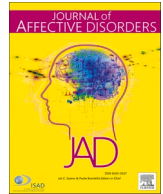




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## Research paper

## Trends in emergency department visits for suicide attempts before and during the COVID-19 pandemic in Korea: A nationwide study, 2016–2021

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## ABSTRACTS

**Background:** There is increasing concern that the effects of the COVID-19 pandemic will result in excess suicides by increasing known risk factors, such as suicide attempts. However, evidence on the long-term impacts of COVID-19 on suicide attempts is lacking. We aimed to assess the short- and long-term effects of the COVID-19 pandemic on patients with suicide attempts in emergency departments (EDs) and to evaluate age- and sex-specific differences.

**Method:** We conducted nationwide cross-sectional study among patients with suicide attempts in the ED from 2016 to 2021. The trend test were used to determine whether study subjects were affected by changes in ED visits for suicide attempts. We estimated the average annual percentage change (APC) stratified by sex and age groups.

**Results:** The number of ED visits related to suicide attempts increased from 27,581 in 2016 to 37,719 in 2021. In particular, it decreased immediately after the COVID-19 pandemic but increased again in 2021. We identified that the average APC increased by 6.8 % overall, 1.6 % among males, and 10.8 % among females. Moreover, the APC of trend sharply increased in patients aged 10s and 20s. The in-hospital mortality was 3.6 % for females, compared to 9.5 % for males, which showed sex differences.

**Limitations:** This study was limited to confirming causal relationship based on a descriptive study.

**Conclusions:** The incidence of suicide attempts in ED has increased in Korea. In particular, there was a sharp increase among women, adolescents and young adults. Patient-tailored treatment and preventive medical system for suicide attempts is important.

## 1. Introduction

Since the first case of COVID-19 was reported in Wuhan, China in December 2019, the infectious disease has spread around the world, with the WHO declaring a pandemic in March 2020 (Cucinotta and Vanelli, 2020; Guan et al., 2020). By August 2022, >600 and 6.4 million were infected with COVID-19 and died worldwide, respectively (World Health Organization, 2022). In response to the pandemic, non-pharmaceutical interventions (NPI) such as “stay-at-home” orders,

closure of schools, and restrictions on social gatherings have been implemented in many countries (Iezadi et al., 2021), leading to many people experiencing social isolation (Morina et al., 2021). In addition, the pandemic has posed a huge economic shock worldwide, causing many individuals to lose their jobs and income (Baird et al., 2022; Mojtahedi et al., 2020; Ruengorn et al., 2021). In this context, serious concerns have been raised that the pandemic itself and its consequences may lead to a deterioration in mental health and an increase in suicidal behavior in the general population (Reger et al., 2020). In fact, data have

**Abbreviations:** ED, emergency department; NEDIS, National Emergency Department Information System; KTAS, Korean Triage and Acuity Scale; ICD-10, International Classification of Disease 10th Edition; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology; LOS, length of stay; APC, annual percentage change; CI, confidence interval; OECD, Organization for Economic Cooperation and Development; KOSIS, Korean Statistical Information Service; NPI, non-pharmaceutical interventions.

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been reported from the United States, the United Kingdom, and Europe that shows suicide deaths and unsolicited self-harm decreased in the early months of the pandemic and then increased over time (Jollant et al., 2022; Kippe et al., 2022; Steeg et al., 2021; Yard et al., 2021). However, the latest data on the growth trend of suicide and suicidal behavior is limited.

Korea has the highest suicide rate among Organization for Economic Cooperation and Development (OECD) countries (OECD, 2017), with suicide attempts increasing rapidly, especially in the young population (Lee et al., 2022a). Although Korea was able to effectively contain the COVID-19 pandemic without strict NPI (Gokmen et al., 2021), there are a number of reports that suggest the prevalence of depression and anxiety in the general population increased during the pandemic (Kim et al., 2021a; Kim et al., 2021b; Lee et al., 2021; Lee et al., 2022b). Another issue in this situation is that there is a lack of data to rapidly monitor the trend of suicide behavior and to guide public health responses (Kuramoto-Crawford et al., 2017). To guide suicide prevention and intervention efforts, it is necessary to understand the trends of suicide and suicide attempts. However, national-level data often have several years of lag. Therefore, these problems hinder the guidance of rapid public health measures (Data and Surveillance Task Force of the National Action Alliance for Suicide, 2014).

The emergency department (ED) provides initial care and assessment of physical injuries and comorbid mental conditions to patients who have attempted suicide. It also serves as a referral center for specialist mental health services. In many regions, EDs are part of a major surveillance system that monitors and detects presentations by patients at risk of suicide (Data and Surveillance Task Force of the National Action Alliance for Suicide, 2014). Korea established a unique nationwide emergency department-based data called the National Emergency Department System (NEDIS) in 2003 (Pak et al., 2021). Therefore, in this study, we aimed to investigate the changes over time of suicide attempt-related ED visits before and during the pandemic using the NEDIS data and the corresponding demographic and clinical characteristics. Based on the available data, we updated the rebound of ED visits for suicide attempts to the latest in the subsequent stages of the pandemic observed in other countries.

## 2. Methods

### 2.1. Study design and data source

This nationwide population-based study included all patients aged  $\geq 12$  years with ED visits for suicide attempts from 2016 to 2021. Suicide attempt-related ED visits were defined as any ED visit for self-injurious behavior and suicidal intent according to the Columbia Classification Algorithm of Suicide Assessment (Posner et al., 2007).

The data were extracted from the NEDIS. In brief, the NEDIS prospectively collects data from each nationwide ED visit, including patient demographics (age, sex, region, and insurance), prehospital factors (ambulance use or others), ED factors (vital signs, triage results according to the Korean Triage and Acuity Scale [KTAS]), disposition, diagnosis codes based on the International Classification of Disease 10th Edition (ICD-10), and final clinical outcomes. All patient-related information was automatically sent from each hospital to the NEDIS in real time, and inaccurate data were filtered out by the data processing system. The detailed design and variables of the NEDIS database have been previously described (Kim et al., 2022; Lee et al., 2022a; Min et al., 2022). This study follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines for observational studies.

### 2.2. Study outcomes and measurements

The primary outcome was the number of ED visits for suicide attempts before and during the COVID-19 pandemic. The secondary

outcome was ED visits for suicide attempts, according to the means of suicide.

The variables used were patient demographics (age and sex) and ED factors (region of the ED, ambulance use, triage result, diagnosis, length of stay in the ED, suicidal means, dispositions, and final clinical outcomes). Patients' age at ED visit was classified into eight groups (12–19, 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and 80+ years). The ED regions were categorized into three groups according to population density and administrative divisions (metropolitan, urban, and rural areas).

### 2.3. Statistical analysis

A descriptive analysis was performed for all patients who attempted suicide by visiting EDs annually. Likelihood ratio test for trend were used to determine whether age, sex, region, ambulance use, ED length of stay (ED LOS), patient triage, admission, and in-hospital mortality were affected by changes in ED visits for suicide attempts according to the year. We calculated p-trend in 2016–2021 and 2016–2019. We utilized the likelihood ratio test from 2016 to 2021 to assess linear interaction in the overall trend of ED visits for suicide attempts before and during the COVID-19 pandemic. Using a linear interaction from 2016 to 2019, we compared it to the p-trend in 2016–2021, and identified whether the trend changes during the pandemic. The chi-square test was performed to determine whether each suicidal means was differed by sex. The annual age- and sex-standardized incidence rates of ED visit-related suicide attempts per 100,000 person-years were calculated using the 2020 population in the Korean Statistical Information Service (KOSIS) database from Statistics Korea. Joinpoint regression analysis was performed to identify trends for standardized incidence rates over time (Kim et al., 2000). We estimated the average annual percentage change (APC) stratified by sex and age groups. The impact of COVID-19 outbreak on was assessed by performing an interrupted time series analysis with a quasi-Poisson regression model, accounting for seasonality, overdispersion of data, secular trend before and during the COVID-19 Pandemic, and interaction between time and the COVID-19 outbreak.

All data preparation and statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA) and R version 4.1.1. (R Development Core Team, <https://cran.r-project.org/>), except for joinpoint regression analysis. The joinpoint regression analysis was performed using the Joinpoint Regression Program, version 4.9.1.0 (National Cancer Institute (NCI), 2020). The significance level was set at 0.05, and a two-sided test was used.

### 2.4. Ethics statement

This study was approved by the Institutional Review Board of the National Medical Center (IRB No. NMC-2022-03-030). The requirement for informed consent was waived owing to the retrospective nature of this study.

## 3. Results

From January 1, 2016, to December 31, 2021, the total number of ED visits for suicide attempts was 200,792, increasing from 27,581 in 2016 to 37,719 in 2021 (Fig. 1). The ED visits for suicide attempts showed seasonality each year that increased during summer and decreased rates in winter (Supplementary Fig. 1), however, number of ED visits for suicide patients decreased in the first quarter of 2020 (Supplementary Fig. 2). By contrast, ED visit for suicide attempts were not impacted by long-term effects of COVID-19 (relative risk 1.14, 95 % confidence interval [CI] 0.91–1.42,  $p = 0.25$ , Supplementary Fig. 3). Although there was a tendency to decrease after 2019 for males, there was a steady increase for females (Fig. 1). Regarding age groups, the patterns of ED visits for suicide attempts from 2016 to 2019 increased in all age groups. After 2019, the number of ED visits decreased in the 40–49 and 50–59

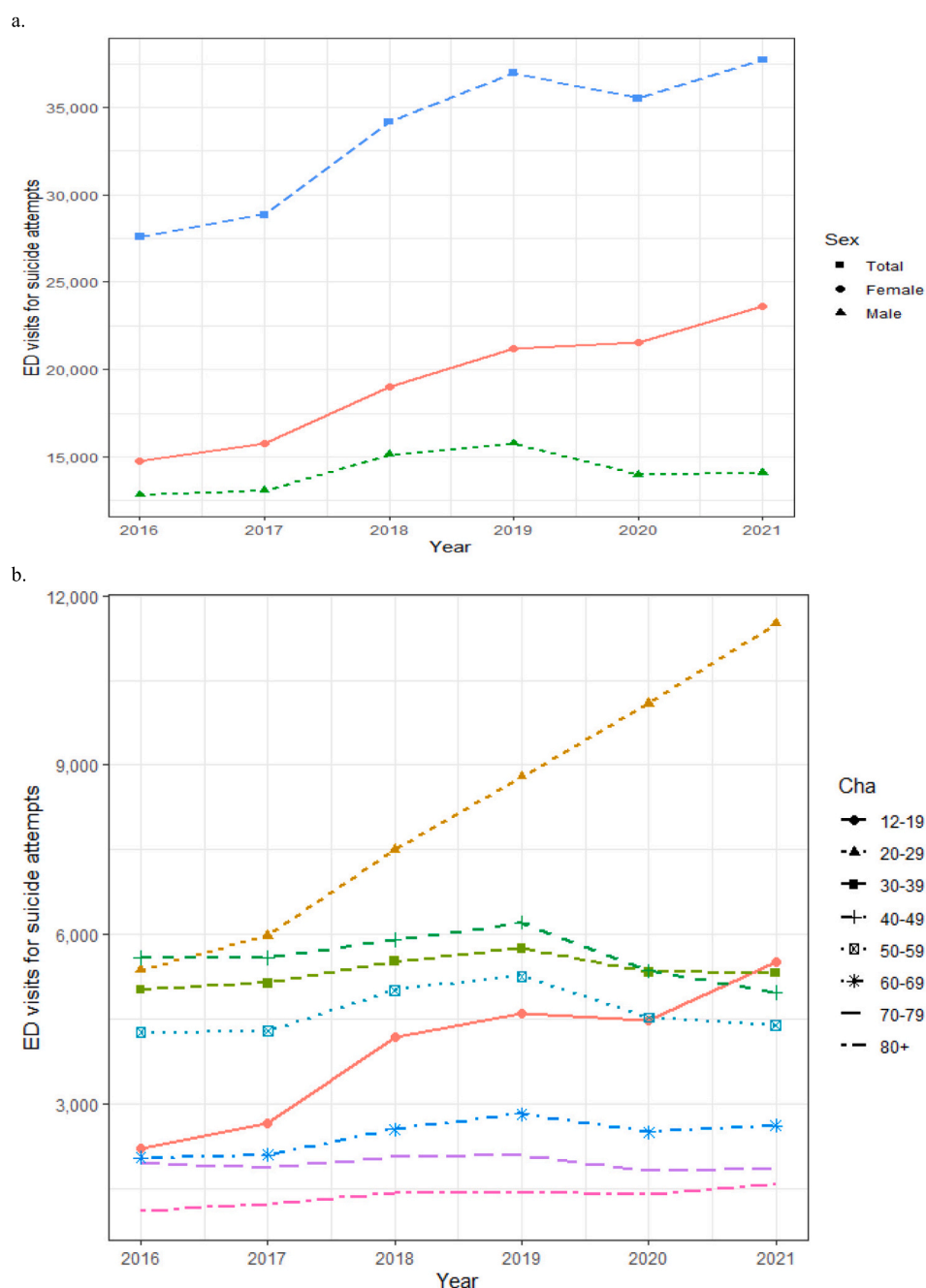


Fig. 1. Number of emergency department visits related to suicide attempts by sex (a) and age groups (b).

years old groups and showed no change in the 30–39 and 60 years and older groups. However, there was a steady increase in the teen and 20–29 years old groups regardless of the year.

There were 49,245 patients (24.5 %) aged 20–29 years old who visited ED, followed by 33,632 patients (16.7 %) in 40–49 years old, 32,083 patients (16.0 %) in 30–39 years old, 27,754 patients (13.8 %) in 50–59 years old, and 23,642 patients (11.8 %) aged 12–19 years old (Table 1). The number of ED visits related to suicide attempts showed a trend of increasing year by year. Among the study participants, the proportion of females was 57.7 %, and it increased each year. In this study, the proportions of patients were 36.8 % for emergency and 70.9 % reported using ambulance. The admission rate and mortality were 31.6 % and 6.1 %, respectively, which steadily decreased (admission rate: 33.4 % in 2016 vs. 29.1 % in 2021; mortality: 6.9 % in 2016 vs. 5.6 % in 2021). The proportion of patients in their teens and twenties

increased for both males and females (Supplementary Tables 1 and 2, respectively). There was no change in patient triage or severity in males (Supplementary Table 1). In females, the number of ED visits increased year by year, whereas hospitalization (33.3 % in 2016 vs. 27.0 % in 2021) and mortality (4.4 % in 2016 vs. 3.2 % in 2021) decreased (Supplementary Table 2).

The standardized incidence rates of ED visits for suicide attempts per 100,000 person-year increased 59.2 (95 % CI 58.5–59.9) in 2016 and 82.2 (95 % CI 81.3–83.0) in 2021 (Fig. 2). We identified that the APC increased by 6.8 % overall, 1.6 % among males and 10.8 % among females ( $p < 0.05$ ) (Fig. 2 [a]). By age group, the APC increased in 12–19 years old (22.3%), 20–29 years old (17.2%), 30–39 years old (3.7%) and 50–59 years old (0.5 %), but decreased in 40–49 years old (–0.2%), 60–69 years old (–3.6%), 70–79 years old (–3.9%), and 80 years and older (–1.1%) ( $p < 0.05$ ) (Fig. 2 [b]). Moreover, the APCs of increasing

**Table 1**

Demographic characteristics of emergency department visits for suicide attempts.

	Total	Year						P-trend	
		2016	2017	2018	2019	2020	2021	2016–2019	2016–2021
Total	200,792 (100.0)	27,581 (100.0)	28,842 (100.0)	34,173 (100.0)	36,964 (100.0)	35,513 (100.0)	37,719 (100.0)	0.02	0.01
Age									
12–19	23,642 (11.8)	2218 (8.0)	2648 (9.2)	4180 (12.2)	4611 (12.5)	4476 (12.6)	5509 (14.6)	0.03	<0.01
20–29	49,245 (24.5)	5375 (19.5)	5982 (20.7)	7507 (22.0)	8797 (23.8)	10,083 (28.4)	11,501 (30.5)	<0.01	<0.01
30–39	32,083 (16.0)	5022 (18.2)	5136 (17.8)	5522 (16.2)	5749 (15.6)	5336 (15.0)	5318 (14.1)	0.02	0.34
40–49	33,632 (16.7)	5591 (20.3)	5587 (19.4)	5909 (17.3)	6211 (16.8)	5360 (15.1)	4974 (13.2)	0.05	0.39
50–59	27,754 (13.8)	4271 (15.5)	4290 (14.9)	5011 (14.7)	5257 (14.2)	4534 (12.8)	4391 (11.6)	0.06	0.68
60–69	14,646 (7.3)	2052 (7.4)	2104 (7.3)	2549 (7.5)	2824 (7.6)	2500 (7.0)	2617 (6.9)	0.03	0.08
70–79	11,643 (5.8)	1942 (7.0)	1873 (6.5)	2074 (6.1)	2085 (5.6)	1830 (5.2)	1839 (4.9)	0.24	0.59
80+	8147 (4.1)	1110 (4.0)	1222 (4.2)	1421 (4.2)	1430 (3.9)	1394 (3.9)	1570 (4.2)	0.04	<0.01
Sex									
Female	115,898 (57.7)	14,756 (53.5)	15,763 (54.7)	19,030 (55.7)	21,191 (57.3)	21,521 (60.6)	23,637 (62.7)	0.02	<0.01
Region									
Metropolitan	142,544 (71.0)	19,974 (72.4)	20,449 (70.9)	24,367 (71.3)	25,599 (69.3)	25,173 (70.9)	26,982 (71.5)	0.05	<0.01
Urban	57,267 (28.5)	7432 (26.9)	8204 (28.4)	9627 (28.2)	11,155 (30.2)	10,212 (28.8)	10,637 (28.2)	0.01	0.03
Rural	981 (0.5)	175 (0.6)	189 (0.7)	179 (0.5)	210 (0.6)	128 (0.4)	100 (0.3)	0.23	0.13
Ambulance use	142,390 (70.9)	19,753 (71.6)	20,667 (71.7)	24,225 (70.9)	26,569 (71.9)	25,004 (70.4)	26,172 (69.4)	0.02	0.02
Patient triage (KTAS)									
Emergency (level 1–2)	73,897 (36.8)	12,382 (44.9)	11,359 (39.4)	12,180 (35.6)	13,053 (35.3)	11,903 (33.5)	13,020 (34.5)	0.50	0.36
ED LOS, median (IQR), hours	3.3 (1.6–7.3)	3.2 (1.5–7.3)	3.1 (1.6–6.9)	3.2 (1.6–7.0)	3.2 (1.6–6.7)	3.4 (1.6–7.2)	3.8 (1.8–8.4)	0.74	0.05
Admission	63,408 (31.6)	9215 (33.4)	9579 (33.2)	10,994 (32.2)	11,583 (31.3)	11,051 (31.1)	10,986 (29.1)	0.02	0.07
ICU	36,057 (18.0)	5389 (19.5)	5437 (18.9)	5996 (17.5)	6779 (18.3)	6436 (18.1)	6020 (16.0)	0.06	0.13
Hospital ward	27,351 (13.6)	3826 (13.9)	4142 (14.4)	4998 (14.6)	4804 (13.0)	4615 (13.0)	4966 (13.2)	0.11	0.07
In-hospital mortality	12,229 (6.1)	1916 (6.9)	1800 (6.2)	2143 (6.3)	2200 (6.0)	2058 (5.8)	2112 (5.6)	0.18	0.19
ED	9172 (4.6)	1441 (5.2)	1364 (4.7)	1615 (4.7)	1672 (4.5)	1522 (4.3)	1558 (4.1)	0.15	0.27
Hospital ward	3057 (1.5)	475 (1.7)	436 (1.5)	528 (1.5)	528 (1.4)	536 (1.5)	554 (1.5)	0.27	0.04

ED, emergency department; KTAS, Korean triage and acuity scale; LOS, length of stay; IQR, interquartile range; ICU, intensive care unit.

trend was sharper in the females, aged 12–19 years and 20–29 years than in the males (APC, 28.8 % vs. 8.5 %; 22.1 % vs. 9.0 %;  $p < 0.05$ ) (Fig. 3).

The most common suicidal means of patients with suicide attempts were poisoning (114,848, 57.2 %), followed by cutting and piercing (50,732, 25.3 %), hanging and choking (13,041, 6.5 %), and crashing of vehicle or object (7892, 3.9 %) (Table 2). In the case of males, cases of hanging and choking (9.3 % vs. 4.5 %), crashing of vehicle or object (7.7 % vs. 1.1 %), falling or jumping from a high place (2.9 % vs. 2.3 %), drowning (1.3 % vs. 0.8 %), and fire and explosive (0.3 % vs. 0.1 %) were more common than in females.

#### 4. Discussion

To our knowledge, this is the first study to identify the temporal trends in suicide attempts across sex and age groups from 2016 to 2021 using the latest and nationally representative data. The core finding was sex and age differences in the incidence rate of suicide attempts during 2016–2021. The number of ED visits related to suicide attempts increased before and during the pandemic. In particular, it decreased immediately after the COVID-19 pandemic but rebounded in 2021. We identified that the APC increased by 1.6 % among males and 10.8 % among females. Moreover, the APCs of trend sharply increased in patients aged 12–19 years (22.3 %) and 20–29 (17.2 %) years. The in-hospital mortality was higher in males (9.5 %) than females (3.6 %). The most common suicidal means were poisoning (114,848, 57.2 %), followed by cutting and piercing (50,732, 25.3 %).

Several studies have reported self-harm and suicide attempts in the early stages of the COVID-19 pandemic (John et al., 2020; Jollant et al., 2021). In France, there was a 42.6 % and 8.6 % decrease in self-harm

during the early periods of the lockdown in 2020 compared to 2019 (Jollant et al., 2021; Pignon et al., 2020). In the UK, Ireland, and Portugal, there was a 33 %, 35 %, and 55.6 % reduction in self-harm incidence in 2020 (John et al., 2020). We identified a 4.1 % decrease between 2019 and 2020. However, it increased by 5.8 % between 2020 and 2021. This may be because previous studies used databases during an earlier period of COVID-19 than our data source. When countries did not prepare for a pandemic, it was possible to focus on solving the chaos caused by COVID-19. The other hypothesis was that decreasing accessibility to EDs was due to fear of infection and rejection of the patients due to lack of beds, which can increase the risk of severity of patients' outcomes (John et al., 2020; Jollant et al., 2021). As the COVID-19 pandemic continued, the restriction of social activities and financial problems led to self-harm and a deterioration of mental health. Therefore, it is necessary to prepare programs and interventions for suicide prevention in the new wave of the COVID-19 crisis and economic recession.

In South Korea, peaks of the COVID-19 pandemic observed in early March 2020 and August 2020, respectively. The number of COVID-19 patients sharply increased in November 2020 and October 2021 and the number of ED visit for suicide attempts decrease slightly during same period. In our research, the time trend of total ED visit for suicide attempts were not significantly changed by COVID-19 patients ( $p = 0.25$ ). By age groups, It was possible that COVID-19 has affected patient aged 40 years and older. However, in the case of adolescents and young adults, the incidence of suicide attempts steeply increased regardless of the COVID-19 pandemic period (APC: 22.3 % and 17.2 %, respectively) compared to other age groups. In many studies, the common risk factors among youth for suicide attempts were bullying, high stress, community violence, academic impairment, previous suicidal ideation and



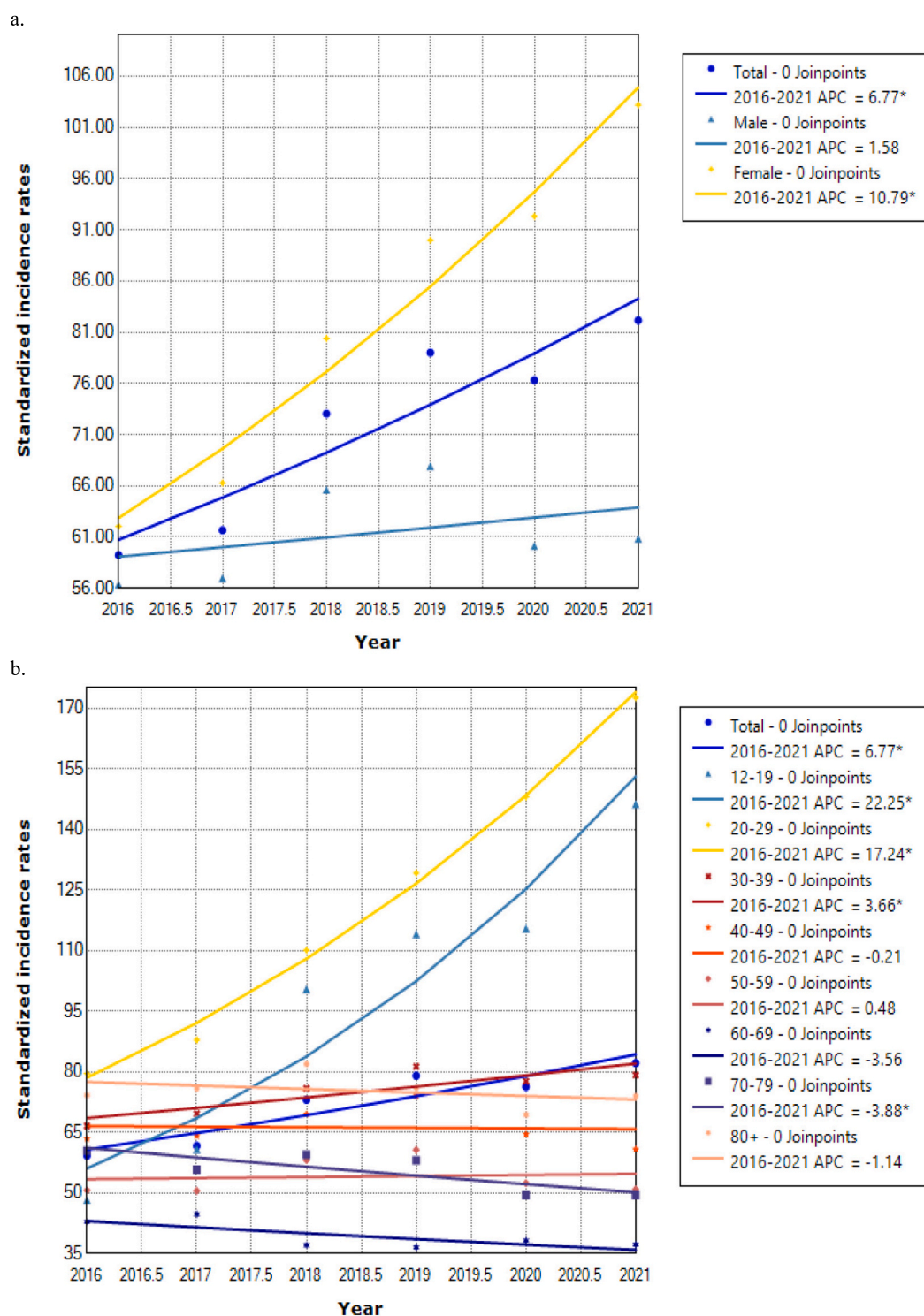


Fig. 2. Standardized incidence rates of emergency department visits related to suicide attempts by year and sex (a) and by year and age groups (b).

behaviors, lack of sleep, history of mental disorder, childhood maltreatment, alcohol or drug abuse, and smartphone or internet addiction (Kim et al., 2019; Kim et al., 2017; Miranda-Mendizabal et al., 2019). In Korea, 11.2 % and 14.2 % of adolescents had experienced anxiety and depression during the COVID-19 period using web-based survey (Lee et al., 2022b). Furthermore, Korea has one of the highest smartphone ownership rates, with a smartphone distribution rate of 88 %, which was the highest in 2016 compared to other countries (Kim et al., 2019; Lee et al., 2017). The life satisfaction among students in Korea was below the OECD average in both 2015 and 2018 from the

Programme for International Student Assessment, although the score increased (Organisation for Economic Cooperation and Development (OECD), 2019). In our study, the slope increased once more among teenage and twenties women in 2020, which may have been exacerbated by the COVID-19 pandemic period. Therefore, a tailored monitoring system and policies are important for patients with suicidal attempts among teenagers and those in their twenties to ensure that patients receive care at the right time.

The APC was different by sex (1.58 % in males and 10.8 % in females). Moreover, the APCs of increasing trend was more sharply in the

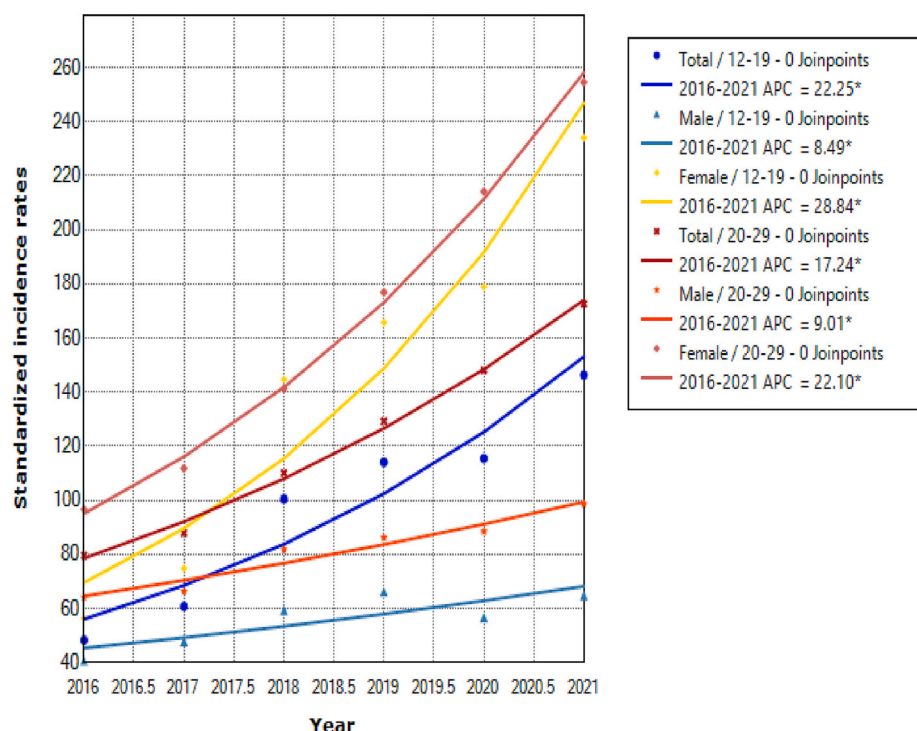


Fig. 3. Standardized incidence rates of emergency department visits for suicide attempts by year and sex among the 12–19 and 20–29 years old groups.

Table 2

Number of emergency department visits for suicide attempts according to suicide means by sex.

	Total	Male	Female	P-Value
Total	200,792 (100.0)	84,894 (100.0)	115,898 (100.0)	
Suicidal means				
Poisoning	114,848 (57.2)	44,101 (51.9)	70,747 (61.0)	<0.01
Cutting, piercing	50,732 (25.3)	19,448 (22.9)	31,284 (27.0)	<0.01
Hanging, choking	13,041 (6.5)	7856 (9.3)	5185 (4.5)	<0.01
Crashing of vehicle or object	7892 (3.9)	6579 (7.7)	1313 (1.1)	<0.01
Falling or jumping from a high place	5152 (2.6)	2475 (2.9)	2677 (2.3)	<0.01
Drowning	2065 (1.0)	1095 (1.3)	970 (0.8)	<0.01
Fire, explosive	412 (0.2)	290 (0.3)	122 (0.1)	<0.01
Others	6178 (3.1)	2824 (3.3)	3354 (2.9)	<0.01
Missing	472 (0.2)	226 (0.3)	246 (0.2)	0.01

females, aged 12–19 years and aged 20–29 years than that in the males (APC, 28.8 % vs. 8.49 %; 22.1 % vs. 9.0 %;  $p < 0.05$ ). In addition, hanging and choking, crashing of a vehicle or object, falling or jumping from a high place, and fire and explosives, which are known to have high lethality, were more common in males than in females (Vuagnat et al., 2019). The German study indicated that males significantly more chose high-risk methods like hanging, drowning, and firearms, and the fatality was three times higher than females (Cibis et al., 2012). Furthermore, suicide rate was 1.5 times higher for males, whereas rate of suicide attempts was 2.9 times higher for females worldwide (Schmidtke et al., 1996; Värnik et al., 2008). In a systematic review, females were associated with suicide attempts (odds ratio 2.0, 95 % CI 1.5–2.5), and males presented a higher risk of suicide death (odds ratio 2.5, 95 % CI 1.8–3.6) (Miranda-Mendizabal et al., 2019). Our study also identified that in-hospital mortality was higher in males (9.5 %) than females (3.6 %). Based on findings of the previous studies, the suicidal means such as

hanging and choking, fire and explosives, and falling or jumping from a high place could be considered as one of the factors for high mortality in men. Female youths are more likely to engage in help-seeking behaviors from friends, family, and professionals (Miranda-Mendizabal et al., 2019). Moreover, considering the high prevalence of mental health disorders among youth who commit suicide, contact with the healthcare system may reduce the risk of suicide (Rhodes et al., 2014). Furthermore, medical staffs and policy makers need to be aware of gender-specific trends.

This study had several limitations. First, other information, such as severity of injury, socioeconomic status, interpersonal relationships, and employment, were not collected from the NEDIS database. Second, it is difficult to distinguish whether patients with suicide attempts were previously diagnosed or if this was their first behavior when they visited the ED. Third, this study was limited to confirming causal relationship based on a descriptive study. The future studies that consider causality adjusted confounding factors need to be conducted. Finally, because our study used data from emergency patients in Korea, it may be difficult to directly reflect the results in other countries with different emergency medical conditions. Therefore, additional studies in other countries are required. However, this study is meaningful as it provides the latest and most pragmatic results at the nationwide level regarding the long-term effects of COVID-19 on suicide attempts.

## 5. Conclusions

In conclusion, the incidence of suicide attempts in ED has increased in Korea. In particular, there was a sharp increase among women and 10s and 20s years. Patient-tailored treatment for suicide attempts is important, and a preventive medical system should be established according to sex and age groups, especially for females, adolescents, and younger adults.

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## CRediT authorship contribution statement

Seonji Kim: Conceptualization, Methodology, Validation, Formal analysis, Data curation, Writing - original draft, Writing - review and editing. Ho Kyung Sung: Methodology, Investigation. Taehui Kim: Data curation, Visualization. Sung-keun Ko: Data curation, Software, Visualization. SeongJung Kim: Conceptualization, Project administration. Jin-Hee Lee: Conceptualization, Supervision, Project administration, Writing - review and editing. All authors provided feedback and interpreted results in this study.

## Declaration of competing interest

The authors declare no conflicts of interest.

## Data availability

The NEDIS database is available to use by researchers via the National Emergency Medical Center (<http://dw.nemc.or.kr/nemcMonitoring/mainmgr/Main.do>).

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jad.2023.03.037>.

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