reduce the increasing suicide rate of men in their 30s and 40s.
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14 **Author contributions**

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16 S-U Lee obtained, analysed the data and wrote the manuscript and J-I P, S Lee, I-H Oh and
17
18 J-M Choi interpreted the data and contributed to revise the manuscript. C-M Oh made the
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20 research design and revised the manuscript.
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26
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29 20170835).
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34 **Conflicts of interests**

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36 On behalf of all the authors, the corresponding author declares that there are no conflicts of
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38 interests.
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43 **Patient consent**

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45 This study was a descriptive epidemiologic study using the cause of death database that
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47 could not identify individuals. Therefore, patient consent form was exempted from IRB.
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51 **Acknowledgments**

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53 All authors participated in the design, execution, and analysis of the results and have read
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4 and approved the final version. We are especially thankful for the advice and help of the
5
6 staffs and colleagues of the Korea Suicide Prevention Center. There was no role or
7
8 participation of patients in our study.
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10 11 12 **Ethical Standards** 13

14 The study protocol was reviewed and approved by Institutional Review Board of Kyung
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16 Hee University (IRB No. KHSIRB-17-086).
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21 **Data sharing statement** 22

23 All data used in this study can be obtained from Homepage of Statistic Korea
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REFERENCES

1. World Health Organisation. Suicide Data.
http://www.who.int/mental_health/prevention/suicide. (Accessed on 14 September 2017).
2. World Health Organisation. Mental health action plan 2013–2020.
http://www.who.int/mental_health/publications/action_plan/en/. (Accessed on 14 September 2017).
3. Hendin H, Phillips MR, Vijayakumar L, Pirkis J, Wang H, Yip P, Wasserman D, Bertolote JM, Fleischmann A. Suicide and suicide prevention in Asia. World Health Organization: Geneva, 2018.
4. Organization for Economic Co-operation and Development. OECD health data 2016.
<https://data.oecd.org/healthstat/suicide-rates.htm>. (Accessed on 14 September 2017).
5. Statistics Korea. Cause-of-Death Statistics 2017. <http://kosis.kr/en>. (Accessed on 14 September 2017).
6. Paik JW, Jo SJ, Lee S, Ong JY, Park JI. The Effect of Korean Standardized Suicide

- 1
2
3
4 Prevention Program on Intervention by Gatekeepers. J Korean Neuropsychiatr Assoc
5
6 2014;53:358-363. [In Korean].
7
- 8 7. Korea Suicide Prevention Center. Suicide White Book. Seoul: Ministry of Health and
9
10 Welfare, 2014 [In Korean].
11
- 12 8. Korea Suicide Prevention Center. Suicide White Book. Seoul: Ministry of Health and
13
14 Welfare, 2015 [In Korean].
15
- 16 9. Korea Suicide Prevention Center. Suicide White Book. Seoul: Ministry of Health and
17
18 Welfare, 2016 [In Korean].
19
- 20 10. Korea Suicide Prevention Center Suicide White Book. Seoul: Ministry of Health and
21
22 Welfare, 2017 [In Korean].
23
- 24 11. Kang HG. Social Welfare Delivery Reform: Achievements and Beyond, Health and
25
26 Welfare Policy Forum 2012;4:35-49
27
- 28 12. Lee SY. Policy options for the improvement of suicide prevention programs. Health and
29
30 Welfare Policy Forum 2015;4:34-49.
31
- 32 13. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with
33
34 applications to cancer rates. Stat Med 2000;19:335-351.
35
- 36 14. Matsubayashi T, Ueda M. The effect of national suicide prevention programs on suicide
37
38 rates in 21 OECD nations. Soc Sci Med 2011;73:1395-400.
39
- 40 15. National Mental Health and Welfare Commission. Guidelines for mental health services,
41
42 Seoul: Ministry of Health and Welfare 2005 [In Korean].
43
- 44 16. Park JI, Nam YY, Lee HK, Park JY, Lee MS, Lee SJ. National suicide prevention plan.
45
46 Seoul: Ministry of Health and Welfare, 2011 [In Korean].
47
- 48 17. De Leo D, Buono MD, Dwyer J. Suicide among the elderly: the long-term impact of a
49
50 telephone support and assessment intervention in northern Italy. Br J Psychiatry
51
52
53
54

- 2002;181: 226-9.
18. De Leo D, Carollo G, Buono MD. Lower suicide rates associated with a Tele-Help/Tele-Check service for the elderly at home. *Am J Psychiatry* 1995;152: 632-4.
19. Sun HJ. Suicide prevention efforts for the elderly in Korea. *Perspect Public Health* 2016;136:269-70.
20. Jeong J, Shin SD, Kim H, Hong YC, Hwang SS, Lee EJ. The effects of celebrity suicide on copycat suicide attempt: a multi-center observational study. *Soc Psychiatry Psychiatr Epidemiol* 2012;47:957-65.
21. Niederkrotenthaler T, Fu KW, Yip PS, Fong DY, Stack S, Cheng Q, Pirkis J. Changes in suicide rates following media reports on celebrity suicide: a meta-analysis. *J Epidemiol Community Health* 2012;66:1037-42.
22. Ju Ji N, Young Lee W, Seok Noh M, Yip PS. The impact of indiscriminate media coverage of a celebrity suicide on a society with a high suicide rate: epidemiological findings on copycat suicides from South Korea. *J Affect Disord* 2014;156:56-61.
23. Chung YW, Kang SJ, Matsubayashi T, Sawada Y, Ueda M. The effectiveness of platform screen doors for the prevention of subway suicides in South Korea. *J Affect Disord*. 2016 ;194:80-3.
24. Cha ES, Chang SS, Gunnell D, Eddleston M, Khang YH, Lee WJ. Impact of paraquat regulation on suicide in South Korea. *Int J Epidemiol* 2015;45:470-9.
25. Zalsman G, Hawton K, Wasserman D, van Heeringen K, Arensman E, Sarchiapone M, Carli V, Höschl C, Barzilay R, Balazs J, Purebl G, Kahn JP, Sáiz PA, Lipsicas CB, Bobes J, Cozman D, Hegerl U, Zohar J. Suicide prevention strategies revisited: 10-year systematic review. *Lancet Psychiatry* 2016;3:646-59.
26. Korea Health Promotion Institute. Health Plan 2020. <http://www.khealth.or.kr/healthplan>.

(Accessed on 24 April 2018).

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27. Lee SU, Oh IH, Jeon HJ, Roh S. Suicide rates across income levels: Retrospective cohort data on 1 million participants collected between 2003 and 2013 in South Korea. *J Epidemiol* 2017;27:258-64.
28. 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.
29. Hawton K, Arensman E, Wasserman D, Hulten A, Bille-Brahe U, Bjerke T, Crepet P, Deisenhammer E, Kerkhof A, De Leo D, Michel K, Ostamo A, Philippe A, Querejeta I, Salander-Renberg E, Schmidtke A, Temesváry B. Relation between attempted suicide and suicide rates among young people in Europe. *J Epidemiol Community Health* 1998;52:191-4
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Table 1. Baseline characteristics of suicide by sex and age group

Characteristics	Overall	Year				<i>p</i> -value [¶]
		1993-1998	1999-2004	2005-2010	2011-2016	
Total number of deaths*	6,007,678	1,445,819	1,467,088	1,479,483	1,615,288	
Number of deaths due to suicide[†]	249,085 (4.15%)	34,064 (2.36%)	51,413 (3.50%)	78,674 (5.32%)	84,934 (5.26%)	
Sex[‡]						<0.0001
Men	169,963 (68.23%)	23,733 (69.67%)	35,619 (69.28%)	51,525 (65.49%)	59,086 (69.57%)	
Women	79,122 (31.77%)	10,331 (30.33%)	15,794 (30.72%)	27,149 (34.51%)	25,848 (30.43%)	
Age group[§]						<0.0001
10-19 years	7,712 (3.1%)	2,338 (6.9%)	1,629 (3.2%)	1,936 (2.5%)	1,809 (2.1%)	
20-29 years	29,988 (12.0%)	7,108 (20.9%)	6,306 (12.3%)	9,097 (11.6%)	7,477 (8.8%)	
30-39 years	43,015 (17.3%)	7,800 (22.9%)	9,654 (18.8%)	12,575 (16.0%)	12,986 (15.3%)	
40-49 years	47,796 (19.2%)	5,815 (17.1%)	10,468 (20.4%)	14,938 (19.0%)	16,575 (19.5%)	
50-59 years	41,960 (16.8%)	4,701 (13.8%)	7,705 (15.0%)	12,593 (16.0%)	16,961 (20.0%)	
60-69 years	33,214 (13.3%)	3,259 (9.6%)	7,441 (14.5%)	11,615 (14.8%)	10,899 (12.8%)	
70-79 years	29,654 (11.9%)	2,142 (6.3%)	5,389 (10.5%)	10,337 (13.1%)	11,786 (13.9%)	
≥80 years	15,661 (6.3%)	873 (2.6%)	2,800 (5.5%)	5,557 (7.1%)	6,431 (7.6%)	

*Total number of deaths present the overall cause of deaths.

[†]The denominator for percentage of number of deaths due to suicide was total number of deaths.

[‡]The number and percentage of death due to suicide by sex and age group were presented among people aged ≥ 10 years old.

[§] The number and percentage of death due to suicide by sex and age group were presented among people aged ≥ 10 years old.

[¶]Chi-square test was used to test the differences in the number of deaths by sex and age group

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Table 2. The number of death from suicide, suicide rates from 1993 to 2016 in South Korea

Year	Population	Number of suicide death	Age-standardized suicide rate*
1993	44,752,157	4,208	10.7
1994	45,208,726	4,277	10.7
1995	45,637,184	4,930	12.1
1996	46,062,143	5,959	14.4
1997	46,475,163	6,068	14.5
1998	46,837,620	8,622	20.4
1999	47,163,425	7,056	16.5
2000	47,534,117	6,444	14.9
2001	47,877,049	6,911	15.7
2002	48,125,745	8,612	19.2
2003	48,308,386	10,898	23.7
2004	48,485,314	11,492	24.6
2005	48,683,040	12,011	25.1
2006	48,887,027	10,653	21.7
2007	49,130,354	12,174	24.3
2008	49,404,648	12,858	25.1
2009	49,656,756	15,412	29.5
2010	49,879,812	15,566	29.1
2011	50,111,476	15,906	29.1
2012	50,345,325	14,160	25.3
2013	50,558,952	14,427	25.3
2014	50,763,158	13,836	24.0
2015	50,951,719	13,513	22.8
2016	51,112,972	13,092	21.9

*Age-standardized rates were expressed per 100,000 people and Korean mid-year population in year 2005 was used for age-standardization. Data was obtained from Statistics Korea (Available from: <http://kosis.kr/>)

Table 3. Joinpoint regression analysis for suicide rate from 1993 to 2016 in Korean by age group

Categories	Suicide rate		Trend 1		Trend 2		Trend 3		Trend 4	
	1993	2016	Years	APC (95% CI)	Years	APC (95% CI)	Years	APC (95% CI)	Years	APC (95% CI)
Men										
10-19 years old	5.35	5.57	1993-1998	4.8% (-5.2% to 16.0%)	1998-2001	-14.7% (-48.4% to 40.9%)	2001-2016	2.8% (0.5% to 5.2%)*		
20-29 years old	14.44	19.91	1993-2006	0.5% (-1.6% to 2.7%)	2006-2010	12.1% (-7.3% to 35.6%)	2010-2016	-5.8% (-11.7% to 0.5%)		
30-39 years old	15.53	31.32	1993-2016	3.0% (2.1% to 4.0%)*						
40-49 years old	18.39	42.34	1993-1998	15.6% (3.0% to 29.8%)*	1998-2016	1.9% (0.8% to 2.9%)*				
50-59 years old	23.92	48.32	1993-2004	8.0% (4.6% to 11.5%)*	2004-2016	-0.2% (-1.9% to 1.6%)				
60-69 years old	26.58	55.74	1993-2005	10.7% (7.8% to 13.7%)*	2005-2016	-3.6% (-5.5% to -1.7%)*				
70-79 years old	34.38	90.32	1993-2004	12.9% (9.9% to 16.0%)*	2004-2011	1.2% (-2.2% to 4.7%)	2011-2016	-7.5% (-11.2% to -3.5%)*		
≥80 years old	41.74	150.52	1993-2000	9.2% (2.3% to 16.7%)*	2000-2003	29.7% (-3.3% to 74.0%)	2003-2010	0.9% (-2.4% to 4.3%)	2010-2016	-6.2% (-8.8% to -3.6%)*
Women										
10-19 years old	3.01	4.15	1993-1998	14.4% (5.2% to 24.3%)*	1998-2001	-21.4% (-47.0% to 16.6%)	2001-2009	8.0% (2.3% to 14.0%)*	2009-2016	-5.1% (-10.0% to -0.0%)*
20-29 years old	6.97	12.46	1993-1998	10.0% (-1.3% to 22.5%)	1998-2001	-14.8% (-47.7% to 38.8%)	2001-2008	19.9% (12.0% to 28.5%)*	2008-2016	-9.5% (-13.3% to -5.6%)*
30-39 years old	8.07	17.65	1993-2006	5.0% (3.2% to 6.8%)*	2006-2009	20.8% (-4.4% to 52.5%)	2009-2016	-5.9% (-8.9% to -2.8%)*		
40-49 years old	7.57	16.47	1993-2010	6.5% (5.4% to 7.7%)*	2010-2016	-3.3% (-6.8% to 0.3%)				
50-59 years old	5.47	16.35	1993-2010	6.6% (5.0% to 8.2%)*	2010-2016	-5.5% (-8.6% to 0.0%)				
60-69 years old	9.10	14.65	1993-2005	9.4% (7.5% to 11.4%)*	2005-2010	0.7% (-5.4% to 7.3%)	2010-2016	-8.7% (-11.9% to -5.5%)*		
70-79 years old	12.19	26.50	1993-2004	13.5% (11.0% to 16.1%)*	2004-2011	-1.5% (-4.6% to 1.7%)	2011-2016	-9.9% (-13.9% to -5.8%)*		
≥80 years old	17.21	45.73	1993-2004	18.0% (14.3% to 21.8%)*	2004-2011	-1.3% (-5.1% to 2.5%)	2011-2016	-11.5% (-15.8% to -6.9%)*		

Joinpoint regression model is used to test that age-standardized rates have significantly changed. The trends in suicide mortality rates were summarized as APC (annual percentage change).

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Age-standardized rates were expressed per 100,000 men and Korean mid-year population in year 2005 was used for age-standardization.
APC: annual percentage change, CI: confidence interval.
**p*-value <0.05

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5 **Figure legends**
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8 **Figure 1.** Trends in age-standardized suicide rates in South Korea, 1993-2016
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10 Footnotes:

11 APC=Annual percent change

12
13 The age-standardized suicide rates are presented as suicide death cases per 100,000 people using Korean mid-year population in 2005 as
14 standard population.
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16 Joinpoint regression analysis was used to determine whether there were significant changes in trends in age-standardized suicide rates for the
17 period between 1993 and 2016.
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19 *p<0.05
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24 **Figure 2.** Implementation of National Suicide Prevention Program and Plan
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26 Footnotes:

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28 The age-standardized suicide rates are presented as connected line from 1993 to 2016.
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30 Each number represents the year in which the major events related to national suicide prevention program or plan were occurred.
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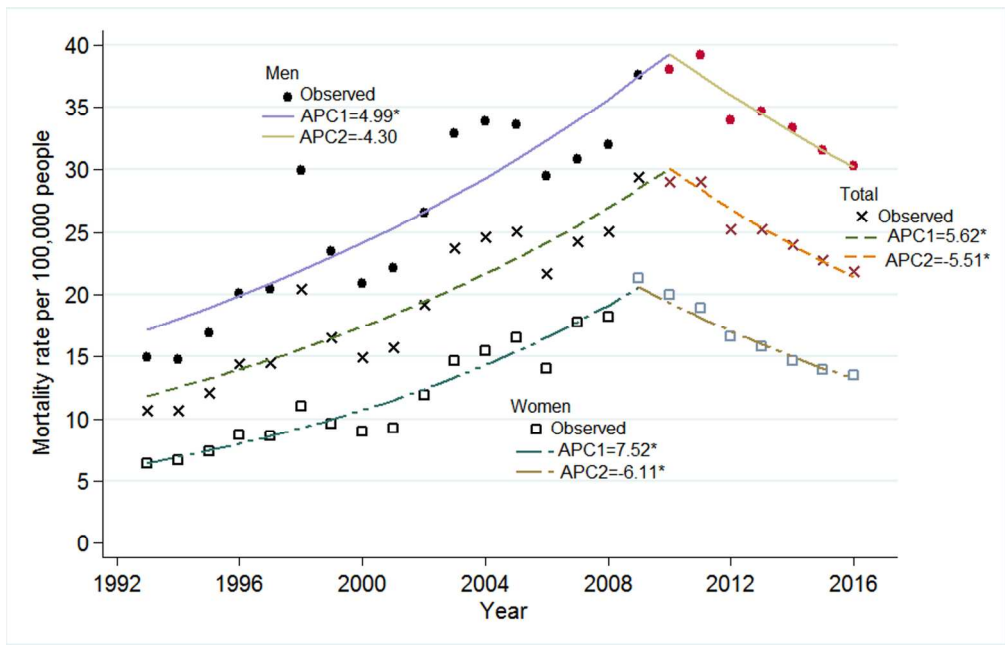
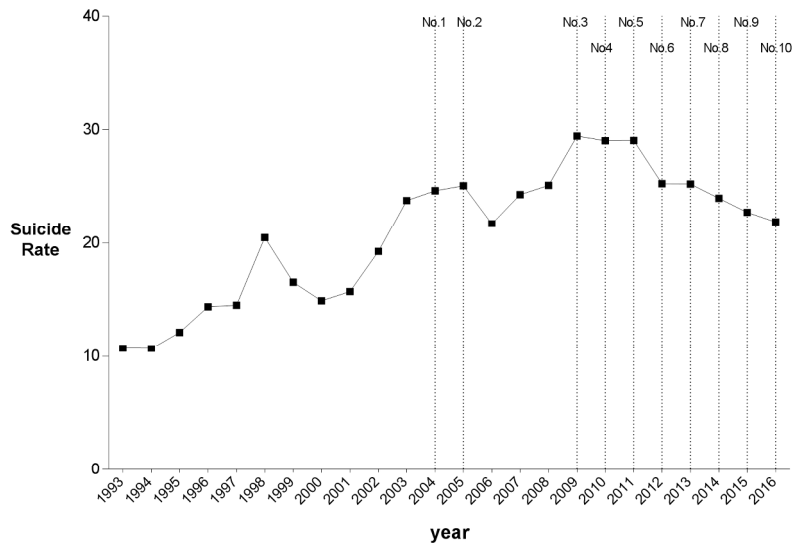


Figure 1. Trends in age-standardized suicide rates in South Korea, 1993-2016

141x90mm (300 x 300 DPI)



No.	Year	National suicide prevention program or plan
1	2004	The establishment of the first 5-year National Strategy for Suicide Prevention
2	2005	Suicide prevention program was introduced into regional mental welfare centers
3	2009	The establishment of the second 5-year National Strategy for Suicide Prevention
4	2010	The establishment of integrated welfare system The expansion of the basic living subsidies The increase in the number of welfare officers
5	2011	The enactment of the Act on Preventing Suicide The inhibition of sales of paraquat pesticides
6	2012	The enforcement of the Act on Preventing Suicide The introduction of the Korean gatekeeper program for suicide prevention entitled "Look and Listening and Say"
7	2013	The introduction of management of emergency department based suicide attempts The certification of private suicide prevention
8	2014	The collaboration the government with religious organizations The establishment of the Korea Psychological Autopsy Center
9	2015	The expansion of screen door on the subway "Are you okay" campaign
10	2016	The establishment of the comprehensive national mental health care strategy "Air kiss" campaign

Figure 2. Implementation of National Suicide Prevention Program and Plan

275x399mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	p.1,2 p.2-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p.5
Objectives	3	State specific objectives, including any prespecified hypotheses	p.5 line8-10
Methods			
Study design	4	Present key elements of study design early in the paper	p.1,2,7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p.6 Line1-10
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (b) For matched studies, give matching criteria and number of exposed and unexposed	p.6 Line1-10 -
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p.6 Line9-10, 17-24
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	p.6 Line17-24
Bias	9	Describe any efforts to address potential sources of bias	p.15 Line16-17 p.16, 17 Line 9
Study size	10	Explain how the study size was arrived at	p.8 Line 9-14
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p.7 Line 9-12
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, explain how loss to follow-up was addressed (e) Describe any sensitivity analyses	p.7 Line 8-9 p.8 Line 5 p.7 Line 9-12 - - -
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage	p.8 Line 9-14 -

		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	p.8 Line 9-14 - p.8 Line 10
Outcome data	15*	Report numbers of outcome events or summary measures over time	p.8 Line 10-14
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	p.8 Line 22- p.10 Line 23 p.7 Line 9-12 Table 2
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	p.11 Line 23- p.12 Line 5
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p.15 Line 16- p.16 Line 4
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p.12 Line 9- p.15 Line 14
Generalisability	21	Discuss the generalisability (external validity) of the study results	p.12 Line 5-7 p.15 Line 8-14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p.17 Line 2-4

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.

BMJ Open

Changing trends in suicide rates in South Korea from 1993 to 2016: A descriptive study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-023144.R2
Article Type:	Research
Date Submitted by the Author:	26-Jun-2018
Complete List of Authors:	Lee, Sang Uk; National Center for Mental Health, Mental Health Research Park, Jong-Ik; Kangwon National University School of Medicine, Department of Psychiatry Lee, Soojung; Kyungnam University, Department of Nursing Oh, In-Hwan; Kyung Hee University, Department of Preventive Medicine Choi, Joong-Myung ; Kyung Hee University, Department of Preventive Medicine Oh, Chang-Mo; Kyung Hee University, Department of Preventive Medicine
Primary Subject Heading:	Mental health
Secondary Subject Heading:	Epidemiology, Health policy, Public health
Keywords:	Suicide & self-harm < PSYCHIATRY, Mortality, Social and political issues, Prevention, Republic of Korea

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4 **Changing trends in suicide rates in South Korea from 1993 to**
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7 **2016: A descriptive study**
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11 Running title: Trends in suicide in South Korea
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16 Sang-Uk Lee^{1,2}, Jong-Ik Park³, Soojung Lee⁴, In-Hwan Oh², Joong-Myung Choi², Chang-Mo
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53 **Word count:** 3,746
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Abstract

Objectives: South Korean government has recently implemented policies to prevent suicide. However, there were few studies examining the recent changing trend in suicide rates. This study aims to examine the changing trend in suicide rates by time and age group.

Design: A descriptive study using nationwide mortality rates

Setting: Data on the nationwide cause of death from 1993 to 2016 were obtained from the Statistics Korea.

Participants: People living in the South Korea

Interventions: Implementation of national suicide prevention policies (1st: 2004 year, 2nd: 2009 year)

Primary outcome measures: Suicide was defined as “X60-X84” code according to the ICD-10 code. Age-standardized suicide rates were estimated, and a Joinpoint regression model was applied to describe the trends in suicide rate.

Results: From 2010 to 2016, the suicide rates in South Korea have been decreasing by 5.5% (95% CI: -10.3% to -0.5%) annually. In terms of sex, the suicide rate for men had increased by 5.0% (95% CI: 3.6% to 6.4%) annually from 1993 to 2010. However, there has been no statistically significant change from 2010 to 2016. For women, the suicide rate had increased by 7.5% (95% CI: 6.3% to 8.7%) annually from 1993 to 2009, but since 2009, the suicide rate has been significantly decreasing by 6.1% (95% CI: -9.1% to -3.0%) annually until 2016. In terms of the age group, the suicide rates among women of almost all age groups have been decreasing since 2010; however, the suicide rates of men aged between 30 and 49 years showed continuously increasing trends.

Conclusion: Our results showed that there were differences in the changing trends in suicide rate by sex and age groups. Our finding suggests that there was a possible relationship

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4 between implementation of second national suicide prevention policies and a decline in
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6 suicide rate.
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10 **Keywords:** Suicide; Mortality; Social and political issues; Prevention; Republic of Korea
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Article Summary

Strengths and limitations of this study

- Our findings show that efforts to reduce suicide at the national level may lead to a decline in suicide rates especially among elderly people through natural experiment.
- Another finding of our study is that suicide rates in men in their 30s and 40s are continuing to increase, suggesting that a different suicide prevention strategy may be necessary in South Korea.
- Because this study is a descriptive epidemiologic study, it is difficult to know exactly which policies have reduced suicide rates in which age group.
- Improved accuracy of statistics on the causes of death may affect to changes in suicide rates.

Introduction

Suicide is a major public health issue, with an estimated 788,000 deaths every year according to the World Health Organization (WHO) statistics.¹ The WHO established the Mental Health Action 2013-2020 plan to implement a national, multi-sectorial promotion and prevention program for promoting mental health and reducing suicide rates of each country by 10% until 2020.² Especially, the developed countries in East Asia have relatively high mortality rates due to suicide.³ Among these countries, suicide in South Korea is a serious health problem because the suicide rate in South Korea in 2013 (28.5 per 100,000 person-years) was 2.4 times higher than the average suicide rates of other Organization for Economic Co-operation and Development (OECD) countries and South Korea has been ranked top among the OECD countries in terms of suicide rates in the last 10 years.⁴ In addition, suicide was the most common cause of death in young people aged between 10 and 39 years, and it was the second-most common cause of death among adults aged 40-59 years in 2016 in South Korea.⁵

South Korea implemented the national suicide prevention program in the early 2000s.⁶ This national suicide prevention program includes both high-risk group-oriented monitoring and prevention of suicide and suicide prevention program for general population such as media campaign.⁷ However, there was a few studies to examine the trends in suicide rates by sex and age group with regard to the national suicide prevention policies in South Korea. Therefore, this study aimed to describe the changing trends in suicide rate by sex and age group in South Korea and exploring the potential effects of implementation of the national suicide prevention policies.

Method

Study participants

The cause of death statistics is a reliable source of data on how the causes of death have changed because of socioeconomic changes and public health developments; it also provides comprehensive information to plan and prioritize health care policies. The number of deaths due to suicide and the corresponding mid-year population counts from 1993 to 2016 were obtained from Statistic Korea (Available from <http://kosis.kr/>). The Statistic Korea used the estimated population as the denominator for mortality rates before year 1993. After 1993, Statistic Korea used the mid-year population based on resident registration number as the denominator for mortality rates. In addition, the cause of death data before 1993 is less accurate, therefore, we selected the suicide rates from 1993 to 2016. The code assigned to the cause of death due to suicide was “X60-X84” according to the ICD-10 code.

Patient and Public Involvement

We did not contact with patients and our study was not directly associated with patients, because we used the administrative secondary data – the cause of death data from Statistic Korea. There was no role or participation of patients in our study.

National suicide prevention program

Information regarding the timing and implementation of the national suicide prevention policy in South Korea were obtained from relevant government data and expert consultants. Initially, the timing and details of the national suicide prevention policy were obtained from the national knowledge information system (<https://nkis.re.kr:4445/main.do>) and publications from Korea Suicide Prevention Center.⁷⁻¹⁰ The contents and details obtained from these

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4 websites were confirmed after review by the experts and staffs of Korea Suicide Prevention
5 Center.⁶⁻¹²
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10 ***Ethics statement***

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12 The study protocol was reviewed by the Institutional Review Board of Kyung Hee
13 University (IRB No.KHSIRB-17-086). Our study was exempted from review because it was
14 not an experimental trial, which required contacting the patients, and our study did not
15 include personal identifiable information.
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23 ***Statistical analysis***

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25 To describe the baseline characteristics of people who die due to suicide, the number of
26 deaths was presented for each 6-year period (1993-1998/1999-2004/2005-2010/2011-2016)
27 from 1993 to 2016. Chi-square test was used to test the differences in the distribution of death
28 due to suicide by sex and age groups. To describe the changes in suicide rates by time period,
29 the age-standardized suicide rates of suicide were calculated. The mid-year Korean
30 population in 2005 was used as the standard population for age-standardized suicide rates.
31 Age-specific suicide rates were applied to the corresponding 5-year age group of the standard
32 population. The sum of expected deaths for each 5-year age group was calculated, and the
33 age-standardized suicide rates were calculated by dividing the sum of expected deaths by the
34 total number of standard population. We used Joinpoint regression program to know whether
35 there were changes in trends in mortality rates. Joinpoint statistical software was developed
36 by the National Cancer Institute in the United States. Joinpoint regression modelling was
37 used to test the trends in age-standardized suicide rates for suicide and detect significant
38 changes over time to fit a better multi-segmented model compared to a simple linear model
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4 using a Monte Carlo permutation method.¹³ Further, it could detect point where significant
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6 change in rates over time. The trends in rates were summarized as annual percentage changes
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8 (APCs) and their 95% confidence intervals (CIs).
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10 *P* values <0.05 were considered statistically significant. We used SPSS (version 23.0,
11 Armonk, NY: IBM Corp., USA) and R software (version 3.1.1, Vienna, Austria) and
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13 Joinpoint Regression Program software (Version 4.1.1, Statistical Methodology and
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15 Applications Branch, Surveillance Research Program, National Cancer Institute, Bethesda,
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17 MD, USA).
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26 **Results**

27 *Baseline characteristics*

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30 The total number of deaths in South Korea from 1993 to 2016 was 6,007,678 (Table 1). Of
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32 these, the total number of deaths due to suicide was 249,085 (4.2%). Of the deaths due to
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34 suicide, 169,963 (68.2%) were men, and 79,122 (31.8%) were women. In terms of the time
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36 period, South Korea had the highest number of deaths from suicide (n=15,906) in 2011 and
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38 the highest age-standardized suicide rate from suicide (29.5 per 100,000 person-year) in 2009
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40 (Table 2). After 2011, the number of deaths and age-standardized suicide rates due to suicide
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42 decreased until 2016. The number of deaths due to suicide in 2011-2016 was 2.5 times higher
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44 than that in 1993-1998. According to the age groups, the proportion of deaths due to suicide
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46 in children and adolescents aged between 10 and 19 years had decreased from 1993-1998 to
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48 2011-2016, whereas the proportion of elderly aged more than 70 years had increased during
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50 the same time period (p<0.0001).
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Trends in suicide rates

According to the joinpoint regression model, the mortality rate from suicide had increased by 5.6% (95% CI: 4.4% to 6.9%) annually from 1993 to 2010 (Figure 1). After 2010, the suicide rate had declined by 5.5% (95% CI: -10.3% to -0.5%) annually until 2016. In terms of sex, suicide rate for men had increased by 5.0% (95% CI: 3.6% to 6.4%) annually from 1993 to 2010. After 2010, suicide rate for men shown decreasing trends (APC=-4.3%, 95% CI: -9.8% to 1.6%), although it was not statistically significant ($p=0.14$). Similarly, the suicide rates for women had increased by 7.5% (95% CI: 6.3% to 8.7%) annually from 1993 to 2009. Following that, suicide rates for women showed a significant decreasing trend (APC=-6.1%, (95% CI: -9.1% to -3.0%)).

Trends in suicide rates for men by age group

Joinpoint regression analysis was performed by sex and age group. Suicide rates for men increased with age (Table 3). The suicide rate of adolescents aged 10-19 years is relatively low, ranging from 3 to 7 people per 100,000 persons. The suicide rate of adolescents aged 10-19 years has been increasing annually by 2.8% since 2001. Although there was no statistically significant change in suicide rate of young adults aged 20-29 years, the rates showed increasing trends from 2006 to 2010, and it has tended to decrease since 2010. The suicide rate of men aged 30-39 years showed a significant annual increase of 3.1% from 1993 to 2016. For men aged 40-49 years, the suicide rate dramatically increased by 15.6% annually from 1993 to 1998. Since 1998, the increasing trend in the suicide rate has attenuated among men aged 40-49 years (APC=1.9% (95% CI: 0.9% to 2.9%)). The suicide rate for men aged 50-59 years has increased by 8.0% from 1993 to 2004. However, there has been no

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4 significant increase since 2004. For men aged 60-69 years, there was a statistically significant
5 increase in suicide rate by 10.7% increase each year between 1993 and 2005; however, there
6 has been a decreasing trend since 2005. The suicide rate for men aged 70-79 years had
7 increased by 12.9% annually from 1993 to 2004 but has been decreasing by 7.5% annually
8 since 2011. For men aged 80 years and above, the suicide rate had increased by 9.2%
9 annually between 1993 and 2000. There was no significant change in the suicide rate for men
10 from 2000 to 2010. Since 2010, the suicide rate has been decreasing by 6.2% annually.
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21 ***Trends in suicide rates for women by age group***

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23 Table 3 shows the suicide rate for women by age group. The suicide rate of adolescents
24 aged 10-19 years is relatively low, and the trends of suicide rates are similar to that in the
25 twenties. Suicide rates in women aged 20-29 years had increased by 19.9% annually from
26 2001 to 2008. Since 2008, suicide rate for women aged 20-29 years has decreased by 9.5%
27 annually. The suicide rate of women aged 30-39 years showed a significant annual increase of
28 5.0% from 1993 to 2006, whereas the suicide rates tended to decrease by 5.9% annually from
29 2009 to 2016. For women aged 40-49 years, the suicide rate had increased by 6.5% annually
30 from 1993 to 2010. Since 2010, there was no significant change in the suicide rate. The
31 suicide rate for women aged 50-59 years had increased by 6.6% from 1993 to 2010. After
32 2010, the suicide rates for women aged 50-59 years showed a decreasing trend (APC=-5.5%
33 (95% CI: -8.6% to 0.0%)). For women aged 60-69 years, there was a statistically significant
34 increase in the suicide rate with 9.4% increase each year from 1993 to 2005; however, there
35 has been a significant decreasing trend since 2010 (APC=-8.7% (95% CI: -11.9% to -5.5%)).
36 The suicide rate for women aged 70-79 years increased by 13.5% annually from 1993 to 2004
37 but has decreased significantly by 9.9% annually since 2011. For women aged 80 years and
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4 above, the suicide rates had dramatically increased by 18.0% annually from 1993 to 2004.
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6 There was no significant change from 2004 to 2011. Since 2011, suicide rate has decreased
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8 by 11.5% annually.
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12 ***The implementation of the National Suicide Prevention Program in South Korea***

14 The first step of the national suicide prevention program was the establishment of the first
15 5-year National Strategy for Suicide Prevention in 2004 (Figure 2). Based on this, a suicide
16 prevention program was introduced in 2005 at regional mental health centres which were
17 public community infrastructures for mental health. Following this, the second 5-year
18 National Strategy for Suicide Prevention was implemented in 2009. Based on this program, a
19 separate budget was newly proposed and executed. In 2010, a screen door was expanded to
20 prevent suicide on the subway. In 2011, the Act for the Prevention of Suicide was passed, the
21 Korea Suicide Prevention Center was established, and the sales of paraquat pesticides were
22 prohibited. The Act for the Prevention of Suicide was enforced in 2012, and the Korean
23 gatekeeper training program for suicide prevention entitled '*Watch, Listen and Talk*' was
24 introduced to the general population in South Korea. In 2013, an emergency department-
25 based suicide attempt survivor management program was implemented, and the Korea
26 Suicide Prevention Center along with Journalists Association of Korea announced the
27 recommendation for media reporting of suicide. In addition, the government authenticated the
28 private suicide prevention program to disseminate the evidence-based suicide prevention
29 program. In 2014, the government collaborated with religious organizations to increase the
30 participation rates of general population in the national suicide program. The Korea
31 Psychological Autopsy Center was established to understand the causes of suicide deaths
32 better.
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Discussion

This study aimed to examine the trends of suicide rate in South Korea by sex and age group and explore these suicide rate changes according to the timing of suicide prevention policies implemented by the Korean government. This study found that the overall suicide rate in South Korea had tended to decline since 2010. However, when analysed by sex and age, the suicide rate trends showed differences according to the sex and age groups. While women's suicide rate has decreased in all age groups since 2010, the suicide rate of men aged between 30 and 49 years is still on the rise. Our findings were consistent with the study findings of Matsubayashi et al.¹⁴ They showed that a national level of suicide prevention intervention was an effective way to reduce suicide rate except for working-age adults in 21 OECD countries.¹⁴

Trend in suicide rate after 2004/2005

From 1993 to 2016, the suicide rates tended to change at two points in time. The suicide rates of South Korea have increased continuously from 1993 to 2010. According to the study of Kwon et al, the recent increase in suicide during 1986-2005 was mainly attributed to increase in suicide in elderly people.¹⁵ The rapid social change such as the increasing tendency of smaller family size may make the elderly feel isolated. In addition, insufficient social security system and economical problem may lead to an increase in suicide rates in the elderly.¹⁵ However, suicide rate of young people aged less than 45 years old have also increased significantly.¹⁵ The rising economic inequality and increasing unemployment rate due to economic crisis in 1997 of Korea may contribute to the increase in suicide rate among

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4 young people. In addition, the fragmentation of social integration may have weakened the
5
6 social ability to overcome mental problem such as depression.¹⁵
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9 However, our study found that the suicide rate changed before and after 2004 and 2005. It
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11 was revealed that after 2004, an increase in the suicide rate of men and women aged 60 years
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13 or older had changed. After 2005, the suicide rate of men in their 60s decreased by 3.6% each
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15 year and that of women in their 60s, which had risen sharply up until 2005, no longer showed
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17 a statistically significant increase from 2005 to 2010.
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20 During this period, Korea's 1st national suicide prevention initiative was implemented in
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22 2004, which included various programs such as mental health improvement and suicide
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24 prevention, suicide prevention counseling calls, the development of a culture that respects life,
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26 treatment and post-suicide attempt management for those who attempt suicide, and suicide
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28 prevention research.¹² In addition, the Mental Health Welfare Center, a national mental health
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30 system, also implemented a regional suicide prevention program in 2005, and the Seoul
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32 Suicide Prevention Center was first established.¹⁶ Although the 1st suicide prevention
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34 initiative was implemented in 2004, the government did not earmark funding for the 1st
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36 suicide prevention initiative.¹⁷ In other words, this project had just added suicide prevention
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38 program to the existing mental health care service without sufficient additional budgets and
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40 manpower. In addition, the scope of this policy was mainly focused on the individuals with
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42 mental disorder, and there was not sufficient consideration for social and environmental
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44 changes. For this reason, it is difficult to find the data that can precisely identify the programs
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46 that were actually implemented among various other programs. Nonetheless, a suicide
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48 prevention program implemented by the Mental Health Welfare Center mainly focused on
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50 management via phone calls, and it has been applied since 2005 without additional funding.
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4 Previous studies reported that interventions and management based on phone calls were
5 effective for the suicide prevention of the elderly,^{18,19} and in this regard, changes in the
6 suicide rate mostly found among those aged 60 years or older can be attributed to the effect
7 of phone-based interventions.²⁰ These changes in the suicide rate, however, were found to be
8 not a statistically significant decline in the suicide rate overall but a change in the increasing
9 trend of the suicide rate.
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19 ***Trend in suicide rate after 2008/2009***

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21 Second, the suicide rate began to decline from 2008 to 2011. As of 2008 and 2009, the
22 suicide rate for females aged 10 to 39 years, which had increased before, began to decrease.
23 As of 2010 and 2011, the suicide rate of women aged 40 years or older also began to decline.
24 Furthermore, the suicide rates of men in their 20s and those aged 70 years or older tended to
25 decline since 2010 and 2011, respectively. In contrast, the suicide rate of men aged 30-49
26 years had not decreased significantly from 1993 to 2016; instead, it continued to rise during
27 this period.
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36 To begin with, the 2nd national suicide prevention initiative was enacted in 2009, which
37 consisted of the research and development of suicide prevention policy, development of a
38 culture that respects life, suicide prevention training and nurturing of specialists, online
39 counselling and harmful suicide information monitoring, and public-private partnerships for
40 suicide prevention.¹² The importance of the 2nd suicide prevention initiative is that the
41 national budget was allocated for suicide prevention unlike the 1st suicide prevention
42 initiative. While this initiative could be effective in reducing the suicide rate of young
43 females in their 10s to 30s, it would be more reasonable to consider that a series of specific
44 events contributed to a surge in the suicide rate of young women in 2008 and 2009. The
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4 effect of a celebrity's suicide on the suicide rate is well-known,^{21, 22} and there were incidents
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6 of suicides among very high-profile celebrities in 2008 and 2009 in South Korea, which were
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8 reported across the country.⁷ Furthermore, it was reported that the effect of a celebrity's
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10 suicide in Korea was five times higher among young women.²³ Considering these results, it is
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12 a reasonable interpretation to view a reduction in the suicide rate of young women after 2009
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14 as a decline in the suicide rate surged previously due to the effect of a series of specific
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16 events—celebrity suicides.
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19 Some important national suicide prevention activities were carried out during the 2nd
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21 suicide prevention initiative, such as the installation of more screen doors to prevent people
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23 from throwing themselves into the subway train²⁴ and a ban on the sale of paraquat
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25 pesticides.²⁵ One of the most effective suicide prevention intervention is to restrict of
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27 assessment to lethal methods.²⁶ Such government-led suicide prevention interventions may
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29 have contributed to the changes in the suicide rate of men in their 20s, men aged 70 years or
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31 older, and women aged 40 years or older in 2010 and 2011. Moreover, a continuous decrease
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33 in the suicide rate since 2011 indicates that the reduction of suicide rates was attributable to
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35 the government intervention efforts. After the introduction of the national suicide prevention
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37 initiative in 2009, the community mental health center has endeavoured to register and
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39 manage more people with severe mental disorder and people with alcoholism. Indeed, the
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41 mental health service utilization rates among people with alcoholism has increased from 8.1%
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43 in 2008 to 12.1% in 2015.²⁷ The registration and management rate for patients with severe
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45 mental disorder in the community mental health center has also increased from 19.2% in
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47 2008 to 26.4% in 2016. In addition, the government implemented an emergency department-
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49 based suicide attempt survivor management program, announced the recommendation for
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51 media reporting of suicide in 2013.⁷ Indeed, the proportion of alcohol abuse and suicidal
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4 thoughts of those participated in emergency department-based suicide attempt survivor
5 management program has decreased by 2.9%p and 6.8%p between the first and fourth contact,
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7 respectively.²⁸
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10 11 12 ***Increase in suicide rate of men in their 30s and 40s*** 13

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15 Nevertheless, it was found that the suicide rate of men in their 30s and 40s had continued
16 to increase significantly from 1993 to 2016. While there was a slight slowdown in the
17 increase of their suicide rate due to suicide prevention programs implemented by the
18 government, it did not result in a decrease in the suicide rate. This might suggest that the
19 currently implemented suicide prevention programs are not effective for men in their 30s and
20 40s. However, in Korea, suicide prevention policies focused on men in their 30s and 40s have
21 not been implemented until now. In previous studies, men were reported to have a higher risk
22 of suicide due to financial reasons than women do,²⁹ and the risk of suicide among men
23 arising due to the unemployment rate and economic crisis was also shown to be higher.^{30,31}
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25 However, the current suicide prevention policies only included the development of an office
26 worker gatekeeper program for men in their 30s and 40s.
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41 ***Strengths and Limitations of this study*** 42

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44 When interpreting the findings of this study, the following limitations need to be
45 considered. This study did not take account of the individual effect of a suicide prevention
46 program; it instead interpreted the changes in suicide rates at each point in time when such
47 programs were implemented. However, we cannot confirm when exactly the effect of policy
48 was seen. This was because the data on the outcome of each individual suicide prevention
49 program were not available as Korea did not have a monitoring system for each individual
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4 program, even though it implemented suicide prevention programs quite extensively. In this
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6 regard, a monitoring system needs to be established in order to identify the policy effect on
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8 the changes in the suicide rate in Korea more accurately, and a follow-up study needs to be
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10 conducted using this system. Furthermore, the accuracy of the cause of death statistics had
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12 continued to improve, so there is a chance that an increase in the number of deaths due to
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14 suicide would have been affected by the improved accuracy of statistics on the causes of
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16 death. Despite these limitations, this study has the following strengths. This study presented
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18 the trends in the suicide rates in Korea based on statistical analysis of a 24-year period. In
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20 addition, it showed that the point in time wherein such changes in the suicide rate occurred
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22 coincided with that wherein the government-led suicide prevention programs were
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24 implemented. Accordingly, further government-level investments and interventions should be
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26 considered to reduce the suicide rate.
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31 **Conclusion**

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34 This study showed that the suicide rate among Korean men and women has decreased
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36 since 2010, based on the causes of death statistics, which could represent the general
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38 population of South Korea. Our findings also showed that there were significant changes in
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40 trends of Korea's suicide rate especially among elderly people after 2010 to 2011. These
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42 changes in suicide rate coincided with those when the 2nd suicide prevention initiative
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44 enacted in 2009. In this regard, it is considered that government-level suicide prevention
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46 interventions had a potential effect on decreasing the suicide rate among elderly people, and
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48 national-level efforts are still needed in the future to reduce the increasing suicide rate of men
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50 in their 30s and 40s.
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Author contributions

S-U Lee obtained, analysed the data and wrote the manuscript and J-I P, S Lee, I-H Oh and J-M Choi interpreted the data and contributed to revise the manuscript. C-M Oh made the research design and revised the manuscript.

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Conflicts of interests

On behalf of all the authors, the corresponding author declares that there are no conflicts of interests.

Patient consent

This study was a descriptive epidemiologic study using the cause of death database that could not identify individuals. Therefore, patient consent form was exempted from IRB.

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All authors participated in the design, execution, and analysis of the results and have read and approved the final version. We are especially thankful for the advice and help of the staffs and colleagues of the Korea Suicide Prevention Center. There was no role or participation of patients in our study.

Ethical Standards

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4 The study protocol was reviewed and approved by Institutional Review Board of Kyung
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6 Hee University (IRB No. KHSIRB-17-086).
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10 **Data sharing statement**

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12 All data used in this study can be obtained from Homepage of Statistic Korea
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28 **REFERENCES**

- 29
30 1. World Health Organisation. Suicide Data.
31
32 http://www.who.int/mental_health/prevention/suicide. (Accessed on 14 September
33
34 2017).
35
36 2. World Health Organisation. Mental health action plan 2013–2020.
37
38 http://www.who.int/mental_health/publications/action_plan/en/. (Accessed on 14
39
40 September 2017).
41
42 3. Hendin H, Phillips MR, Vijayakumar L, Pirkis J, Wang H, Yip P, Wasserman D, Bertolote
43
44 JM, Fleischmann A. Suicide and suicide prevention in Asia. World Health
45
46 Organization: Geneva, 2018.
47
48 4. Organization for Economic Co-operation and Development. OECD health data 2016.
49
50 <https://data.oecd.org/healthstat/suicide-rates.htm>. (Accessed on 14 September 2017).
51
52 5. Statistics Korea. Cause-of-Death Statistics 2017. <http://kosis.kr/en>. (Accessed on 14
53
54
55

- 1
2
3
4 September 2017).
- 5
6 6. Paik JW, Jo SJ, Lee S, Ong JY, Park JI. The Effect of Korean Standardized Suicide
7
8 Prevention Program on Intervention by Gatekeepers. *J Korean Neuropsychiatr Assoc*
9
10 2014;53:358-363. [In Korean].
- 11
12 7. Korea Suicide Prevention Center. *Suicide White Book*. Seoul: Ministry of Health and
13
14 Welfare, 2014 [In Korean].
- 15
16 8. Korea Suicide Prevention Center. *Suicide White Book*. Seoul: Ministry of Health and
17
18 Welfare, 2015 [In Korean].
- 19
20 9. Korea Suicide Prevention Center. *Suicide White Book*. Seoul: Ministry of Health and
21
22 Welfare, 2016 [In Korean].
- 23
24 10. Korea Suicide Prevention Center *Suicide White Book*. Seoul: Ministry of Health and
25
26 Welfare, 2017 [In Korean].
- 27
28 11. Kang HG. Social Welfare Delivery Reform: Achievements and Beyond, *Health and*
29
30 *Welfare Policy Forum* 2012;4:35-49
- 31
32 12. Lee SY. Policy options for the improvement of suicide prevention programs. *Health and*
33
34 *Welfare Policy Forum* 2015;4:34-49.
- 35
36 13. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with
37
38 applications to cancer rates. *Stat Med* 2000;19:335-351.
- 39
40 14. Matsubayashi T, Ueda M. The effect of national suicide prevention programs on suicide
41
42 rates in 21 OECD nations. *Soc Sci Med* 2011;73:1395-400.
- 43
44 15. Kwon JW, Chun H, Cho SI. A closer look at the increase in suicide rates in South Korea
45
46 from 1986-2005. *BMC Public Health* 2009;9:72-80.
- 47
48 16. National Mental Health and Welfare Commission. *Guidelines for mental health services*,
49
50 Seoul: Ministry of Health and Welfare 2005 [In Korean].
- 51
52
53
54
55
56
57
58
59
60

17. Park JI, Nam YY, Lee HK, Park JY, Lee MS, Lee SJ. National suicide prevention plan. Seoul: Ministry of Health and Welfare, 2011 [In Korean].
18. De Leo D, Buono MD, Dwyer J. Suicide among the elderly: the long-term impact of a telephone support and assessment intervention in northern Italy. *Br J Psychiatry* 2002;181: 226-9.
19. De Leo D, Carollo G, Buono MD. Lower suicide rates associated with a Tele-Help/Tele-Check service for the elderly at home. *Am J Psychiatry* 1995;152: 632-4.
20. Sun HJ. Suicide prevention efforts for the elderly in Korea. *Perspect Public Health* 2016;136:269-70.
21. Jeong J, Shin SD, Kim H, Hong YC, Hwang SS, Lee EJ. The effects of celebrity suicide on copycat suicide attempt: a multi-center observational study. *Soc Psychiatry Psychiatr Epidemiol* 2012;47:957-65.
22. Niederkrotenthaler T, Fu KW, Yip PS, Fong DY, Stack S, Cheng Q, Pirkis J. Changes in suicide rates following media reports on celebrity suicide: a meta-analysis. *J Epidemiol Community Health* 2012;66:1037-42.
23. Ju Ji N, Young Lee W, Seok Noh M, Yip PS. The impact of indiscriminate media coverage of a celebrity suicide on a society with a high suicide rate: epidemiological findings on copycat suicides from South Korea. *J Affect Disord* 2014;156:56-61.
24. Chung YW, Kang SJ, Matsubayashi T, Sawada Y, Ueda M. The effectiveness of platform screen doors for the prevention of subway suicides in South Korea. *J Affect Disord*. 2016 ;194:80-3.
25. Cha ES, Chang SS, Gunnell D, Eddleston M, Khang YH, Lee WJ. Impact of paraquat regulation on suicide in South Korea. *Int J Epidemiol* 2015;45:470-9.
26. Zalsman G, Hawton K, Wasserman D, van Heeringen K, Arensman E, Sarchiapone M,

- 1
2
3
4 Carli V, Höschl C, Barzilay R, Balazs J, Purebl G, Kahn JP, Sáiz PA, Lipsicas CB,
5
6 Bobes J, Cozman D, Hegerl U, Zohar J. Suicide prevention strategies revisited: 10-year
7
8 systematic review. *Lancet Psychiatry* 2016;3:646-59.
9
- 10 27. Korea Health Promotion Institute. Health Plan 2020. <http://www.khealth.or.kr/healthplan>.
11
12 (Accessed on 24 April 2018).
13
- 14 28. Korea Suicide Prevention Center. 2013-2015 Emergency Department Based Post-Suicidal
15
16 Care Program Report Summary. <http://www.spckorea.or.kr/> (Accessed on 25 June,
17
18 2018)
19
- 20 29. Lee SU, Oh IH, Jeon HJ, Roh S. Suicide rates across income levels: Retrospective cohort
21
22 data on 1 million participants collected between 2003 and 2013 in South Korea. *J*
23
24 *Epidemiol* 2017;27:258-64.
25
26
- 27 30. Chang SS, Gunnell D, Sterne JA, Lu TH, Cheng AT. Was the economic crisis 1997–1998
28
29 responsible for rising suicide rates in East/Southeast Asia? A time–trend analysis for
30
31 Japan, Hong Kong, South Korea, Taiwan, Singapore and Thailand. *Soc Sci Med*.
32
33 2009;68:1322-31.
34
35
- 36 31. Hawton K, Arensman E, Wasserman D, Hulten A, Bille-Brahe U, Bjerke T, Crepet P,
37
38 Deisenhammer E, Kerkhof A, De Leo D, Michel K, Ostamo A, Philippe A, Querejeta I,
39
40 Salander-Renberg E, Schmidtke A, Temesváry B. Relation between attempted suicide
41
42 and suicide rates among young people in Europe. *J Epidemiol Community Health*
43
44 1998;52:191-4
45
46
47
48
49
50
51
52
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For peer review only

Table 1. Baseline characteristics of suicide by sex and age group

Characteristics	Overall	Year				<i>p</i> -value [¶]
		1993-1998	1999-2004	2005-2010	2011-2016	
Total number of deaths*	6,007,678	1,445,819	1,467,088	1,479,483	1,615,288	
Number of deaths due to suicide[†]	249,085 (4.15%)	34,064 (2.36%)	51,413 (3.50%)	78,674 (5.32%)	84,934 (5.26%)	
Sex[‡]						<0.0001
Men	169,963 (68.23%)	23,733 (69.67%)	35,619 (69.28%)	51,525 (65.49%)	59,086 (69.57%)	
Women	79,122 (31.77%)	10,331 (30.33%)	15,794 (30.72%)	27,149 (34.51%)	25,848 (30.43%)	
Age group[§]						<0.0001
10-19 years	7,712 (3.1%)	2,338 (6.9%)	1,629 (3.2%)	1,936 (2.5%)	1,809 (2.1%)	
20-29 years	29,988 (12.0%)	7,108 (20.9%)	6,306 (12.3%)	9,097 (11.6%)	7,477 (8.8%)	
30-39 years	43,015 (17.3%)	7,800 (22.9%)	9,654 (18.8%)	12,575 (16.0%)	12,986 (15.3%)	
40-49 years	47,796 (19.2%)	5,815 (17.1%)	10,468 (20.4%)	14,938 (19.0%)	16,575 (19.5%)	
50-59 years	41,960 (16.8%)	4,701 (13.8%)	7,705 (15.0%)	12,593 (16.0%)	16,961 (20.0%)	
60-69 years	33,214 (13.3%)	3,259 (9.6%)	7,441 (14.5%)	11,615 (14.8%)	10,899 (12.8%)	
70-79 years	29,654 (11.9%)	2,142 (6.3%)	5,389 (10.5%)	10,337 (13.1%)	11,786 (13.9%)	
≥80 years	15,661 (6.3%)	873 (2.6%)	2,800 (5.5%)	5,557 (7.1%)	6,431 (7.6%)	

*Total number of deaths present the overall cause of deaths.

[†]The denominator for percentage of number of deaths due to suicide was total number of deaths.

[‡]The number and percentage of death due to suicide by sex and age group were presented among people aged ≥ 10 years old.

[§] The number and percentage of death due to suicide by sex and age group were presented among people aged ≥ 10 years old.

[¶]Chi-square test was used to test the differences in the number of deaths by sex and age group

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Table 2. The number of death from suicide, suicide rates from 1993 to 2016 in South Korea

Year	Population	Number of suicide death	Age-standardized suicide rate*
1993	44,752,157	4,208	10.7
1994	45,208,726	4,277	10.7
1995	45,637,184	4,930	12.1
1996	46,062,143	5,959	14.4
1997	46,475,163	6,068	14.5
1998	46,837,620	8,622	20.4
1999	47,163,425	7,056	16.5
2000	47,534,117	6,444	14.9
2001	47,877,049	6,911	15.7
2002	48,125,745	8,612	19.2
2003	48,308,386	10,898	23.7
2004	48,485,314	11,492	24.6
2005	48,683,040	12,011	25.1
2006	48,887,027	10,653	21.7
2007	49,130,354	12,174	24.3
2008	49,404,648	12,858	25.1
2009	49,656,756	15,412	29.5
2010	49,879,812	15,566	29.1
2011	50,111,476	15,906	29.1
2012	50,345,325	14,160	25.3
2013	50,558,952	14,427	25.3
2014	50,763,158	13,836	24.0
2015	50,951,719	13,513	22.8
2016	51,112,972	13,092	21.9

*Age-standardized rates were expressed per 100,000 people and Korean mid-year population in year 2005 was used for age-standardization. Data was obtained from Statistics Korea (Available from: <http://kosis.kr/>)

Table 3. Joinpoint regression analysis for suicide rate from 1993 to 2016 in Korean by age group

Categories	Suicide rate		Trend 1		Trend 2		Trend 3		Trend 4	
	1993	2016	Years	APC (95% CI)	Years	APC (95% CI)	Years	APC (95% CI)	Years	APC (95% CI)
Men										
10-19 years old	5.35	5.57	1993-1998	4.8% (-5.2% to 16.0%)	1998-2001	-14.7% (-48.4% to 40.9%)	2001-2016	2.8% (0.5% to 5.2%)*		
20-29 years old	14.44	19.91	1993-2006	0.5% (-1.6% to 2.7%)	2006-2010	12.1% (-7.3% to 35.6%)	2010-2016	-5.8% (-11.7% to 0.5%)		
30-39 years old	15.53	31.32	1993-2016	3.0% (2.1% to 4.0%)*						
40-49 years old	18.39	42.34	1993-1998	15.6% (3.0% to 29.8%)*	1998-2016	1.9% (0.8% to 2.9%)*				
50-59 years old	23.92	48.32	1993-2004	8.0% (4.6% to 11.5%)*	2004-2016	-0.2% (-1.9% to 1.6%)				
60-69 years old	26.58	55.74	1993-2005	10.7% (7.8% to 13.7%)*	2005-2016	-3.6% (-5.5% to -1.7%)*				
70-79 years old	34.38	90.32	1993-2004	12.9% (9.9% to 16.0%)*	2004-2011	1.2% (-2.2% to 4.7%)	2011-2016	-7.5% (-11.2% to -3.5%)*		
≥80 years old	41.74	150.52	1993-2000	9.2% (2.3% to 16.7%)*	2000-2003	29.7% (-3.3% to 74.0%)*	2003-2010	0.9% (-2.4% to 4.3%)	2010-2016	-6.2% (-8.8% to -3.6%)*
Women										
10-19 years old	3.01	4.15	1993-1998	14.4% (5.2% to 24.3%)*	1998-2001	-21.4% (-47.0% to 16.6%)	2001-2009	8.0% (2.3% to 14.0%)*	2009-2016	-5.1% (-10.0% to -0.0%)*
20-29 years old	6.97	12.46	1993-1998	10.0% (-1.3% to 22.5%)	1998-2001	-14.8% (-47.7% to 38.8%)	2001-2008	19.9% (12.0% to 28.5%)*	2008-2016	-9.5% (-13.3% to -5.6%)*
30-39 years old	8.07	17.65	1993-2006	5.0% (3.2% to 6.8%)*	2006-2009	20.8% (-4.4% to 52.5%)	2009-2016	-5.9% (-8.9% to -2.8%)*		
40-49 years old	7.57	16.47	1993-2010	6.5% (5.4% to 7.7%)*	2010-2016	-3.3% (-6.8% to 0.3%)				
50-59 years old	5.47	16.35	1993-2010	6.6% (5.0% to 8.2%)*	2010-2016	-5.5% (-8.6% to 0.0%)				
60-69 years old	9.10	14.65	1993-2005	9.4% (7.5% to 11.4%)*	2005-2010	0.7% (-5.4% to 7.3%)	2010-2016	-8.7% (-11.9% to -5.5%)*		
70-79 years old	12.19	26.50	1993-2004	13.5% (11.0% to 16.1%)*	2004-2011	-1.5% (-4.6% to 1.7%)	2011-2016	-9.9% (-13.9% to -5.8%)*		
≥80 years old	17.21	45.73	1993-2004	18.0% (14.3% to 21.8%)*	2004-2011	-1.3% (-5.1% to 2.5%)	2011-2016	-11.5% (-15.8% to -6.9%)*		

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Joinpoint regression model is used to test that age-standardized rates have significantly changed. The trends in suicide mortality rates were summarized as APC (annual percentage change). Age-standardized rates were expressed per 100,000 men and Korean mid-year population in year 2005 was used for age-standardization. APC: annual percentage change, CI: confidence interval.
**p*-value <0.05

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5 **Figure legends**
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8 **Figure 1.** Trends in age-standardized suicide rates in South Korea, 1993-2016
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10 Footnotes:

11 APC=Annual percent change

12
13 The age-standardized suicide rates are presented as suicide death cases per 100,000 people using Korean mid-year population in 2005 as
14 standard population.
15

16 Joinpoint regression analysis was used to determine whether there were significant changes in trends in age-standardized suicide rates for the
17 period between 1993 and 2016.
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19 *p<0.05
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24 **Figure 2.** Implementation of National Suicide Prevention Program and Plan
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26 Footnotes:

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28 The age-standardized suicide rates are presented as connected line from 1993 to 2016.
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30 Each number represents the year in which the major events related to national suicide prevention program or plan were occurred.
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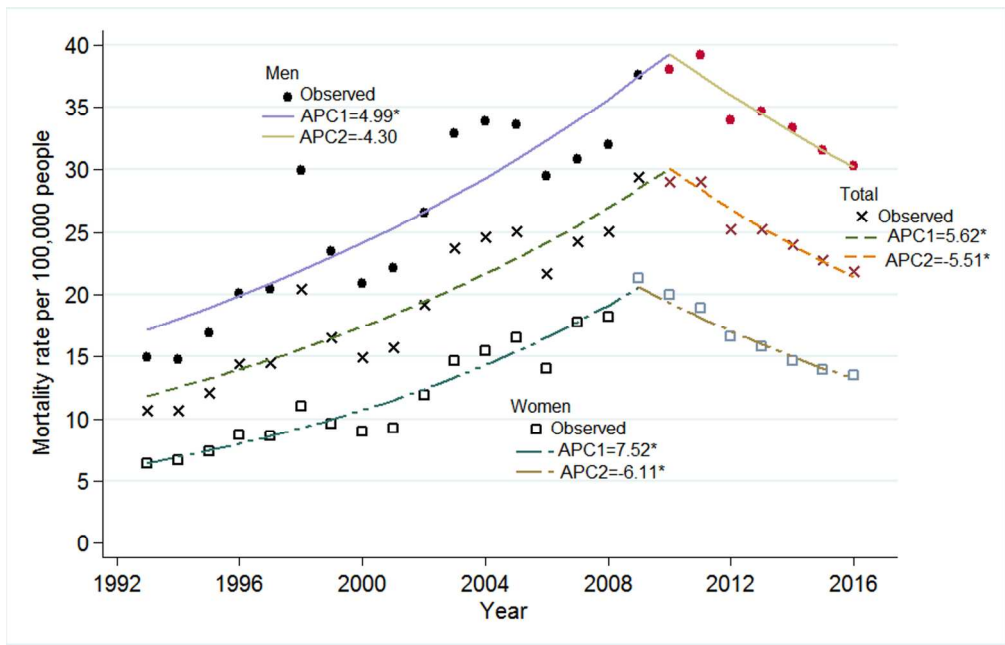
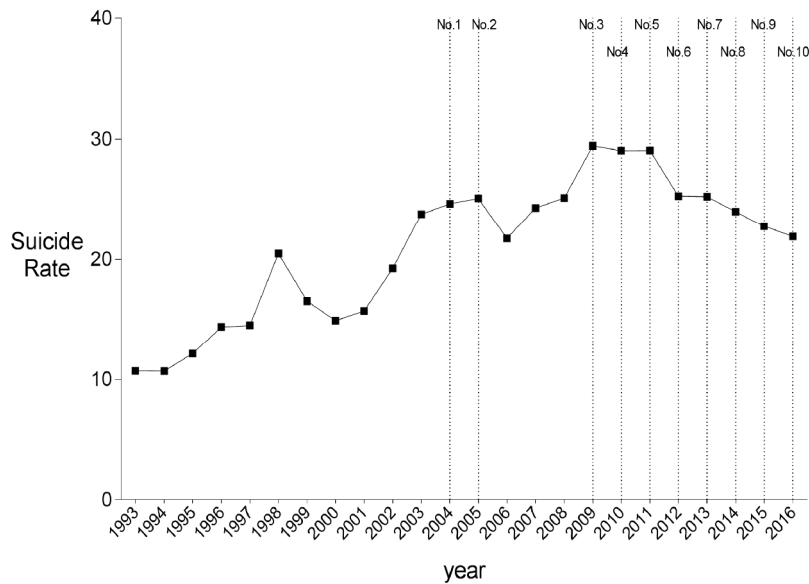


Figure 1. Trends in age-standardized suicide rates in South Korea, 1993-2016

141x90mm (300 x 300 DPI)



No.	Year	National suicide prevention program or plan
1	2004	The establishment of the first 5-year National Strategy for Suicide Prevention
2	2005	Suicide prevention program was introduced into regional mental welfare centers
3	2009	The establishment of the second 5-year National Strategy for Suicide Prevention
4	2010	The establishment of integrated welfare system
		The expansion of the basic living subsidies
		The increase in the number of welfare officers
5	2011	The enactment of the Act on Preventing Suicide
		The inhibition of sales of paraquat pesticides
6	2012	The enforcement of the Act on Preventing Suicide
		The introduction of the Korean gatekeeper program for suicide prevention entitled "Watch, Listen and Talk"
7	2013	The introduction of management of emergency department based suicide attempts
		The certification of private suicide prevention
8	2014	The collaboration the government with religious organizations
		The establishment of the Korea Psychological Autopsy Center
9	2015	The expansion of screen door on the subway
		"Are you okay" campaign
10	2016	The establishment of the comprehensive national mental health care strategy
		"Air kiss" campaign

Figure 2. Implementation of National Suicide Prevention Program and Plan

190x275mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	p.1,2 p.2-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p.5
Objectives	3	State specific objectives, including any prespecified hypotheses	p.5 line 18-21
Methods			
Study design	4	Present key elements of study design early in the paper	p.1,2,7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p.6 Line 1-10
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (b) For matched studies, give matching criteria and number of exposed and unexposed	p.6 Line 1-10 -
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p.6 Line 9-10, 17-24
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	p.6 Line 17-24
Bias	9	Describe any efforts to address potential sources of bias	p.16 Line 10-21
Study size	10	Explain how the study size was arrived at	p.8 Line 10-15
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p.7 Line 9-12
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, explain how loss to follow-up was addressed (e) Describe any sensitivity analyses	p.7 Line 8-8 p.8 Line 5 p.7 Line 9-12 - - -
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage	p.8 Line 9-14 -

		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	p.8 Line 9-14 - p.8 Line 10
Outcome data	15*	Report numbers of outcome events or summary measures over time	p.8 Line 10-14
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	p.8 Line 22- p.10 Line 23 p.7 Line 9-12 Table 2
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	p.11 Line 23- p.12 Line 5
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p.4 Line 10-11 p.16 Line 10-21 -
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p.12 Line 9- p.16 Line 7
Generalisability	21	Discuss the generalisability (external validity) of the study results	p.12 Line 5-7 p.16 Line 22- p.17 Line 2
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p.17 Line 19-21

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.

BMJ Open

Changing trends in suicide rates in South Korea from 1993 to 2016: A descriptive study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-023144.R3
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Primary Subject Heading:	Mental health
Secondary Subject Heading:	Epidemiology, Health policy, Public health
Keywords:	Suicide & self-harm < PSYCHIATRY, Mortality, Social and political issues, Prevention, Republic of Korea

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4 **Changing trends in suicide rates in South Korea from 1993 to**
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7 **2016: A descriptive study**
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11 Running title: Trends in suicide in South Korea
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16 Sang-Uk Lee^{1,2}, Jong-Ik Park³, Soojung Lee⁴, In-Hwan Oh², Joong-Myung Choi², Chang-Mo
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53 **Word count:** 4,054
54

Abstract

Objectives: South Korean government has recently implemented policies to prevent suicide. However, there were few studies examining the recent changing trend in suicide rates. This study aims to examine the changing trend in suicide rates by time and age group.

Design: A descriptive study using nationwide mortality rates

Setting: Data on the nationwide cause of death from 1993 to 2016 were obtained from the Statistics Korea.

Participants: People living in the South Korea

Interventions: Implementation of national suicide prevention policies (1st: 2004 year, 2nd: 2009 year)

Primary outcome measures: Suicide was defined as “X60-X84” code according to the ICD-10 code. Age-standardized suicide rates were estimated, and a Joinpoint regression model was applied to describe the trends in suicide rate.

Results: From 2010 to 2016, the suicide rates in South Korea have been decreasing by 5.5% (95% CI: -10.3% to -0.5%) annually. In terms of sex, the suicide rate for men had increased by 5.0% (95% CI: 3.6% to 6.4%) annually from 1993 to 2010. However, there has been no statistically significant change from 2010 to 2016. For women, the suicide rate had increased by 7.5% (95% CI: 6.3% to 8.7%) annually from 1993 to 2009, but since 2009, the suicide rate has been significantly decreasing by 6.1% (95% CI: -9.1% to -3.0%) annually until 2016. In terms of the age group, the suicide rates among women of almost all age groups have been decreasing since 2010; however, the suicide rates of men aged between 30 and 49 years showed continuously increasing trends.

Conclusion: Our results showed that there were differences in the changing trends in suicide rate by sex and age groups. Our finding suggests that there was a possible relationship

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between implementation of second national suicide prevention policies and a decline in suicide rate.

Keywords: Suicide; Mortality; Social and political issues; Prevention; Republic of Korea

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Article Summary

Strengths and limitations of this study

- Our findings show that efforts to reduce suicide at the national level may lead to a decline in suicide rates especially among elderly people through natural experiment.
- Another finding of our study is that suicide rates in men in their 30s and 40s are continuing to increase, suggesting that a different suicide prevention strategy may be necessary in South Korea.
- Because this study is a descriptive epidemiologic study, it is difficult to know exactly which policies have reduced suicide rates in which age group.
- Improved accuracy of statistics on the causes of death may affect to changes in suicide rates.

Introduction

Suicide is a major public health issue, with an estimated 788,000 deaths every year according to the World Health Organization (WHO) statistics.¹ The WHO established the Mental Health Action 2013-2020 plan to implement a national, multi-sectorial promotion and prevention program for promoting mental health and reducing suicide rates of each country by 10% until 2020.² Especially, the developed countries in East Asia have relatively high mortality rates due to suicide.³ Among these countries, suicide in South Korea is a serious health problem because the suicide rate in South Korea in 2013 (28.5 per 100,000 person-years) was 2.4 times higher than the average suicide rates of other Organization for Economic Co-operation and Development (OECD) countries and South Korea has been ranked top among the OECD countries in terms of suicide rates in the last 10 years.⁴ In addition, suicide was the most common cause of death in young people aged between 10 and 39 years, and it was the second-most common cause of death among adults aged 40-59 years in 2016 in South Korea.⁵

South Korea implemented the national suicide prevention program in the early 2000s.⁶ This national suicide prevention program includes both high-risk group-oriented monitoring and prevention of suicide and suicide prevention program for general population such as media campaign.⁷ However, there was a few studies to examine the trends in suicide rates by sex and age group with regard to the national suicide prevention policies in South Korea. Therefore, this study aimed to describe the changing trends in suicide rate by sex and age group in South Korea and exploring the potential effects of implementation of the national suicide prevention policies.

Method

Study participants

The cause of death statistics is a reliable source of data on how the causes of death have changed because of socioeconomic changes and public health developments; it also provides comprehensive information to plan and prioritize health care policies. The number of deaths due to suicide and the corresponding mid-year population counts from 1993 to 2016 were obtained from Statistic Korea (Available from <http://kosis.kr/>). The Statistic Korea used the estimated population as the denominator for mortality rates before year 1993. After 1993, Statistic Korea used the mid-year population based on resident registration number as the denominator for mortality rates. In addition, the cause of death data before 1993 is less accurate, therefore, we selected the suicide rates from 1993 to 2016. The code assigned to the cause of death due to suicide was “X60-X84” according to the ICD-10 code.

Patient and Public Involvement

We did not contact with patients and our study was not directly associated with patients, because we used the administrative secondary data – the cause of death data from Statistic Korea. There was no role or participation of patients in our study.

National suicide prevention program

Information regarding the timing and implementation of the national suicide prevention policy in South Korea were obtained from relevant government data and expert consultants. Initially, the timing and details of the national suicide prevention policy were obtained from the national knowledge information system (<https://nkis.re.kr:4445/main.do>) and publications from Korea Suicide Prevention Center.⁷⁻¹⁰ The contents and details obtained from these

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4 websites were confirmed after review by the experts and staffs of Korea Suicide Prevention
5 Center.⁶⁻¹²
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10 ***Ethics statement***

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12 The study protocol was reviewed by the Institutional Review Board of Kyung Hee
13 University (IRB No.KHSIRB-17-086). Our study was exempted from review because it was
14 not an experimental trial, which required contacting the patients, and our study did not
15 include personal identifiable information.
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23 ***Statistical analysis***

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25 To describe the baseline characteristics of people who die due to suicide, the number of
26 deaths was presented for each 6-year period (1993-1998/1999-2004/2005-2010/2011-2016)
27 from 1993 to 2016. Chi-square test was used to test the differences in the distribution of death
28 due to suicide by sex and age groups. To describe the changes in suicide rates by time period,
29 the age-standardized suicide rates of suicide were calculated. The mid-year Korean
30 population in 2005 was used as the standard population for age-standardized suicide rates.
31 Age-specific suicide rates were applied to the corresponding 5-year age group of the standard
32 population. The sum of expected deaths for each 5-year age group was calculated, and the
33 age-standardized suicide rates were calculated by dividing the sum of expected deaths by the
34 total number of standard population. We used Joinpoint regression program to know whether
35 there were changes in trends in mortality rates. Joinpoint statistical software was developed
36 by the National Cancer Institute in the United States. Joinpoint regression modelling was
37 used to test the trends in age-standardized suicide rates for suicide and detect significant
38 changes over time to fit a better multi-segmented model compared to a simple linear model
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4 using a Monte Carlo permutation method.¹³ Further, it could detect point where significant
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6 change in rates over time. The trends in rates were summarized as annual percentage changes
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8 (APCs) and their 95% confidence intervals (CIs).
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10 *P* values <0.05 were considered statistically significant. We used SPSS (version 23.0,
11 Armonk, NY: IBM Corp., USA) and R software (version 3.1.1, Vienna, Austria) and
12 Joinpoint Regression Program software (Version 4.1.1, Statistical Methodology and
13 Applications Branch, Surveillance Research Program, National Cancer Institute, Bethesda,
14 MD, USA).
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26 **Results**

27 *Baseline characteristics*

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30 The total number of deaths in South Korea from 1993 to 2016 was 6,007,678 (Table 1). Of
31 these, the total number of deaths due to suicide was 249,085 (4.2%). Of the deaths due to
32 suicide, 169,963 (68.2%) were men, and 79,122 (31.8%) were women. In terms of the time
33 period, South Korea had the highest number of deaths from suicide (n=15,906) in 2011 and
34 the highest age-standardized suicide rate from suicide (29.5 per 100,000 person-year) in 2009
35 (Table 2). After 2011, the number of deaths and age-standardized suicide rates due to suicide
36 decreased until 2016. The number of deaths due to suicide in 2011-2016 was 2.5 times higher
37 than that in 1993-1998. According to the age groups, the proportion of deaths due to suicide
38 in children and adolescents aged between 10 and 19 years had decreased from 1993-1998 to
39 2011-2016, whereas the proportion of elderly aged more than 70 years had increased during
40 the same time period (p<0.0001).
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Trends in suicide rates

According to the joinpoint regression model, the mortality rate from suicide had increased by 5.6% (95% CI: 4.4% to 6.9%) annually from 1993 to 2010 (Figure 1). After 2010, the suicide rate had declined by 5.5% (95% CI: -10.3% to -0.5%) annually until 2016. In terms of sex, suicide rate for men had increased by 5.0% (95% CI: 3.6% to 6.4%) annually from 1993 to 2010. After 2010, suicide rate for men shown decreasing trends (APC=-4.3%, 95% CI: -9.8% to 1.6%), although it was not statistically significant ($p=0.14$). Similarly, the suicide rates for women had increased by 7.5% (95% CI: 6.3% to 8.7%) annually from 1993 to 2009. Following that, suicide rates for women showed a significant decreasing trend (APC=-6.1%, (95% CI: -9.1% to -3.0%)).

Trends in suicide rates for men by age group

Joinpoint regression analysis was performed by sex and age group. Suicide rates for men increased with age (Table 3). The suicide rate of adolescents aged 10-19 years is relatively low, ranging from 3 to 7 people per 100,000 persons. The suicide rate of adolescents aged 10-19 years has been increasing annually by 2.8% since 2001. Although there was no statistically significant change in suicide rate of young adults aged 20-29 years, the rates showed increasing trends from 2006 to 2010, and it has tended to decrease since 2010. The suicide rate of men aged 30-39 years showed a significant annual increase of 3.1% from 1993 to 2016. For men aged 40-49 years, the suicide rate dramatically increased by 15.6% annually from 1993 to 1998. Since 1998, the increasing trend in the suicide rate has attenuated among men aged 40-49 years (APC=1.9% (95% CI: 0.9% to 2.9%)). The suicide rate for men aged 50-59 years has increased by 8.0% from 1993 to 2004. However, there has been no

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4 significant increase since 2004. For men aged 60-69 years, there was a statistically significant
5 increase in suicide rate by 10.7% increase each year between 1993 and 2005; however, there
6 has been a decreasing trend since 2005. The suicide rate for men aged 70-79 years had
7 increased by 12.9% annually from 1993 to 2004 but has been decreasing by 7.5% annually
8 since 2011. For men aged 80 years and above, the suicide rate had increased by 9.2%
9 annually between 1993 and 2000. There was no significant change in the suicide rate for men
10 from 2000 to 2010. Since 2010, the suicide rate has been decreasing by 6.2% annually.
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21 ***Trends in suicide rates for women by age group***

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23 Table 3 shows the suicide rate for women by age group. The suicide rate of adolescents
24 aged 10-19 years is relatively low, and the trends of suicide rates are similar to that in the
25 twenties. Suicide rates in women aged 20-29 years had increased by 19.9% annually from
26 2001 to 2008. Since 2008, suicide rate for women aged 20-29 years has decreased by 9.5%
27 annually. The suicide rate of women aged 30-39 years showed a significant annual increase of
28 5.0% from 1993 to 2006, whereas the suicide rates tended to decrease by 5.9% annually from
29 2009 to 2016. For women aged 40-49 years, the suicide rate had increased by 6.5% annually
30 from 1993 to 2010. Since 2010, there was no significant change in the suicide rate. The
31 suicide rate for women aged 50-59 years had increased by 6.6% from 1993 to 2010. After
32 2010, the suicide rates for women aged 50-59 years showed a decreasing trend (APC=-5.5%
33 (95% CI: -8.6% to 0.0%)). For women aged 60-69 years, there was a statistically significant
34 increase in the suicide rate with 9.4% increase each year from 1993 to 2005; however, there
35 has been a significant decreasing trend since 2010 (APC=-8.7% (95% CI: -11.9% to -5.5%)).
36 The suicide rate for women aged 70-79 years increased by 13.5% annually from 1993 to 2004
37 but has decreased significantly by 9.9% annually since 2011. For women aged 80 years and
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4 above, the suicide rates had dramatically increased by 18.0% annually from 1993 to 2004.
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6 There was no significant change from 2004 to 2011. Since 2011, suicide rate has decreased
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8 by 11.5% annually.
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12 ***The implementation of the National Suicide Prevention Program in South Korea***

14 The first step of the national suicide prevention program was the establishment of the first
15 5-year National Strategy for Suicide Prevention in 2004 (Figure 2). Based on this, a suicide
16 prevention program was introduced in 2005 at regional mental health centres which were
17 public community infrastructures for mental health. Following this, the second 5-year
18 National Strategy for Suicide Prevention was implemented in 2009. Based on this program, a
19 separate budget was newly proposed and executed. In 2010, a screen door was expanded to
20 prevent suicide on the subway. In 2011, the Act for the Prevention of Suicide was passed, the
21 Korea Suicide Prevention Center was established, and the sales of paraquat pesticides were
22 prohibited. The Act for the Prevention of Suicide was enforced in 2012, and the Korean
23 gatekeeper training program for suicide prevention entitled '*Watch, Listen and Talk*' was
24 introduced to the general population in South Korea. In 2013, an emergency department-
25 based suicide attempt survivor management program was implemented, and the Korea
26 Suicide Prevention Center along with Journalists Association of Korea announced the
27 recommendation for media reporting of suicide. In addition, the government authenticated the
28 private suicide prevention program to disseminate the evidence-based suicide prevention
29 program. In 2014, the government collaborated with religious organizations to increase the
30 participation rates of general population in the national suicide program. The Korea
31 Psychological Autopsy Center was established to understand the causes of suicide deaths
32 better.
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Discussion

This study aimed to examine the trends of suicide rate in South Korea by sex and age group and explore these suicide rate changes according to the timing of suicide prevention policies implemented by the Korean government. This study found that the overall suicide rate in South Korea had tended to decline since 2010. However, when analysed by sex and age, the suicide rate trends showed differences according to the sex and age groups. While women's suicide rate has decreased in all age groups since 2010, the suicide rate of men aged between 30 and 49 years is still on the rise. Our findings were consistent with the study findings of Matsubayashi et al.¹⁴ They showed that a national level of suicide prevention intervention was an effective way to reduce suicide rate except for working-age adults in 21 OECD countries.¹⁴

Trend in suicide rate between 1993 and 2004/2005

From 1993 to 2016, the suicide rates tended to change at two points in time. The suicide rates of South Korea have increased continuously from 1993 to 2010. According to the study of Kwon et al, the recent increase in suicide during 1986-2005 was mainly attributed to increase in suicide in elderly people.¹⁵ The rapid social change such as the increasing tendency of smaller family size may make the elderly feel isolated. In addition, insufficient social security system and economical problem may lead to an increase in suicide rates in the elderly.¹⁵ However, suicide rate of young people aged less than 45 years old have also increased significantly.¹⁵ The rising economic inequality and increasing unemployment rate due to economic crisis in 1997 of Korea may contribute to the increase in suicide rate among

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4 young people. In addition, the fragmentation of social integration may have weakened the
5
6 social ability to overcome mental problem such as depression.¹⁵
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10 11 ***Trend in suicide rate after 2004/2005*** 12

13 However, our study found that the suicide rate changed before and after 2004 and 2005. It
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15 was revealed that after 2004, an increase in the suicide rate of men and women aged 60 years
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17 or older had changed. After 2005, the suicide rate of men in their 60s decreased by 3.6% each
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19 year and that of women in their 60s, which had risen sharply up until 2005, no longer showed
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21 a statistically significant increase from 2005 to 2010.
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24 During this period, Korea's 1st national suicide prevention initiative was implemented in
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26 2004, which included various programs such as mental health improvement and suicide
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28 prevention, suicide prevention counseling calls, the development of a culture that respects life,
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30 treatment and post-suicide attempt management for those who attempt suicide, and suicide
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32 prevention research.¹² In addition, the Mental Health Welfare Center, a national mental health
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34 system, also implemented a regional suicide prevention program in 2005, and the Seoul
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36 Suicide Prevention Center was first established.¹⁶ Although the 1st suicide prevention
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38 initiative was implemented in 2004, the government did not earmark funding for the 1st
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40 suicide prevention initiative.¹⁷ In other words, this project had just added suicide prevention
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42 program to the existing mental health care service without sufficient additional budgets and
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44 manpower. In addition, the scope of this policy was mainly focused on the individuals with
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46 mental disorder, and there was not sufficient consideration for social and environmental
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48 changes. For this reason, it is difficult to find the data that can precisely identify the programs
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50 that were actually implemented among various other programs. Nonetheless, a suicide
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4 prevention program implemented by the Mental Health Welfare Center mainly focused on
5 management via phone calls, and it has been applied since 2005 without additional funding.
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8 Previous studies reported that interventions and management based on phone calls were
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10 effective for the suicide prevention of the elderly,^{18,19} and in this regard, changes in the
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12 suicide rate mostly found among those aged 60 years or older can be attributed to the effect
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14 of phone-based interventions.²⁰ These changes in the suicide rate, however, were found to be
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16 not a statistically significant decline in the suicide rate overall but a change in the increasing
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18 trend of the suicide rate.
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23 ***Trend in suicide rate among middle aged people between 2004/2005 and 2010***

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25 On the other hands, suicide rates have continuously increased from 2004/2005 to 2010
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27 among men aged 30-49 years old and women aged 40-59 years old. Although we could not
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29 explain the exact cause of increase in suicide rates among middle aged men and women, high
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31 economic burden and unemployment rates after the International Monetary Fund (IMF) may
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33 have contributed to increase in suicide rates. In the United States, suicide rates among
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35 individuals aged 40-64 years old have increased from 2005 to 2010, and the external
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37 circumstances such as job, financial, and legal problems were closely associated with
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39 increased suicide among these middle aged people.²¹ In the England, more suicides were
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41 observed both in men and women than expected due to the economic regression between
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43 2008 and 2010. A study of Ben Barr et al. found that about 40% of increased suicide among
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45 men were attributed to elevated unemployment during this period.²² According to the 2008
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47 National Survey of the National statistics office, the most common causes for suicidal
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49 ideation was economic difficulties (36.2%), followed by family trouble (15.6%) and
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51 loneliness (14.4%) in South Korea.²³ Especially, the proportion of suicidal ideation due to
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4 economic difficulties was the highest among people aged 40-59 years old.²³
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6 Other factors, such as changes in alcohol consumption and suicide by famous celebrities,
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8 may have affected suicide rates among middle-aged people. Indeed, age-standardized alcohol
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10 abuse disorder rates have increased from 32.7% in 2005 to 38.8% in 2009.²⁴ In addition, Fu et
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12 al. analysed the impact of suicide of Korean famous celebrities on the overall suicides rate
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14 from 2005 to 2008. After adjusting for seasonal effects, changing trends, and unemployment,
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16 significant increase of suicide cases was followed by the suicide of Korean famous
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18 celebrities.²⁵
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23 ***Trend in suicide rate after 2008/2009***

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25 Second, the suicide rate began to decline from 2008 to 2011. As of 2008 and 2009, the
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27 suicide rate for females aged 10 to 39 years, which had increased before, began to decrease.
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29 As of 2010 and 2011, the suicide rate of women aged 40 years or older also began to decline.
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31 Furthermore, the suicide rates of men in their 20s and those aged 70 years or older tended to
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33 decline since 2010 and 2011, respectively. In contrast, the suicide rate of men aged 30-49
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35 years had not decreased significantly from 1993 to 2016; instead, it continued to rise during
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37 this period.
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40 To begin with, the 2nd national suicide prevention initiative was enacted in 2009, which
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42 consisted of the research and development of suicide prevention policy, development of a
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44 culture that respects life, suicide prevention training and nurturing of specialists, online
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46 counselling and harmful suicide information monitoring, and public-private partnerships for
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48 suicide prevention.¹² The importance of the 2nd suicide prevention initiative is that the
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50 national budget was allocated for suicide prevention unlike the 1st suicide prevention
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52 initiative. While this initiative could be effective in reducing the suicide rate of young
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4 females in their 10s to 30s, it would be more reasonable to consider that a series of specific
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6 events contributed to a surge in the suicide rate of young women in 2008 and 2009. The
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8 effect of a celebrity's suicide on the suicide rate is well-known,^{26,27} and there were incidents
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10 of suicides among very high-profile celebrities in 2008 and 2009 in South Korea, which were
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12 reported across the country.⁷ Furthermore, it was reported that the effect of a celebrity's
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14 suicide in Korea was five times higher among young women.²⁸ Considering these results, it is
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16 a reasonable interpretation to view a reduction in the suicide rate of young women after 2009
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18 as a decline in the suicide rate surged previously due to the effect of a series of specific
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20 events—celebrity suicides.
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23 Some important national suicide prevention activities were carried out during the 2nd
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25 suicide prevention initiative, such as the installation of more screen doors to prevent people
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27 from throwing themselves into the subway train²⁹ and a ban on the sale of paraquat
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29 pesticides.³⁰ One of the most effective suicide prevention intervention is to restrict of
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31 assessment to lethal methods.³¹ Such government-led suicide prevention interventions may
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33 have contributed to the changes in the suicide rate of men in their 20s, men aged 70 years or
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35 older, and women aged 40 years or older in 2010 and 2011. Moreover, a continuous decrease
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37 in the suicide rate since 2011 indicates that the reduction of suicide rates was attributable to
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39 the government intervention efforts. After the introduction of the national suicide prevention
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41 initiative in 2009, the community mental health center has endeavoured to register and
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43 manage more people with severe mental disorder and people with alcoholism. Indeed, the
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45 mental health service utilization rates among people with alcoholism has increased from 8.1%
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47 in 2008 to 12.1% in 2015.³² The registration and management rate for patients with severe
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49 mental disorder in the community mental health center has also increased from 19.2% in
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51 2008 to 26.4% in 2016. In addition, the government implemented an emergency department-

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4 based suicide attempt survivor management program, announced the recommendation for
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6 media reporting of suicide in 2013.⁷ Indeed, the proportion of alcohol abuse and suicidal
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8 thoughts of those participated in emergency department-based suicide attempt survivor
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10 management program has decreased by 2.9%p and 6.8%p between the first and fourth contact,
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12 respectively.³³
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16 17 ***Increase in suicide rate of men in their 30s and 40s***

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19 Nevertheless, it was found that the suicide rate of men in their 30s and 40s had continued
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21 to increase significantly from 1993 to 2016. While there was a slight slowdown in the
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23 increase of their suicide rate due to suicide prevention programs implemented by the
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25 government, it did not result in a decrease in the suicide rate. This might suggest that the
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27 currently implemented suicide prevention programs are not effective for men in their 30s and
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29 40s. However, in Korea, suicide prevention policies focused on men in their 30s and 40s have
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31 not been implemented until now. In previous studies, men were reported to have a higher risk
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33 of suicide due to financial reasons than women do,³⁴ and the risk of suicide among men
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35 arising due to the unemployment rate and economic crisis was also shown to be higher.^{35,36}
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37 However, the current suicide prevention policies only included the development of an office
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39 worker gatekeeper program for men in their 30s and 40s.
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45 ***Strengths and Limitations of this study***

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47 When interpreting the findings of this study, the following limitations need to be
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49 considered. This study did not take account of the individual effect of a suicide prevention
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51 program; it instead interpreted the changes in suicide rates at each point in time when such
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53 programs were implemented. However, we cannot confirm when exactly the effect of policy
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4 was seen. This was because the data on the outcome of each individual suicide prevention
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6 program were not available as Korea did not have a monitoring system for each individual
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8 program, even though it implemented suicide prevention programs quite extensively. In this
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10 regard, a monitoring system needs to be established in order to identify the policy effect on
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12 the changes in the suicide rate in Korea more accurately, and a follow-up study needs to be
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14 conducted using this system. Furthermore, the accuracy of the cause of death statistics had
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16 continued to improve, so there is a chance that an increase in the number of deaths due to
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18 suicide would have been affected by the improved accuracy of statistics on the causes of
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20 death. Despite these limitations, this study has the following strengths. This study presented
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22 the trends in the suicide rates in Korea based on statistical analysis of a 24-year period. In
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24 addition, it showed that the point in time wherein such changes in the suicide rate occurred
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26 coincided with that wherein the government-led suicide prevention programs were
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28 implemented. Accordingly, further government-level investments and interventions should be
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30 considered to reduce the suicide rate.
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36 **Conclusion**

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38 This study showed that the suicide rate among Korean men and women has decreased
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40 since 2010, based on the causes of death statistics, which could represent the general
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42 population of South Korea. Our findings also showed that there were significant changes in
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44 trends of Korea's suicide rate especially among elderly people after 2010 to 2011. These
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46 changes in suicide rate coincided with those when the 2nd suicide prevention initiative
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48 enacted in 2009. In this regard, it is considered that government-level suicide prevention
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50 interventions had a potential effect on decreasing the suicide rate among elderly people, and
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52 national-level efforts are still needed in the future to reduce the increasing suicide rate of men
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4 in their 30s and 40s.
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8 **Author contributions**

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10 S-U Lee obtained, analysed the data and wrote the manuscript and J-I P, S Lee, I-H Oh and
11 J-M Choi interpreted the data and contributed to revise the manuscript. C-M Oh made the
12 research design and revised the manuscript.
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26 **Conflicts of interests**

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29 On behalf of all the authors, the corresponding author declares that there are no conflicts of
30 interests.
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36 **Patient consent**

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38 This study was a descriptive epidemiologic study using the cause of death database that
39 could not identify individuals. Therefore, patient consent form was exempted from IRB.
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46
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49 staffs and colleagues of the Korea Suicide Prevention Center. There was no role or
50 participation of patients in our study.
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Ethical Standards

The study protocol was reviewed and approved by Institutional Review Board of Kyung Hee University (IRB No. KHSIRB-17-086).

Data sharing statement

All data used in this study can be obtained from Homepage of Statistic Korea (<http://kosis.kr/eng/>).

REFERENCES

1. World Health Organisation. Suicide Data.
http://www.who.int/mental_health/prevention/suicide. (Accessed on 14 September 2017).
2. World Health Organisation. Mental health action plan 2013–2020.
http://www.who.int/mental_health/publications/action_plan/en/. (Accessed on 14 September 2017).
3. Hendin H, Phillips MR, Vijayakumar L, Pirkis J, Wang H, Yip P, Wasserman D, Bertolote JM, Fleischmann A. Suicide and suicide prevention in Asia. World Health Organization: Geneva, 2018.
4. Organization for Economic Co-operation and Development. OECD health data 2016.
<https://data.oecd.org/healthstat/suicide-rates.htm>. (Accessed on 14 September 2017).
5. Statistics Korea. Cause-of-Death Statistics 2017. <http://kosis.kr/en>. (Accessed on 14

- 1
2
3
4 September 2017).
- 5
6 6. Paik JW, Jo SJ, Lee S, Ong JY, Park JI. The Effect of Korean Standardized Suicide
7
8 Prevention Program on Intervention by Gatekeepers. *J Korean Neuropsychiatr Assoc*
9
10 2014;53:358-363. [In Korean].
- 11
12 7. Korea Suicide Prevention Center. *Suicide White Book*. Seoul: Ministry of Health and
13
14 Welfare, 2014 [In Korean].
- 15
16 8. Korea Suicide Prevention Center. *Suicide White Book*. Seoul: Ministry of Health and
17
18 Welfare, 2015 [In Korean].
- 19
20 9. Korea Suicide Prevention Center. *Suicide White Book*. Seoul: Ministry of Health and
21
22 Welfare, 2016 [In Korean].
- 23
24 10. Korea Suicide Prevention Center *Suicide White Book*. Seoul: Ministry of Health and
25
26 Welfare, 2017 [In Korean].
- 27
28 11. Kang HG. Social Welfare Delivery Reform: Achievements and Beyond, *Health and*
29
30 *Welfare Policy Forum* 2012;4:35-49
- 31
32 12. Lee SY. Policy options for the improvement of suicide prevention programs. *Health and*
33
34 *Welfare Policy Forum* 2015;4:34-49.
- 35
36 13. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with
37
38 applications to cancer rates. *Stat Med* 2000;19:335-351.
- 39
40 14. Matsubayashi T, Ueda M. The effect of national suicide prevention programs on suicide
41
42 rates in 21 OECD nations. *Soc Sci Med* 2011;73:1395-400.
- 43
44 15. Kwon JW, Chun H, Cho SI. A closer look at the increase in suicide rates in South Korea
45
46 from 1986-2005. *BMC Public Health* 2009;9:72-80.
- 47
48 16. National Mental Health and Welfare Commission. *Guidelines for mental health services*,
49
50 Seoul: Ministry of Health and Welfare 2005 [In Korean].
- 51
52
53
54
55
56
57
58
59
60

17. Park JI, Nam YY, Lee HK, Park JY, Lee MS, Lee SJ. National suicide prevention plan. Seoul: Ministry of Health and Welfare, 2011 [In Korean].
18. De Leo D, Buono MD, Dwyer J. Suicide among the elderly: the long-term impact of a telephone support and assessment intervention in northern Italy. *Br J Psychiatry* 2002;181: 226-9.
19. De Leo D, Carollo G, Buono MD. Lower suicide rates associated with a Tele-Help/Tele-Check service for the elderly at home. *Am J Psychiatry* 1995;152: 632-4.
20. Sun HJ. Suicide prevention efforts for the elderly in Korea. *Perspect Public Health* 2016;136:269-70.
21. Hempstead KA, Phillips JA. Rising suicide among adults aged 40-64 years: the role of job and financial circumstances. *Am J Prev Med* 2015;48:491-500.
22. Barr B, Taylor-Robinson D, Scott-Samuel A, McKee M, Stuckler D. Suicides associated with the 2008-10 economic recession in England: time trend analysis. *BMJ* 2012;345:e5142.
23. Statistics Korea. Social Survey 2008. <http://kosis.kr/en>. (Accessed on 30 July 2018).
24. Park SH, Kim CH, Kim DJ, Suk KT, Park HY, Lee JG, Shin KJ, Park JH, Kim TO, Yang SY, Moon YS, Lee HY. Secular trends in prevalence of alcohol use disorder and its correlates in Korean adults: results from Korea National Health and Nutrition Examination Survey 2005 and 2009. *Subst Abus* 2012;33:327-35.
25. Fu KW, Chan CH. A study of the impact of thirteen celebrity suicides on subsequent suicide rates in South Korea from 2005 to 2009. *PLoS One* 2013;8:e53870.
26. Jeong J, Shin SD, Kim H, Hong YC, Hwang SS, Lee EJ. The effects of celebrity suicide on copycat suicide attempt: a multi-center observational study. *Soc Psychiatry Psychiatr Epidemiol* 2012;47:957-65.

- 1
2
3
4 27. Niederkrotenthaler T, Fu KW, Yip PS, Fong DY, Stack S, Cheng Q, Pirkis J. Changes in
5
6 suicide rates following media reports on celebrity suicide: a meta-analysis. *J Epidemiol*
7
8 *Community Health* 2012;66:1037-42.
9
- 10 28. Ju Ji N, Young Lee W, Seok Noh M, Yip PS. The impact of indiscriminate media
11
12 coverage of a celebrity suicide on a society with a high suicide rate: epidemiological
13
14 findings on copycat suicides from South Korea. *J Affect Disord* 2014;156:56-61.
15
- 16 29. Chung YW, Kang SJ, Matsubayashi T, Sawada Y, Ueda M. The effectiveness of platform
17
18 screen doors for the prevention of subway suicides in South Korea. *J Affect Disord*.
19
20 2016 ;194:80-3.
21
- 22 30. Cha ES, Chang SS, Gunnell D, Eddleston M, Khang YH, Lee WJ. Impact of paraquat
23
24 regulation on suicide in South Korea. *Int J Epidemiol* 2015;45:470-9.
25
- 26 31. Zalsman G, Hawton K, Wasserman D, van Heeringen K, Arensman E, Sarchiapone M,
27
28 Carli V, Höschl C, Barzilay R, Balazs J, Purebl G, Kahn JP, Sáiz PA, Lipsicas CB,
29
30 Bobes J, Cozman D, Hegerl U, Zohar J. Suicide prevention strategies revisited: 10-year
31
32 systematic review. *Lancet Psychiatry* 2016;3:646-59.
33
- 34 32. Korea Health Promotion Institute. Health Plan 2020. <http://www.khealth.or.kr/healthplan>.
35
36 (Accessed on 24 April 2018).
37
- 38 33. Korea Suicide Prevention Center. 2013-2015 Emergency Department Based Post-Suicidal
39
40 Care Program Report Summary. <http://www.spckorea.or.kr/> (Accessed on 25 June,
41
42 2018)
43
- 44 34. Lee SU, Oh IH, Jeon HJ, Roh S. Suicide rates across income levels: Retrospective cohort
45
46 data on 1 million participants collected between 2003 and 2013 in South Korea. *J*
47
48 *Epidemiol* 2017;27:258-64.
49
- 50 35. Chang SS, Gunnell D, Sterne JA, Lu TH, Cheng AT. Was the economic crisis 1997–1998
51
52

1
2
3
4 responsible for rising suicide rates in East/Southeast Asia? A time-trend analysis for
5
6 Japan, Hong Kong, South Korea, Taiwan, Singapore and Thailand. Soc Sci Med.
7
8 2009;68:1322-31.
9

- 10
11 36. Hawton K, Arensman E, Wasserman D, Hulten A, Bille-Brahe U, Bjerke T, Crepet P,
12
13 Deisenhammer E, Kerkhof A, De Leo D, Michel K, Ostamo A, Philippe A, Querejeta I,
14
15 Salander-Renberg E, Schmidtke A, Temesváry B. Relation between attempted suicide
16
17 and suicide rates among young people in Europe. J Epidemiol Community Health
18
19 1998;52:191-4
20
21
22
23
24
25
26
27
28
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Table 1. Baseline characteristics of suicide by sex and age group

Characteristics	Overall	Year				<i>p</i> -value [¶]
		1993-1998	1999-2004	2005-2010	2011-2016	
Total number of deaths*	6,007,678	1,445,819	1,467,088	1,479,483	1,615,288	
Number of deaths due to suicide[†]	249,085 (4.15%)	34,064 (2.36%)	51,413 (3.50%)	78,674 (5.32%)	84,934 (5.26%)	
Sex[‡]						<0.0001
Men	169,963 (68.23%)	23,733 (69.67%)	35,619 (69.28%)	51,525 (65.49%)	59,086 (69.57%)	
Women	79,122 (31.77%)	10,331 (30.33%)	15,794 (30.72%)	27,149 (34.51%)	25,848 (30.43%)	
Age group[§]						<0.0001
10-19 years	7,712 (3.1%)	2,338 (6.9%)	1,629 (3.2%)	1,936 (2.5%)	1,809 (2.1%)	
20-29 years	29,988 (12.0%)	7,108 (20.9%)	6,306 (12.3%)	9,097 (11.6%)	7,477 (8.8%)	
30-39 years	43,015 (17.3%)	7,800 (22.9%)	9,654 (18.8%)	12,575 (16.0%)	12,986 (15.3%)	
40-49 years	47,796 (19.2%)	5,815 (17.1%)	10,468 (20.4%)	14,938 (19.0%)	16,575 (19.5%)	
50-59 years	41,960 (16.8%)	4,701 (13.8%)	7,705 (15.0%)	12,593 (16.0%)	16,961 (20.0%)	
60-69 years	33,214 (13.3%)	3,259 (9.6%)	7,441 (14.5%)	11,615 (14.8%)	10,899 (12.8%)	
70-79 years	29,654 (11.9%)	2,142 (6.3%)	5,389 (10.5%)	10,337 (13.1%)	11,786 (13.9%)	
≥80 years	15,661 (6.3%)	873 (2.6%)	2,800 (5.5%)	5,557 (7.1%)	6,431 (7.6%)	

*Total number of deaths present the overall cause of deaths.

[†]The denominator for percentage of number of deaths due to suicide was total number of deaths.

[‡]The number and percentage of death due to suicide by sex and age group were presented among people aged ≥ 10 years old.

[§] The number and percentage of death due to suicide by sex and age group were presented among people aged ≥ 10 years old.

[¶]Chi-square test was used to test the differences in the number of deaths by sex and age group

Table 2. The number of death from suicide, suicide rates from 1993 to 2016 in South Korea

Year	Population	Number of suicide death	Age-standardized suicide rate*
1993	44,752,157	4,208	10.7
1994	45,208,726	4,277	10.7
1995	45,637,184	4,930	12.1
1996	46,062,143	5,959	14.4
1997	46,475,163	6,068	14.5
1998	46,837,620	8,622	20.4
1999	47,163,425	7,056	16.5
2000	47,534,117	6,444	14.9
2001	47,877,049	6,911	15.7
2002	48,125,745	8,612	19.2
2003	48,308,386	10,898	23.7
2004	48,485,314	11,492	24.6
2005	48,683,040	12,011	25.1
2006	48,887,027	10,653	21.7
2007	49,130,354	12,174	24.3
2008	49,404,648	12,858	25.1
2009	49,656,756	15,412	29.5
2010	49,879,812	15,566	29.1
2011	50,111,476	15,906	29.1
2012	50,345,325	14,160	25.3
2013	50,558,952	14,427	25.3
2014	50,763,158	13,836	24.0
2015	50,951,719	13,513	22.8
2016	51,112,972	13,092	21.9

*Age-standardized rates were expressed per 100,000 people and Korean mid-year population in year 2005 was used for age-standardization.

Data was obtained from Statistics Korea (Available from: <http://kosis.kr/>)

Table 3. Joinpoint regression analysis for suicide rate from 1993 to 2016 in Korean by age group

Categories	Suicide rate		Trend 1		Trend 2		Trend 3		Trend 4	
	1993	2016	Years	APC (95% CI)	Years	APC (95% CI)	Years	APC (95% CI)	Years	APC (95% CI)
Men										
10-19 years old	5.35	5.57	1993-1998	4.8% (-5.2% to 16.0%)	1998-2001	-14.7% (-48.4% to 40.9%)	2001-2016	2.8% (0.5% to 5.2%)*		
20-29 years old	14.44	19.91	1993-2006	0.5% (-1.6% to 2.7%)	2006-2010	12.1% (-7.3% to 35.6%)	2010-2016	-5.8% (-11.7% to 0.5%)		
30-39 years old	15.53	31.32	1993-2016	3.0% (2.1% to 4.0%)*						
40-49 years old	18.39	42.34	1993-1998	15.6% (3.0% to 29.8%)*	1998-2016	1.9% (0.8% to 2.9%)*				
50-59 years old	23.92	48.32	1993-2004	8.0% (4.6% to 11.5%)*	2004-2016	-0.2% (-1.9% to 1.6%)				
60-69 years old	26.58	55.74	1993-2005	10.7% (7.8% to 13.7%)*	2005-2016	-3.6% (-5.5% to -1.7%)*				
70-79 years old	34.38	90.32	1993-2004	12.9% (9.9% to 16.0%)*	2004-2011	1.2% (-2.2% to 4.7%)	2011-2016	-7.5% (-11.2% to -3.5%)*		
≥80 years old	41.74	150.52	1993-2000	9.2% (2.3% to 16.7%)*	2000-2003	29.7% (-3.3% to 74.0%)*	2003-2010	0.9% (-2.4% to 4.3%)	2010-2016	-6.2% (-8.8% to -3.6%)*
Women										
10-19 years old	3.01	4.15	1993-1998	14.4% (5.2% to 24.3%)*	1998-2001	-21.4% (-47.0% to 16.6%)	2001-2009	8.0% (2.3% to 14.0%)*	2009-2016	-5.1% (-10.0% to -0.0%)*
20-29 years old	6.97	12.46	1993-1998	10.0% (-1.3% to 22.5%)	1998-2001	-14.8% (-47.7% to 38.8%)	2001-2008	19.9% (12.0% to 28.5%)*	2008-2016	-9.5% (-13.3% to -5.6%)*
30-39 years old	8.07	17.65	1993-2006	5.0% (3.2% to 6.8%)*	2006-2009	20.8% (-4.4% to 52.5%)	2009-2016	-5.9% (-8.9% to -2.8%)*		
40-49 years old	7.57	16.47	1993-2010	6.5% (5.4% to 7.7%)*	2010-2016	-3.3% (-6.8% to 0.3%)				
50-59 years old	5.47	16.35	1993-2010	6.6% (5.0% to 8.2%)*	2010-2016	-5.5% (-8.6% to 0.0%)				
60-69 years old	9.10	14.65	1993-2005	9.4% (7.5% to 11.4%)*	2005-2010	0.7% (-5.4% to 7.3%)	2010-2016	-8.7% (-11.9% to -5.5%)*		
70-79 years old	12.19	26.50	1993-2004	13.5% (11.0% to 16.1%)*	2004-2011	-1.5% (-4.6% to 1.7%)	2011-2016	-9.9% (-13.9% to -5.8%)*		
≥80 years old	17.21	45.73	1993-2004	18.0% (14.3% to 21.8%)*	2004-2011	-1.3% (-5.1% to 2.5%)	2011-2016	-11.5% (-15.8% to -6.9%)*		

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5 Joinpoint regression model is used to test that age-standardized rates have significantly changed. The trends in suicide mortality rates were summarized as APC (annual percentage change).

6 Age-standardized rates were expressed per 100,000 men and Korean mid-year population in year 2005 was used for age-standardization.

7 APC: annual percentage change, CI: confidence interval.

8 **p*-value <0.05
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5 **Figure legends**
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7
8 **Figure 1.** Trends in age-standardized suicide rates in South Korea, 1993-2016
9

10 Footnotes:

11 APC=Annual percent change

12
13 The age-standardized suicide rates are presented as suicide death cases per 100,000 people using Korean mid-year population in 2005 as
14 standard population.
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16 Joinpoint regression analysis was used to determine whether there were significant changes in trends in age-standardized suicide rates for the
17 period between 1993 and 2016.
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19 *p<0.05
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24 **Figure 2.** Implementation of National Suicide Prevention Program and Plan
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26 Footnotes:

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28 The age-standardized suicide rates are presented as connected line from 1993 to 2016.
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30 Each number represents the year in which the major events related to national suicide prevention program or plan were occurred.
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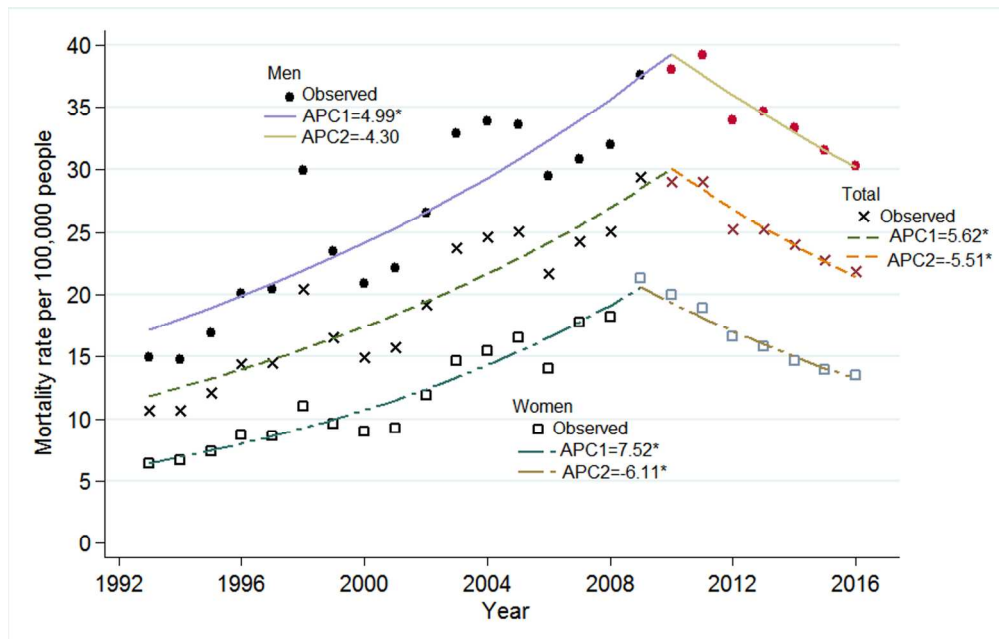
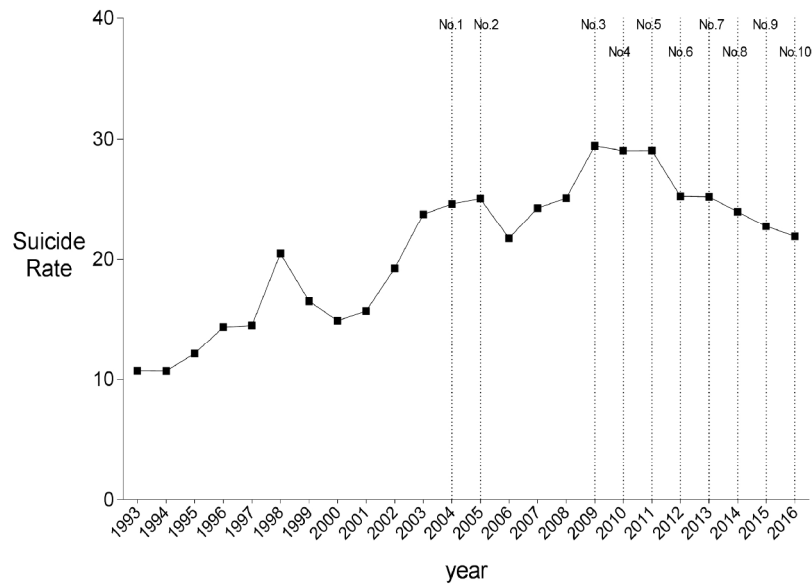


Figure 1. Trends in age-standardized suicide rates in South Korea, 1993-2016

141x90mm (300 x 300 DPI)



No.	Year	National suicide prevention program or plan
1	2004	The establishment of the first 5-year National Strategy for Suicide Prevention
2	2005	Suicide prevention program was introduced into regional mental welfare centers
3	2009	The establishment of the second 5-year National Strategy for Suicide Prevention
4	2010	The establishment of integrated welfare system The expansion of the basic living subsidies The increase in the number of welfare officers
5	2011	The enactment of the Act on Preventing Suicide The inhibition of sales of paraquat pesticides
6	2012	The enforcement of the Act on Preventing Suicide The introduction of the Korean gatekeeper program for suicide prevention entitled "Watch, Listen and Talk"
7	2013	The introduction of management of emergency department based suicide attempts The certification of private suicide prevention
8	2014	The collaboration the government with religious organizations The establishment of the Korea Psychological Autopsy Center
9	2015	The expansion of screen door on the subway "Are you okay" campaign
10	2016	The establishment of the comprehensive national mental health care strategy "Air kiss" campaign

Figure 2. Implementation of National Suicide Prevention Program and Plan

190x275mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	p.1,2 p.2-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p.5
Objectives	3	State specific objectives, including any prespecified hypotheses	p.5 line 18-21
Methods			
Study design	4	Present key elements of study design early in the paper	p.1,2,7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p.6 Line 1-10
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (b) For matched studies, give matching criteria and number of exposed and unexposed	p.6 Line 1-10 -
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p.6 Line 9-10, 17-24
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	p.6 Line 17-24
Bias	9	Describe any efforts to address potential sources of bias	p.16 Line 10-21
Study size	10	Explain how the study size was arrived at	p.8 Line 10-15
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p.7 Line 9-12
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, explain how loss to follow-up was addressed (e) Describe any sensitivity analyses	p.7 Line 8-8 p.8 Line 5 p.7 Line 9-12 - - -
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage	p.8 Line 9-14 -

		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	p.8 Line 9-14 - p.8 Line 10
Outcome data	15*	Report numbers of outcome events or summary measures over time	p.8 Line 10-14
Main results			
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	p.8 Line 22- p.10 Line 23 p.7 Line 9-12 Table 2
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	p.11 Line 23- p.12 Line 5
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p.4 Line 10-11 p.17 Line 11-23
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p.12 Line 9- p.17 Line 9
Generalisability	21	Discuss the generalisability (external validity) of the study results	p.12 Line 5-7 p.17 Line 24- p.18 Line 8
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p.18 Line 21-23

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.