Impact of the Early COVID-19 Pandemic on Suicide Attempts and Suicide Deaths in South Korea, 2016–2020: An Interrupted Time Series Analysis

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Objective   This study aimed to investigate the impact of coronavirus disease-2019 (COVID-19) on suicide attempts and suicide deaths in South Korea, focusing on age and sex differences.

Methods   We analyzed the monthly number of suicide attempts and suicide deaths during pre-pandemic (January 2016–February 2020) and pandemic (March–December 2020) periods using nationally representative databases. We conducted an interrupted time series analysis and calculated the relative risk (RR) with a 95% confidence interval (CI), categorizing subjects into adolescents (<18), young adults (18–29), middle-aged (30–59), and older adults (≥60).

Results   During the pandemic, the number of suicide attempts abruptly declined in adolescents (RR [95% CI] level change: 0.58 [0.45–0.75]) and older adults (RR [95% CI] level change: 0.74 [0.66–0.84]). In older males, there was a significant rebound in the suicide attempt trend (RR [95% CI] slope change: 1.03 [1.01–1.05]). The number of suicide deaths did not change among age/sex strata significantly except for older males. There was a brief decline in suicide deaths in older males, while the trend showed a following increase with marginal significance (RR [95% CI] level change: 0.76 [0.66–0.88], slope change: 1.02 [1.00–1.04]).

Conclusion   This study suggests the heterogeneous impact of the COVID-19 pandemic on suicide attempts and suicide deaths across age and sex strata in South Korea. These findings highlight the need for more targeted mental health interventions, given the observed trends in suicide attempts and suicide deaths during the pandemic.   **Psychiatry Investig 2024;21(9):1007-1015**

Keywords   Suicide attempt; Suicide; South Korea; COVID-19.

INTRODUCTION

The coronavirus disease-2019 (COVID-19) outbreak has caused significant changes in the lifestyle of humans world-

wide. Concerns have been raised regarding the deterioration of the population's mental health caused by the direct and indirect effects of the COVID-19 pandemic.[1] Various factors, including fear and anxiety about getting infected, inaccessibility to medical care, stress caused by the implementation of social distancing or lockdowns, and unemployment or financial crises, have been proposed as factors that may negatively affect mental health. These mental health burdens, in turn, may increase the risk of suicidal ideation, behaviors, and death.[1-5] Thus, various studies on the COVID-19 pandemic and suicide deaths in different countries have been conducted to compare suicide death rates before and during the pandemic. While some studies reported an increase in suicide death during the early COVID-19 pandemic in Japan[6] and Nepal,[7] several studies, including those from South Korea, have observed

either unchanged[8-12] or reduced[13-16] suicide deaths trends.

With the variation in suicide death trends between countries, deviations in suicide death rates across different subpopulations have been observed. A study from Taiwan found that, unlike suicide death trends in the general population, the suicide death rate had increased in older adults after the outbreak of the COVID-19 pandemic.[17] A study from South Korea reported that the number of suicides increased in females, indicating the vulnerable state of females' mental health during the COVID-19 pandemic.[18] Considering the heterogeneous impacts of the pandemic on various subgroups, it is necessary to identify these patterns within specific population. Additionally, to better understand the overall effect of the COVID-19 pandemic on suicide deaths, it is important to investigate both suicide attempt and suicide death trends, as suicide attempts are significant risk factors for completed suicides.[19] However, few studies have examined and provided a comprehensive comparison of both trends in suicide attempts and deaths before and during the pandemic in South Korea.

Investigating changes in trends of suicide attempts and suicide deaths during the ongoing COVID-19 pandemic could elucidate the vulnerability of specific subpopulations in the context of this unprecedented crisis. Thus, we aimed to evaluate the disproportionate impact of the COVID-19 pandemic on suicide attempts and suicide deaths in South Korea, primarily focusing on sex- and age-specific differences using nationwide databases.

METHODS

Data sources

To collect data on attempted suicides, we used the National Emergency Department Information System (NEDIS) database in South Korea from January 2016 to December 2020. NEDIS is a nationwide Emergency Department (ED)-based database developed by the National Emergency Medical Center under the Ministry of Health and Welfare. This database collects real-time clinical and administrative data on patients who have visited EDs, including demographic information (age and sex), insurance type, intentionality, injury mechanism, injury severity, geographic location of the ED, route of ED visit, and outcomes (discharge, transfer, and death).[20,21]

Suicide death data between January 2016 and December 2020 were obtained from the MicroData Integrated Service (MDIS) managed by Statistics Korea.[22] We extracted the monthly number of suicide deaths stratified by sex and age from the MDIS.

Study population

Patients who visited the EDs after a suicide attempt between January 2016 and December 2020 were included in this study. ED visits for suicide attempts were defined as any ED visit for injury related to intentional self-harm according to the Columbia Classification Algorithm of Suicide Assessment.[23] Suicide deaths were identified by cause of death codes using the International Classification of Diseases, 10th revision codes X60-X84 (Intentional self-harm). Individuals under 6 years of age were excluded from this study.

Study design

We used an interrupted time series (ITS) study design, which is widely used to investigate the association between suicide-related outcomes and COVID-19 pandemic.[8,10,24] Using a quasi-experimental design, the ITS analysis was used to assess the impact of population-level health interventions.[25] To evaluate the temporal impact of the COVID-19 pandemic, the monthly number of suicide attempts and suicide deaths before (January 2016−February 2020) and during (March−December 2020) the pandemic were compared.

After the first case of COVID-19 was confirmed in South Korea on January 20, 2020, the number of confirmed cases increased rapidly from February 18, 2020.[26] On February 29, 2020, the Korea Centers for Disease Control and Prevention Agency implemented a social distancing policy to limit the spread of COVID-19.[27] Thus, March 1, 2020, was considered the beginning of the COVID-19 pandemic period in the ITS analysis.

Outcomes and covariates

The primary outcome was the incidence of suicide attempts or suicide deaths. We stratified the monthly number of suicide attempts according to sex and age group or insurance type. For suicide deaths, we stratified the monthly number of suicide deaths according to sex and age group, occupation, or education level. Age was categorized into the following four groups: adolescents (<18), young adults (18−29), middle-aged (30−59), and older adults (≥60). Insurance type was categorized into five levels, including national health insurance (NHI), medical aid (medical aid type 1 and 2), self-pay, others, or unknown. Occupation was categorized into occupied (8 types of occupation, including managers, professionals, clerks, etc.) and unoccupied (unoccupied, housewife, and others). Education level was classified into four categories, including middle school or less, high school, college or higher, or unknown. Subjects with unknown insurance type, occupation, or education level were not included in the ITS analyses.

In the ITS analysis, we included a continuous variable that counted the number of months from January 2016 as our time variable, a binary dummy variable indicating exposure to the COVID-19 pandemic (0: before the pandemic, 1: during the

pandemic), and a continuous variable that counted the number of months after the emergence of COVID-19 (0: before the pandemic, time−50: after the pandemic). Additional covariates were the Fourier terms (pairs of sine and cosine functions) used to adjust for seasonality.

Statistical analysis

The annual incidence rates per 100,000 person-years were calculated using the mid-year census population of the respective years in Korean Statistical Information Service (KO-SIS). We calculated the age-and sex-specific incidence rates of attempted suicides and suicide deaths and their corresponding 95% confidence intervals (CI) for 2019 and 2020. We then calculated the incidence rate ratios and corresponding 95% CI to compare the incidence rates in 2019 and 2020.

ITS analysis was performed to identify changes in the monthly number of suicide attempts and suicide deaths before and during the COVID-19 outbreak. The pandemic onset was defined as March 2020. To handle overdispersion, we used quasi-Poisson regression and quantified the relative risk (RR) and 95% CI. A time variable to indicate the pre-pandemic trend, a binary indicator variable estimating the level change in the number of suicide attempts or suicide deaths, and a continuous variable that counted the number of months during the COVID-19 pandemic to measure the changes in the slope during the pandemic were included in the model. We used Fourier terms to adjust for seasonality. After fitting the model, residual analyses were conducted to test autocorrelation.

We extended the quasi-Poisson regression model to forecast the monthly number of suicide deaths. Using data from January 2016 to December 2020, we forecasted the monthly number of suicide deaths and calculated the corresponding 95% prediction interval for the period from January 2021 to July 2022 based on the forecasting scenarios. These scenarios are as follows: 1) no further effects of the COVID-19 pandemic, 2) continuous effects of the COVID-19 pandemic, and 3) based on the periods before and during the COVID-19 pandemic.[24] To validate our forecasting scenarios, we compared the forecasted and actual estimated monthly number of suicide deaths. The actual estimated number of suicide deaths was calculated by fitting a quasi-Poisson regression model using suicide death data obtained from KOSIS between January 2016 and July 2022.

All analyses were performed using R programming language version 4.1.1 (R Foundation for Statistical Computing, Vienna, Austria). A two-tailed p-value of <0.05 was considered statistically significant.

Ethics statement

This study was performed in accordance with the Declara-tion of Helsinki and was approved by the Institutional Review Board of the Yonsei University (4-2021-0259). Informed consent from the participants was waived by the Institutional Review Board of the Yonsei University due to the retrospective nature of this study.

RESULTS

We identified 152,075 cases who visited EDs because of suicide attempts and 66,219 individuals who committed suicide between January 2016 and December 2020. Table 1 shows the baseline characteristics of ED visits for suicide attempts. The annual incidence rates of suicide attempts per 100,000 person-years increased every year between 2016 and 2019 (52.8 to 70.7) and then decreased in 2020 (67.7). The proportion of females who attempted suicide increased from 54.6% in 2016 to 61.8% in 2020. Additionally, the mean age of those who attempted suicide decreased from 42.3 years in 2016 to 38.5 years in 2020. The most frequent method of suicide attempts was poisoning, followed by stabbing. The baseline characteristics of suicide deaths are presented in Table 2. In line with the tendency for suicide attempts, there was an increasing trend in suicide as well, which decreased in 2020 (27.0 in 2016 vs. 26.5 in 2020). The proportion of suicide deaths was higher in males than in females. Annual incidence rates of suicide attempts and suicide deaths by sex and age in 2019 and 2020 are presented in Supplementary Tables 1 and 2, respectively.

Temporal change in suicide attempts

The changes in monthly attempted suicide patterns during the COVID-19 pandemic according to sex and age groups are shown in Table 3, Figure 1, Supplementary Table 3 and Supplementary Figure 1. Until February 2020, the total number of suicide attempts increased (RR [95% CI] pre-pandemic trend: 1.01 [1.01–1.01]). After the onset of the pandemic (March 2020), the number of suicide attempts immediately decreased, but there was no significant change in the slope compared with the pre-pandemic trend (RR [95% CI] level change: 0.88 [0.80–0.97], slope change: 0.99 [0.98–1.01]).

Stratified by sex and age, the results from the ITS analyses showed that the immediate reduction of attempted suicides was significant only among males (RR [95% CI] level change: 0.85 [0.76–0.94]), and not among females (RR [95% CI] level change: 0.90 [0.82–1.01]) after the pandemic began. Specifically, the monthly number of suicide attempts immediately dropped in adolescent boys (RR [95% CI] level change: 0.65 [0.50–0.87]) and girls (RR [95% CI] level change: 0.56 [0.40–0.78]). For older males, the number of suicide attempts declined sharply at the beginning of the pandemic but thereaf-

Table 1. Baseline characteristics of emergency department visits due to suicide attempts by year (N=152,075)

	2016 (N=25,567)	2017 (N=26,831)	2018 (N=31,780)	2019 (N=34,610)	2020 (N=33,287)
Incidence rates per 100,000 person−years*	52.8 (52.2−53.5)	55.2 (54.5−55.9)	65.1 (64.4−65.8)	70.7 (69.9−71.4)	67.7 (67.0−68.5)
Sex (female)	13,956 (54.6)	15,001 (55.9)	18,095 (56.9)	20,248 (58.5)	20,584 (61.8)
Age (yr)	42.3±18.1	41.5±18.3	40.4±18.8	39.8±18.6	38.5±18.6
Type of insurance					
NHI	19,509 (76.3)	20,770 (77.4)	25,032 (78.8)	27,906 (80.6)	2,7430 (82.4)
Medical aid	2,355 (9.2)	2,596 (9.7)	3,158 (9.9)	3,385 (9.8)	3,133 (9.4)
Self-pay	3,465 (13.6)	3,219 (12.0)	3,399 (10.7)	3,120 (9.0)	2,564 (7.7)
Others	168 (0.7)	186 (0.7)	177 (0.6)	182 (0.5)	119 (0.4)
Unknown	70 (0.3)	60 (0.2)	14 (0.04)	17 (0.05)	41 (0.1)
Mechanisms of injury					
Traffic accident	79 (0.3)	78 (0.3)	100 (0.3)	68 (0.2)	72 (0.2)
Fall	479 (1.9)	501 (1.9)	580 (1.8)	605 (1.7)	594 (1.8)
Struck	1,210 (4.7)	1,183 (4.4)	1,327 (4.2)	1,403 (4.1)	1,174 (3.5)
Laceration/stabbing	6,189 (24.2)	6,881 (25.6)	8,086 (25.4)	9,123 (26.4)	9,543 (28.7)
Drowning	244 (1.0)	275 (1.0)	284 (0.9)	321 (0.9)	313 (0.9)
Poisoning	15,227 (59.6)	15,609 (58.2)	18,859 (59.3)	20,443 (59.1)	19,164 (57.6)
Suffocation/hanging	1,073 (4.2)	1,166 (4.3)	1,375 (4.3)	1,473 (4.3)	1,361 (4.1)
Others	987 (3.9)	1,079 (4.0)	1,118 (3.5)	1,103 (3.2)	956 (2.9)
Unknown	79 (0.3)	59 (0.2)	51 (0.2)	71 (0.2)	110 (0.3)
Route of arrival					
Direct	22,510 (88.0)	23,828 (88.8)	28,527 (89.8)	31,573 (91.2)	31,112 (93.5)
Transfer in	3,005 (11.8)	2,956 (11.0)	3,182 (10.0)	2,981 (8.6)	2,084 (6.3)
Referral from outpatient	39 (0.2)	35 (0.1)	60 (0.2)	53 (0.2)	89 (0.3)
Others	9 (0.04)	8 (0.03)	9 (0.03)	2 (0.01)	2 (0.01)
Unknown	4 (0.02)	4 (0.01)	2 (0.01)	1 (0.003)	0 (0.0)
Emergent symptom					
Yes	23,751 (92.9)	24,964 (93.0)	29,618 (93.2)	32,077 (92.7)	30,909 (92.9)
No	1,816 (7.1)	1,867 (7.0)	2,162 (6.8)	2,533 (7.3)	2,377 (7.1)
Unknown	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.003)

Data are presented as number (%) or mean±standard deviation. *incidence rates per 100,000 person-years were calculated using the mid-year census population of respective year. NHI, national health insurance

ter, the slope increased by 3.0% against the pre-pandemic levels (RR [95% CI] level change: 0.67 [0.59–0.77], slope change: 1.03 [1.01–1.05]). However, the slope of suicide attempts among older females did not change during the pandemic compared with the pre-pandemic period (RR [95% CI] level change: 0.83 [0.71–0.97], slope change: 1.01 [0.99–1.03]).

Stratified by insurance type, the monthly number of suicide attempts shortly declined in patients with NHI (RR [95% CI] level change: 0.89 [0.80–0.98]), medical aid (RR [95% CI] level change: 0.82 [0.71–0.95]), and self-pay (RR [95% CI] level change: 0.84 [0.71–0.99]). There were no significant changes for patients with other insurance at the beginning of the pandemic. However, there was an increasing trend during the pan-

demic compared to the pre-pandemic trend (RR [95% CI] level change: 1.20 [0.77–1.88], slope change: 0.90 [0.83–0.97]) in patients with other insurance.

Temporal change in suicide deaths

The results of the association between the COVID-19 pandemic and changes in the number of suicide deaths are shown in Table 4, Figure 2, Supplementary Table 4 and Supplementary Figure 2. The total number of suicide deaths did not show specific changes during the COVID-19 pandemic (RR [95% CI] level change: 0.95 [0.85–1.07], slope change: 1.00 [0.97–1.01]). In addition, no statistically significant changes were observed in any of the subpopulations except older males. The

Table 2. Baseline characteristics of the subjects who committed suicide by year (N=66,219)

	2016 (N=13,092)	2017 (N=12,463)	2018 (N=13,670)	2019 (N=13,799)	2020 (N=13,195)
Incidence rates per 100,000 person−years*	27.0 (26.6−27.5)	25.6 (25.2−26.1)	28.0 (27.5−28.5)	28.2 (27.4−28.3)	26.5 (26.1−27.0)
Sex (female)	3,849 (29.4)	3,541 (28.4)	3,808 (27.9)	4,069 (29.5)	4,102 (31.1)
Age (yr)	53.0±18.1	53.0±21.7	52.7±18.0	53.2±26.8	51.9±18.5
Occupation					
Managers	414 (3.2)	407 (3.3)	137 (1.0)	122 (0.9)	95 (0.7)
Professionals and related	677 (5.2)	636 (5.1)	550 (4.0)	563 (4.1)	636 (4.8)
Clerks	602 (4.6)	581 (4.7)	1,236 (9.0)	1,242 (9.0)	1,212 (9.2)
Service and sales	1,380 (10.5)	1,304 (10.5)	1,080 (7.9)	1,112 (8.1)	1,350 (10.2)
Skilled agricultural, forestry and fishery	677 (5.2)	628 (5.0)	395 (2.9)	382 (2.8)	360 (2.7)
Craft and related trades	372 (2.8)	318 (2.6)	148 (1.1)	118 (0.9)	122 (0.9)
Equipment, machine operating and assembling	286 (2.2)	273 (2.2)	436 (3.2)	415 (3.0)	231 (1.8)
Elementary	824 (6.3)	752 (6.0)	1,268 (9.3)	1,294 (9.4)	1,136 (8.6)
Unoccupied	7,383 (56.4)	6,704 (53.8)	8,161 (59.7)	8,318 (60.3)	7,771 (58.9)
Armed forces or unknown	477 (3.6)	860 (6.9)	259 (1.9)	233 (1.7)	282 (2.1)
Marital status					
Unmarried	3,776 (28.8)	3,636 (29.2)	4,126 (30.2)	4,226 (30.6)	4,489 (34.0)
Married	5,803 (44.3)	5,493 (44.1)	5,911 (43.2)	5,857 (42.4)	5,297 (40.1)
Divorced	2,063 (15.8)	2,034 (16.3)	2,273 (16.6)	2,356 (17.1)	2,197 (16.7)
Widowed	1,408 (10.8)	1,268 (10.2)	1,326 (9.7)	1,315 (9.5)	1,194 (9.0)
Unknown	42 (0.3)	32 (0.3)	34 (0.2)	45 (0.3)	18 (0.1)
Education level					
Middel school or less	4,708 (36.0)	4,263 (34.2)	4,407 (32.2)	4,156 (30.1)	3,764 (28.5)
High school	4,873 (37.2)	4,657 (37.4)	4,984 (36.5)	5,023 (36.4)	4,834 (36.6)
College or higher	3,023 (23.1)	2,943 (23.6)	3,586 (26.2)	3,743 (27.1)	3,656 (27.7)
Unknown	488 (3.7)	600 (4.8)	693 (5.1)	877 (6.4)	941 (7.1)

Data are presented as number (%) or mean±standard deviation. *incidence rates per 100,000 person-years were calculated using the mid-year census population of respective year

number of suicide deaths significantly decreased at the beginning of the pandemic, but the trend did not change during the pandemic in older males (RR [95% CI] level change: 0.76 [0.66–0.88], slope change: 1.02 [1.00–1.04]).

The forecasted and validated suicide death trends by sex between January 2021 and July 2022 are shown in Supplementary Tables 5-7 and Supplementary Figure 3.

DISCUSSION

In this study, we identified the early impact of the COVID-19 pandemic on both suicide attempts and deaths using national data from South Korea. To comprehensively understand the impact of the COVID-19 pandemic on suicide-related outcomes, we investigated trends in suicide attempts and suicide deaths across different subgroups, mainly focusing on sex and age differences. We found that the impact of the COVID-19 pandemic on suicide attempts or deaths are not evenly distributed across sex and age group. At the beginning of the pandemic, significant reductions in suicide attempts were observed in both adolescent and older adult populations. However, compared to the pre-pandemic years, the trend of suicide attempts increased among older males during the pandemic. Regarding suicide deaths, we found an initial reduction after the pandemic only in older males; however, the post-pandemic trend appeared to be increasing among older males, albeit insignificantly.

In adolescents

This sudden decline in suicide attempts among adolescents can be attributed to nationwide school closures and the implementation of online classes in South Korea. This is in line

Table 3. Interrupted time series analysis of the impact of the COVID-19 pandemic on suicide attempt in South Korea

	Pre-pandemic trend* RR (95% CI)	p	Level change RR (95% CI)	p	Slope change RR (95% CI)	p
Total	1.01 (1.01−1.01)	<0.001	0.88 (0.80−0.97)	0.012	0.99 (0.98−1.01)	0.382
Male	1.01 (1.01−1.01)	<0.001	0.85 (0.76−0.94)	0.002	0.99 (0.97−1.01)	0.186
Female	1.01 (1.01−1.01)	<0.001	0.90 (0.82−1.01)	0.073	0.99 (0.98−1.01)	0.501
Adolescents	1.02 (1.02−1.03)	<0.001	0.58 (0.45−0.75)	<0.001	1.01 (0.97−1.05)	0.562
Male	1.01 (1.01−1.01)	<0.001	0.65 (0.50−0.87)	0.003	1.01 (0.96−1.05)	0.716
Female	1.03 (1.03−1.04)	<0.001	0.56 (0.40−0.78)	<0.001	1.01 (0.96−1.06)	0.772
Young adults	1.01 (1.01−1.02)	<0.001	1.00 (0.88−1.13)	0.981	0.99 (0.97−1.01)	0.291
Male	1.01 (1.01−1.01)	<0.001	0.96 (0.83−1.10)	0.543	0.98 (0.96−1.00)	0.092
Female	1.02 (1.02−1.02)	<0.001	1.02 (0.89−1.17)	0.787	0.99 (0.97−1.01)	0.430
Middle-aged	1.00 (1.00−1.01)	<0.001	0.91 (0.81−1.02)	0.114	0.98 (0.96−1.00)	0.026
Male	1.00 (1.00−1.01)	<0.001	0.90 (0.80−1.02)	0.094	0.97 (0.95−0.99)	0.006
Female	1.00 (1.00−1.01)	<0.001	0.92 (0.81−1.05)	0.227	0.98 (0.96−1.00)	0.125
Older adults	1.01 (1.00−1.01)	<0.001	0.74 (0.66−0.84)	<0.001	1.02 (1.00−1.04)	0.038
Male	1.01 (1.01−1.01)	<0.001	0.67 (0.59−0.77)	<0.001	1.03 (1.01−1.05)	0.008
Female	1.00 (1.00−1.01)	<0.001	0.83 (0.71−0.97)	0.016	1.01 (0.99−1.03)	0.449

Age was categorized into the following four groups: adolescents (<18), young adults (18–29), middle-aged (30–59), older adults (≥60). *time period from January 2016 to February 2020. COVID-19; coronavirus disease-2019; RR, relative risk; CI, confidence interval
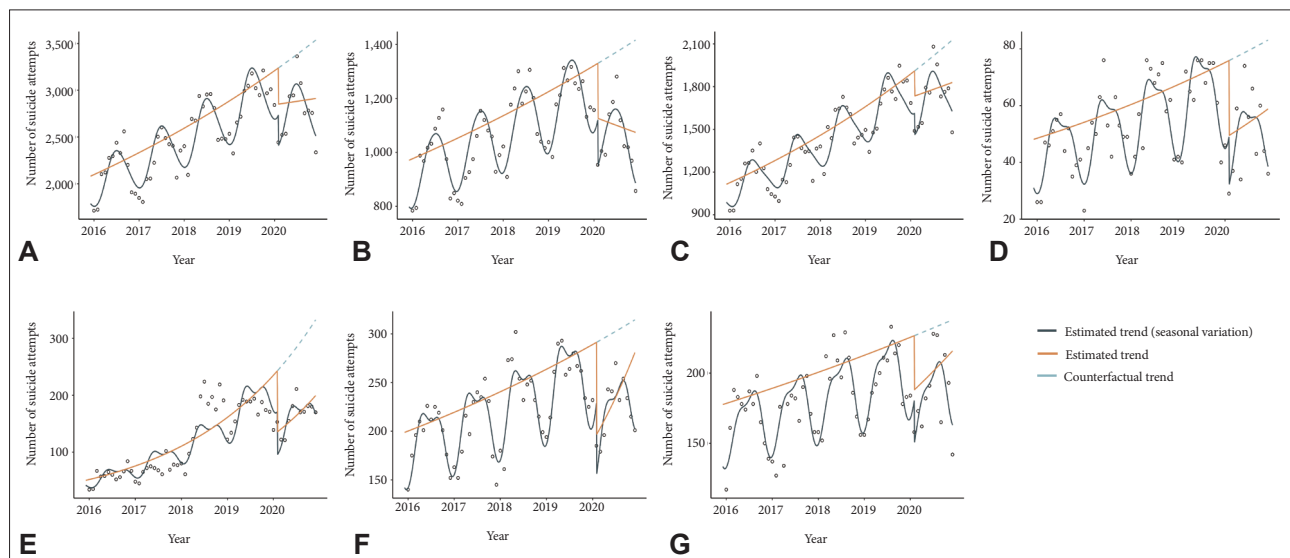

Figure 1. Interrupted time series analysis of the impact of the COVID-19 pandemic on suicide attempt in South Korea. Counterfactual trend indicates estimated value as if there is no COVID-19 exposure. A: Total. B: Male. C: Female. D: Adolescent male. E: Adolescent female. F: Older male. G: Older female. COVID-19; coronavirus disease-2019.

with previous studies examining the mental health of adolescents in South Korea that showed that suicidal ideation and attempts were lower initially in the pandemic (2020) than in previous years; these suggest a close association with school closure and in-home online classes by lowering the burden of school activity, academic achievement, stress from interpersonal relationships in school which could have been risk factors for suicide attempts in adolescents.[28,29]

In our sex-specific analysis, we observed a heterogeneous impact of the pandemic on suicide attempts among adolescents. Compared with adolescent boys, although the increasing trend during the pre-pandemic period was more evident in adolescent girls, the decline in the level change was more pronounced among girls. These findings suggest that the pandemic had a more significant impact on girls than boys, which can be resulted from the differences in risk factors for suicide

Table 4. Interrupted time series analysis of the impact of the COVID-19 pandemic on suicide death in South Korea

	Pre-pandemic trend* RR (95% CI)	p	Level change RR (95% CI)	p	Slope change RR (95% CI)	p
Total	1.00 (1.00−1.00)	0.011	0.95 (0.85−1.07)	0.439	1.00 (0.97−1.01)	0.667
Male	1.00 (1.00−1.00)	0.009	0.89 (0.79−1.00)	0.050	1.00 (0.98−1.02)	0.825
Female	1.00 (1.00−1.00)	0.073	1.12 (0.95−1.32)	0.164	0.98 (0.96−1.01)	0.155
Adolescents	1.01 (1.00−1.01)	0.007	1.12 (0.75−1.68)	0.584	0.98 (1.00−1.01)	0.549
Male	1.00 (0.99−1.01)	0.758	1.15 (0.67−1.99)	0.615	1.01 (0.93−1.10)	0.744
Female	1.01 (1.01−1.02)	<0.001	1.10 (0.61−1.98)	0.746	0.94 (0.86−1.04)	0.240
Young adults	1.00 (1.00−1.01)	0.004	1.16 (0.93−1.45)	0.191	0.99 (0.96−1.02)	0.474
Male	1.00 (1.00−1.00)	0.398	1.08 (0.86−1.36)	0.511	1.00 (0.97−1.04)	0.924
Female	1.01 (1.00−1.01)	<0.001	1.29 (0.90−1.86)	0.172	0.97 (0.91−1.02)	0.212
Middle-aged	1.00 (1.00−1.00)	0.094	0.98 (0.86−1.11)	0.761	0.99 (0.97−1.01)	0.185
Male	1.00 (1.00−1.00)	0.071	0.95 (0.83−1.07)	0.396	0.99 (0.97−1.01)	0.300
Female	1.00 (1.00−1.00)	0.349	1.08 (0.90−1.29)	0.434	0.98 (0.95−1.01)	0.139
Older adults	1.00 (1.00−1.00)	0.018	0.85 (0.75−0.97)	0.015	1.01 (0.99−1.03)	0.178
Male	1.00 (1.00−1.00)	0.002	0.76 (0.66−0.88)	<0.001	1.02 (1.00−1.04)	0.057
Female	1.00 (1.00−1.00)	0.634	1.12 (0.95−0.32)	0.161	1.00 (0.97−1.02)	0.699

Age was categorized into the following four groups: adolescents (<18), young adults (18–29), middle-aged (30–59), older adults (≥60). *time period from January 2016 to February 2020. COVID-19; coronavirus disease-2019; RR, relative risk; CI, confidence interval
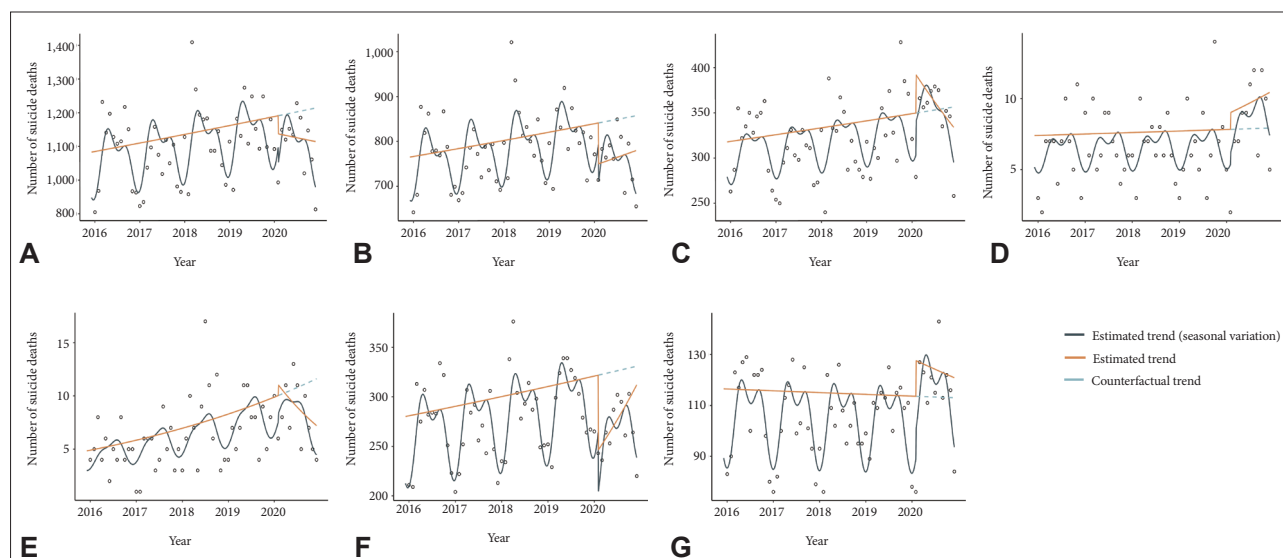

Figure 2. Interrupted time series analysis of the impact of the COVID-19 pandemic on suicide death in South Korea. Counterfactual trend indicates estimated value as if there is no COVID-19 exposure. A: Total. B: Male. C: Female. D: Adolescent male. E: Adolescent female. F: Older male. G: Older female. COVID-19; coronavirus disease-2019.

attempts in adolescents based on sex.[30] Given the long-term implications of suicide attempts in younger generations,[31] further investigation will be needed to fully account for the sex differences in suicide attempts during the pandemic.

In older adults

Our study observed initial reductions in suicide attempts among older adults and in suicide deaths among older males.

These declines may be explained by a phenomenon called the "honeymoon effect".[32] The increased sense of belonging and empathy during the early phase of the epidemic could be contributed to short-term decreases in the risk of suicide-related outcomes.[33,34] Conversely, the decline in suicide attempts could be associated with decreased help-seeking behaviors in other adults. The excessive fear of becoming infected with COVID-19 due to the higher mortality risk[35] might lead to reduced

help-seeking behaviors, especially among older adults. In line with this, the number of ED visits by older adults during the early phase of the pandemic also declined.[36-38]

Following the immediate decline at the initial stage of the pandemic, suicide attempts and suicide deaths among older males rebounded during the pandemic compared to the pre-pandemic years, although the increase in suicide deaths was marginally significant. Older adults are more susceptible to social isolation, and the effect of social isolation is generally greater in males than in females.[39,40] Physical distancing measures during the COVID-19 pandemic have reduced social participation and access to community services over time, negatively impacting the overall well-being of the older population.[41] Moreover, since older adults are vulnerable during the disaster, feelings of being a burden to families and younger generations could exacerbate the suicide risk.[42] As the pandemic continues, feelings of loneliness and isolation, and perceived burdensomeness will have a greater impact on the mental health of older adults, especially older males. These factors may contribute to an increase in the risk of suicide attempts or suicide deaths.

This study has several limitations. First, since the current study obtained data on suicide attempt incidence from the ED visit data, the observed number could have been underestimated because some individuals may not have sought help after suicide attempts. Second, the collected covariates do not rule out all other confounders that may affect suicide attempts and deaths, including a history of mental illness and individual economic status, which are known risk factors for suicidality and were not assessed in this study. Therefore, further studies are needed to investigate individual-level risk factors that affect suicide-related outcomes during the COVID-19 pandemic. Third, our study only covered the first year of the COVID-19 pandemic, which is relatively short for capturing the long-term effects of the pandemic on suicide attempts and suicide deaths. Given that the COVID-19 pandemic has persisted for several years and may continue to influence the trends of suicide attempts and suicide deaths, future studies with extended time frames will be needed to provide a more comprehensive understanding of the pandemic's impacts. Finally, this study was conducted on a South Korean population. As the impact of the COVID-19 pandemic on suicidality varies between nations and across time, attention should be paid when applying our results to other countries.

In conclusion, our study provides a comprehensive overview of the multifaceted impact of the COVID-19 pandemic on suicide attempts and suicide deaths using nationwide data. Our findings revealed that the effects of the pandemic on these outcomes were disproportionate, with variations observed across sex and age groups, specifically among adolescents and

older adults. These results highlight the importance of considering sex and age differences when formulating and implementing targeted suicide prevention measures in the aftermath of a pandemic.

Supplementary Materials

Availability of Data and Material

The datasets analyzed during the study are not publicly available due to restrictions from the NEDIS policy but are available from the corresponding author on reasonable request. The datasets analyzed during the current study are available in the MDIS website [https://doi.org/10.23333/P.101054.001].

Conflicts of Interest

Seng Chan You reports being a chief executive officer of PHI Digital Healthcare; and receiving grants from DaiichiSankyo. All remaining authors have declared no conflicts of interest.

Author Contributions

Conceptualization: Subin Kim, Min Ho An, Seng Chan You. Data curation: Subin Kim, Min Ho An, Yunjung Heo, Seng Chan You. Formal analysis: Subin Kim, Min Ho An. Investigation: Subin Kim, Min Ho An, Dong Yun Lee, Min-Gyu Kim, Gyubeom Hwang, Seng Chan You. Methodology: Subin Kim, Min Ho An, Seng Chan You. Project administration: Yunjung Heo, Seng Chan You. Resources: Subin Kim, Min Ho An, Yunjung Heo, Seng Chan You. Software: Subin Kim, Min Ho An. Supervision: Yunjung Heo, Seng Chan You. Validation: Subin Kim, Min Ho An, Seng Chan You. Visualization: Subin Kim. Writing—original draft: Subin Kim, Min Ho An, Seng Chan You. Writing—review & editing: all authors.

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