

National trends in suicide-related behaviors among youths between 2005-2020, including COVID-19: a Korean representative survey of one million adolescents

N. KIM¹, J.Y. SONG², H. YANG^{3,4}, M.J. KIM⁵, K. LEE⁶, Y.H. SHIN², S.Y. RHEE^{3,4,7}, J. HWANG⁸, M.S. KIM⁹, G. FOND¹⁰, L. BOYER¹⁰, S.Y. KIM¹¹, J.I. SHIN⁵, S.W. LEE¹², D.K. YON^{3,13}

¹Department of Neuropsychiatry, Seoul National University College of Medicine, Seoul, South Korea

²Department of Pediatrics, CHA Gangnam Medical Center, CHA University School of Medicine, Seoul, South Korea

³Center for Digital Health, Medical Science Research Institute, Kyung Hee University Medical Center, Kyung Hee University College of Medicine, Seoul, South Korea

⁴Department of Regulatory Science, Kyung Hee University Graduate School, Seoul, South Korea

⁵Department of Pediatrics, Yonsei University College of Medicine, Seoul, South Korea

⁶Department of Pediatrics, Seoul National University Hospital, Seoul National University College of Medicine, Seoul, South Korea

⁷Department of Endocrinology and Metabolism, Kyung Hee University College of Medicine, Seoul, South Korea

⁸Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, USA

⁹Samsung Advanced Institute for Health Sciences & Technology (SAIHST), Sungkyunkwan University, Samsung Medical Center, Seoul, South Korea

¹⁰CEReSS-Health Service Research and Quality of Life Center, Assistance Publique - Hôpitaux de Marseille, Aix-Marseille University, Marseille, France

¹¹Department of Otorhinolaryngology-Head and Neck Surgery, CHA University School of Medicine, Seongnam, South Korea

¹²Department of Precision Medicine, Sungkyunkwan University School of Medicine, Suwon, South Korea

¹³Department of Pediatrics, Kyung Hee University College of Medicine, Seoul, South Korea

Namwoo Kim, Joo Young Song, and Hwi Yang contributed equally

Abstract. – OBJECTIVE: It is difficult to conclude that COVID-19 is associated with a decrease in the suicide attempts rate by comparing only a short-term period. Therefore, it is necessary to examine attempted suicide rates through a trend analysis over a longer period. This study aimed to investigate an estimated long-term trend regarding the prevalence of suicide-related behaviors among adolescents in South Korea from 2005 to 2020, including COVID-19.

SUBJECTS AND METHODS: We sourced data from a national representative survey (Korea Youth Risk Behavior Survey) and analyzed one million Korean adolescents aged 13 to 18 years (n=1,057,885) from 2005 to 2020. The 16-year trends regarding the prevalence of sadness or despair and suicidal ideation and attempt and the trend changes before and during COVID-19.

RESULTS: Data of 1,057,885 Korean adolescents was analyzed (weighted mean age, 15.03 years; males, 52.5%; females, 47.5%). Although the 16-year trend in the prevalence of sadness or despair and suicide ideation and attempt consistently decreased (prevalence of sadness or despair between 2005-2008, 38.0% with 95% confidence interval [CI], 37.7 to 38.4 vs. prevalence in 2020, 25.0% [24.5 to 25.6]; suicide ideation between 2005-2008, 21.9% [21.6 to 22.1] vs. prevalence in 2020, 10.7% [10.3 to 11.1]; and suicide attempt between 2005-2008, 5.0% [4.9 to 5.2] vs. prevalence in 2020, 1.9% [1.8 to 2.0]), the downward slope decreased during COVID-19 (β_{diff} in sadness, 0.215 with 95% CI 0.206 to 0.224; β_{diff} in suicidal ideation, 0.245 [0.234 to 0.256]; and β_{diff} in suicide attempt, 0.219 [0.201 to 0.237]) compared with pre-pandemic period.

Corresponding Authors: Dong Keon Yon, MD; e-mail: yonkkang@gmail.com
Jae Il Shin, Ph.D; e-mail: SHINJI@yuhs.ac

Seung Won Lee, MD, Ph.D; e-mail: LSW2920@gmail.com

CONCLUSIONS: This study found that the observed risk of suicide-related behaviors during the pandemic was higher than expected through long-term trend analysis of the prevalence of sadness/despair and suicidal ideation and attempts among South Korean adolescents. We need a profound epidemiologic study of the change in mental health due to the pandemic's impact and the establishment of prevention strategies for suicide ideation and attempt.

Key Words:

COVID-19, Sadness, Suicide, Adolescent, KYRBS.

Introduction

The coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) significantly impacted mental health across the world¹⁻³. According to various studies⁴⁻⁶, symptoms such as depressive mood, anxiety, or suicidal thoughts occurred both in people infected with SARS-CoV-2 and the general population. The deterioration in population-wide mental health was highlighted in multiple parts of the world; still, according to a recent meta-analysis, the suicide mortality rate in the early period of the pandemic remained essentially unchanged or declined worldwide⁷. It has been hypothesized that, in a disaster situation, a social change wherein people cooperate to overcome the crisis reduces the suicide rate (even if the decrease is temporary) and that the rate will rise again if economic difficulties worsen as the national financial support gradually decreases^{3,7,8}.

However, according to the national statistics data of the United States and South Korea, the suicide rate among adolescents increased in 2020^{9,10}. Nonetheless, previous studies had a small number of subjects ($n=362$ ¹¹), short-term observation period^{12,13}, or insufficient representativeness (i.e., random sampling¹¹ or hospital-based data set¹⁴), thus further research is needed. However, there are inconclusive results to concluding that the COVID-19 pandemic is associated with a decrease in the suicide attempts rate^{12,13}. Therefore, it is necessary to examine through a trend analysis based on the suicide attempts rate observed over a longer period.

To investigate whether the suicide attempts rate increased with the rise in suicide mortality among Korean adolescents in the early period of the pandemic, this study aimed to analyze a 16-year trend using the data of a nationally representative survey, from 2005 to 2020. Also, we conducted on more than one million adolescents to examine whether

the observed suicide-related behavior rate in the early period of the pandemic differs from the expected level. Moreover, we evaluated the pandemic-related changes in suicide-related behavior of adolescents by comparing trends in suicide-related behavior during the pre-pandemic (2005 to 2019) and pandemic period (2020).

Subjects and Methods

Study Population and Data Sources

We sourced a national representative data from the Korea Youth Risk Behavior Web-based Survey (KYRBS)¹⁵ between 2005 and 2020 supervised by the Korea Disease Control and Prevention Agency (KDCA) and Ministry of Education, South Korea for the government policies. The study population was selected using a two-step stratification based on school and class and were investigated to account for sample clustering, weights, and stratification to provide national representative sampling and estimates of the total adolescent population in South Korea; specified details were available on previous research¹⁶. We enrolled adolescents aged between 12 to 18 years (middle to high school), who voluntarily participated in a web-based survey in computer laboratories at their respective schools, and the response rate was over 95%¹⁶. Those with missing data were excluded from the analysis. The study protocol has ethical approval from the Institutional Review Board of Sejong University (SJU-HR-E-2020-003) and KDCA. All participants provided written informed consent and detailed information regarding the survey is available elsewhere¹⁵.

Covariate Definitions

We classified the residential areas into urban (Seoul, Gyeonggi, Busan, Daegu, Incheon, Gwangju, Daejeon, Ulsan, and Sejong) and rural (Gangwon, Chungbuk, Chungnam, Jeonbuk, Jeonnam, Gyeongbuk, Gyeongnam, and Jeju) areas^{17,18}. Smoking status was defined as cigarette smoking at least once within the last 30 days¹⁹. We used the self-reported data of parents' educational levels (high school or lower, college or higher, and unknown), economic status (high, middle-high, middle, middle-low, and low), and school performance (high, middle-high, middle, middle-low, and low)²⁰. Body mass index (BMI) was classified as underweight (<5th percentile), normal (5th-84th percentile), overweight (85th-94th percentile), and obese (≥ 95 th percentile), according to age- and sex-specific equations based on the 2007 Korean national growth charts²¹.

Endpoints

The youth participants were asked if they had felt sadness or despair that interfered with social lives for two weeks (sadness or despair), considered suicide (thinking of suicide), and attempted suicide within the past 12 months (suicide attempt)¹². The main outcomes were a 16-year trend of changes in the prevalence of sadness or despair, suicidal ideation and attempt to evaluate whether COVID-19 affected these trends. Moreover, we analyzed the trend change in each prevalence during COVID-19 from those before it in each subgroup by sex, grade, and residence area.

Patient and Public Involvement

None of the patients were directly involved in designing the research questions or conducting the research. Patients were not asked for advice on the interpretation or writing of the results. There were no plans to involve patients or the relevant patient community in the dissemination of study findings.

Statistical Analysis

We sourced data from the KYRBS between 2005 to 2020 and analyzed the trend of changes in the proportion of sadness or despair, suicidal ideation and attempts stratified by sex, grade, and residence area. For the prevalence's stabilization, the pre-COVID-19 period of the KYRBS cycle was set for four consecutive years (2005-2008, 2009-2012, 2013-2016, 2017-2019). We performed a weighted complex sampling analysis with the binary and linear logistic regression models. These analyses are presented as weighted odds ratios (ORs) with 95% confidence intervals (CIs) or weighted β -coefficients with 95% CIs. In linear regression, we analyzed the KYRBS cycles as a continuous variable [2005-2008, 2009-2012, 2013-2016, 2017-2019, and 2020 (COVID-19 pandemic)]²². In binary regression, we selected the KYRBS cycle [last pre-pandemic (2017-2019) vs. COVID-19]. All the analyses were performed using SPSS (version 25.0; IBM, Armonk, NY, USA) and R software (V.3.1.1; R Foundation, Vienna, Austria)^{23,24}. We defined statistical significance as a two-sided p -value lower than 0.05.

Results

A total of 1,057,885 adolescents were included in the KYRBS with 52.5% males (95% CI, 51.8-53.2) and 47.5% females (95% CI, 46.8-48.2), from 2005 to 2020. Table I illustrates their gener-

al characteristics. The weighted estimated mean age was 15.03 years (95% CI, 15.02 to 15.04), and 50.2% were in the 7 to 9th grade (middle school) and 49.8% in the 10th to 12th grade (high school).

Figure 1 illustrates the trends in the prevalence of sadness or despair, suicidal ideation, and attempts in general Korean adolescents from 2005 to 2020, including COVID-19. All prevalence presented a steady decreasing trend with different slopes at each set period. Tables II, III, and IV present the trend change and proportion of sadness or despair, suicidal ideation, and attempt from 2005 to 2020. However, the downward slope decreased during COVID-19 (sadness: β diff, 0.215; 95% CI, 0.206-0.224; suicidal ideation: β diff, 0.245; 95% CI, 0.234-0.256; suicide attempt: β diff, 0.219; 95% CI, 0.201-0.237) compared with pre-pandemic period.

The national weighted prevalence of sadness or despair was 38.0% (95% CI, 37.7 to 38.4) from 2005 to 2008 and 25.0% (95% CI, 24.5 to 25.6) in 2020 (Table II). The slope of 16-year trend in overall prevalence of sadness or despair presented a consistency in subgroups by sex (male: β diff, 0.252; 95% CI, 0.240 to 0.264; female: β diff, 0.026 to 0.037; 95% CI, -0.040 to -0.035), grade (7-9th grade: β diff, -0.015; 95% CI, -0.017 to -0.013; 10-12th grade: β diff, -0.032; 95% CI, -0.034 to -0.030), and residence area (rural: β diff, -0.031; 95% CI, -0.034 to -0.029; urban: β diff, -0.022; 95% CI, -0.025 to -0.020).

The national weighted prevalence of suicidal ideation was 21.9% (95% CI, 21.6-22.1) from 2005 to 2008 and 10.7% (95% CI, 10.3-11.1) in 2020 (Table III). Its prevalence presents a consistent decline in slope of each subgroup by the sex (male: β diff, 0.264; 95% CI, 0.249-0.279; female: β diff, 0.238; 95% CI, 0.224-0.252), grade (7-9th grade: β diff, 0.198; 95% CI, 0.183-0.213; 10-12th grade: β diff, 0.285; 95% CI, 0.268-0.301), and residence area (rural: β diff, 0.252; 95% CI, 0.236-0.238; urban: β diff, 0.234; 95% CI, 0.218-0.250).

The national weighted prevalence of suicide attempt was 5.0% (95% CI, 4.9-5.2) from 2005 to 2008 and 1.9% (95% CI, 1.8-2.0) in 2020 (Table IV). The decline in the slope of trend regarding suicide attempt within each subgroup was consistent with overall prevalence, regardless of sex (male: β diff, 0.252; 95% CI, 0.224 to 0.280; female: β diff, 0.203; 95% CI, 0.181-0.225), grade (7-9th grade: β diff, 0.132; 95% CI, 0.109-0.155; 10-12th grade: β diff, 0.307; 95% CI, 0.278-0.336), and residence area (rural: β diff, 0.220; 95% CI, 0.195-0.245; urban: β diff, 0.221; 95% CI, 0.195-0.247).

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Table I. Demographic characteristics of participating adolescents in the KYRBS, 2005-2020 (N = 1,057,885).

Characteristic	Weighted sample, n (%) or weighted % (95% CI)
Number, n (%)	1,057,885 (100.0)
Age, years, weighted mean (95% CI)	15.03 (15.02 to 15.04)
Grade, weighted % (95% CI)	
7 th -9 th grade (middle school)	50.2 (49.8 to 50.6)
10 th -12 th grade (high school)	49.8 (49.4 to 50.2)
Sex, male, weighted % (95% CI)	52.5 (51.8 to 53.2)
Body mass index, kg/m ² , weighted mean (95% CI)	20.8 (20.7 to 20.8)
Body mass index, kg/m ² , weighted % (95% CI)	
Underweight (below 5 th percentile)	5.0 (4.9 to 5.1)
Normal (5 th -85 th percentile)	80.9 (80.8 to 81.0)
Overweight (85 th -95 th percentile)	9.6 (9.5 to 9.7)
Obese (above 95 th percentile)	4.5 (4.4 to 4.5)
Region of residence, weighted % (95% CI)	
Rural	55.2 (54.8 to 55.6)
Urban	44.8 (44.4 to 45.2)
Smoking, weighted % (95% CI)	21.7 (21.5 to 21.9)
Highest educational level of parents, weighted % (95% CI)	
High school or lower	34.7 (34.5 to 35.0)
College or higher	51.1 (50.8 to 51.4)
Unknown	14.2 (14.0 to 14.3)
Economic level, weighted % (95% CI)	
High	4.3 (4.2 to 4.3)
Middle-high	16.3 (16.1 to 16.4)
Middle	44.6 (44.4 to 44.8)
Middle-low	26.9 (26.7 to 27.1)
Low	8.0 (7.9 to 8.1)
School performance, weighted % (95% CI)	
High	12.2 (12.1 to 12.3)
Middle-high	25.5 (25.4 to 25.6)
Middle	28.4 (28.3 to 28.5)
Middle-low	23.5 (23.3 to 23.6)
Low	10.4 (10.3 to 10.5)

BMI, body mass index; CI, confidence interval; KYRBS, Korea Youth Risk Behavior Web-based Survey.

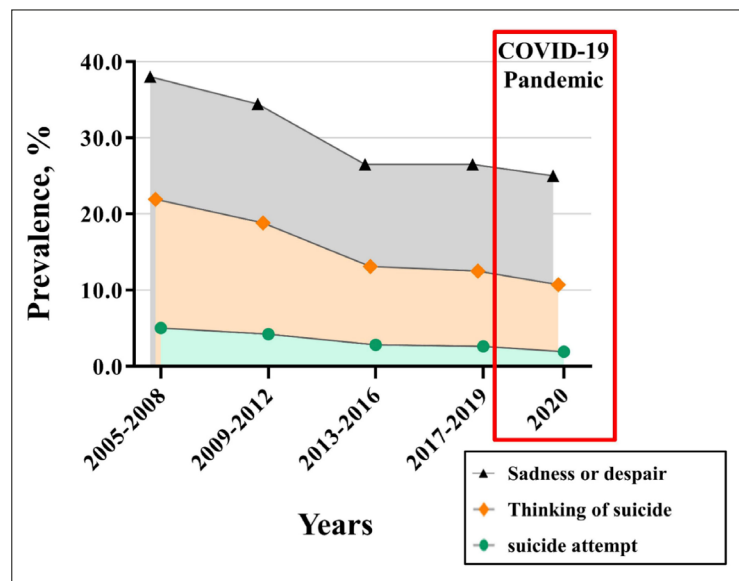


Figure 1. Nationwide 15-year trends and prevalence of sadness or despair, suicidal ideation, and suicide attempt among one million Korean adolescents from 2005 to 2020.

Table II. National weighted prevalence and trend of sadness or despair among the adolescent population in South Korea using the KYRBS from 2005 to 2020.

	2005 to 2008	2009 to 2012	2013 to 2016	2017 to 2019	2020 (COVID-19 pandemic)	Trend before entering the COVID-19 pandemic, β (95% CI)^a	Trend after entering the COVID-19 pandemic, β (95% CI)^a	Trend difference, β_{diff} (95% CI)	2017 to 2019 versus 2020 (COVID-19 pandemic), OR (95% CI)^b
Sadness or despair, weighted % (95% CI)									
Overall	38.0 (37.7 to 38.4)	34.4 (34.1 to 34.6)	26.5 (26.3 to 26.8)	26.5 (26.1 to 26.8)	25.0 (24.5 to 25.6)	-0.228 (-0.235 to -0.221)	-0.013 (-0.019 to -0.007)	0.215 (0.206 to 0.224)	0.928 (0.896 to 0.960)
Sex									
Male	33.4 (33.1 to 33.8)	29.4 (29.1 to 29.7)	21.8 (21.5 to 22.1)	20.9 (20.5 to 21.2)	19.9 (19.3 to 20.5)	-0.263 (-0.273 to -0.254)	-0.011 (-0.018 to -0.003)	0.252 (0.240 to 0.264)	0.942 (0.902 to 0.984)
Female	43.2 (42.8 to 43.6)	39.9 (39.5 to 40.3)	31.6 (31.3 to 32.0)	32.5 (32.1 to 32.9)	30.6 (29.8 to 31.3)	-0.203 (-0.212 to -0.194)	-0.016 (-0.023 to -0.009)	0.187 (0.176 to 0.198)	0.913 (0.878 to 0.949)
Grade, weighted % (95% CI)									
7th-9th grade (middle school)	34.7 (34.3 to 35.1)	31.6 (31.2 to 32.0)	24.3 (24.0 to 24.7)	24.9 (24.5 to 25.3)	22.8 (22.2 to 23.5)	-0.208 (-0.218 to -0.198)	-0.021 (-0.029 to -0.013)	0.187 (0.174 to 0.200)	0.893 (0.853 to 0.934)
10th-12th grade (high school)	42.1 (41.6 to 42.6)	37.1 (36.7 to 37.5)	28.5 (28.1 to 28.9)	27.8 (27.3 to 28.3)	27.2 (26.3 to 28.1)	-0.261 (-0.271 to -0.250)	-0.006 (-0.014 to 0.003)	0.255 (0.241 to 0.269)	0.969 (0.921 to 1.018)
Region of residence									
Rural	38.0 (37.6 to 38.5)	34.2 (33.8 to 34.6)	26.5 (26.1 to 26.8)	26.7 (26.3 to 27.2)	25.6 (24.9 to 26.3)	-0.224 (-0.234 to -0.214)	-0.011 (-0.019 to -0.003)	0.213 (0.200 to 0.226)	0.943 (0.901 to 0.986)
Urban	38.1 (37.7 to 38.5)	34.5 (34.1 to 34.9)	26.6 (26.2 to 26.9)	26.1 (25.6 to 26.6)	24.3 (23.4 to 25.1)	-0.232 (-0.242 to -0.222)	-0.017 (-0.027 to -0.008)	0.215 (0.201 to 0.229)	0.906 (0.860 to 0.955)

CI, confidence interval; KYRBS, Korea Youth Risk Behavior Web-based Survey; OR, odds ratio. ^a: Estimated β (95% CI) was derived using linear regression, and this analysis included the KYRBS cycle (2005-2008, 2009-2012, 2013-2016, 2017-2019, and 2020) as a continuous variable. ^b: Estimated OR (95% CI) was calculated using binary logistic regression, and this analysis included the KYRBS cycle (2017-2019 vs. 2020) as a categorical variable. Numbers in bold indicate a significant difference (p -value < 0.05).

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Table III. National weighted prevalence and trend of suicidal ideation among the adolescent population in South Korea using the KYRBS from 2005 to 2020.

	2005 to 2008	2009 to 2012	2013 to 2016	2017 to 2019	2020 (COVID-19 pandemic)	Trend before entering the COVID-19 pandemic, β (95% CI) ^a	Trend after entering the COVID-19 pandemic, β (95% CI) ^a	Trend difference, β_{diff} (95% CI)	2017 to 2019 versus 2020 (COVID-19 pandemic), OR (95% CI) ^b
Suicidal ideation, weighted % (95% CI)									
Overall	21.9 (21.6 to 22.1)	18.8 (18.5 to 19.0)	13.1 (12.9 to 13.3)	12.5 (12.3 to 12.7)	10.7 (10.3 to 11.1)	-0.275 (-0.283 to -0.267)	-0.030 (-0.037 to -0.023)	0.245 (0.234 to 0.256)	0.839 (0.804 to 0.877)
Sex									
Male	17.7 (17.4 to 18.0)	14.7 (14.5 to 15.0)	10.5 (10.3 to 10.7)	9.1 (8.9 to 9.3)	7.9 (7.5 to 8.4)	-0.290 (-0.301 to -0.280)	-0.026 (-0.036 to -0.015)	0.264 (0.249 to 0.279)	0.863 (0.810 to 0.918)
Female	26.6 (26.2 to 27.0)	23.3 (22.9 to 23.6)	15.9 (15.7 to 16.2)	16.2 (15.8 to 16.5)	13.7 (13.1 to 14.2)	-0.272 (-0.282 to -0.261)	-0.034 (-0.043 to -0.025)	0.238 (0.224 to 0.252)	0.821 (0.780 to 0.865)
Grade, weighted % (95% CI)									
7th-9th grade (middle school)	21.9 (21.6 to 22.3)	19.0 (18.7 to 19.3)	13.6 (13.3 to 13.8)	13.2 (12.9 to 13.5)	10.1 (9.6 to 10.6)	-0.252 (-0.264 to -0.241)	-0.054 (-0.064 to -0.044)	0.198 (0.183 to 0.213)	0.736 (0.694 to 0.781)
10th-12th grade (high school)	21.9 (21.5 to 22.3)	18.5 (18.2 to 18.9)	12.7 (12.5 to 13.0)	11.8 (11.5 to 12.1)	11.3 (10.7 to 11.9)	-0.294 (-0.306 to -0.282)	-0.009 (-0.020 to 0.002)	0.285 (0.268 to 0.301)	0.949 (0.891 to 1.011)
Region of residence									
Rural	21.9 (21.5 to 22.3)	18.7 (18.4 to 19.0)	13.0 (12.7 to 13.2)	12.5 (12.2 to 12.8)	11.0 (10.5 to 11.5)	-0.278 (-0.290 to -0.266)	-0.026 (-0.036 to -0.016)	0.252 (0.236 to 0.268)	0.863 (0.816 to 0.913)
Urban	21.9 (21.5 to 22.2)	18.8 (18.5 to 19.2)	13.3 (13.1 to 13.6)	12.5 (12.1 to 12.8)	10.3 (9.7 to 10.9)	-0.271 (-0.282 to -0.259)	-0.037 (-0.048 to -0.025)	0.234 (0.218 to 0.250)	0.807 (0.753 to 0.866)

CI, confidence interval; KYRBS, Korea Youth Risk Behavior Web-based Survey; OR, odds ratio. ^a: Estimated β (95% CI) was derived using linear regression, and this analysis included the KYRBS cycle (2005-2008, 2009-2012, 2013-2016, 2017-2019, and 2020) as a continuous variable. ^b: Estimated OR (95% CI) was calculated using binary logistic regression, and this analysis included the KYRBS cycle (2017-2019 vs. 2020) as a categorical variable. Numbers in bold indicate a significant difference (p -value < 0.05).

Table IV. National crude weighted prevalence and trend of suicide attempt among the adolescent population in South Korea using the KYRBS from 2005 to 2020.

	2005 to 2008	2009 to 2012	2013 to 2016	2017 to 2019	2020 (COVID-19 pandemic)	Trend before entering the COVID-19 pandemic, β (95% CI)^a	Trend after entering the COVID-19 pandemic, β (95% CI)^a	Trend difference, β_{diff} (95% CI)	2017 to 2019 versus 2020 (COVID-19 pandemic), OR (95% CI)^b
Suicidal ideation, weighted % (95% CI)									
Overall	5.0 (4.9 to 5.2)	4.2 (4.1 to 4.3)	2.8 (2.7 to 2.8)	2.6 (2.5 to 2.7)	1.9 (1.8 to 2.0)	-0.274 (-0.288 to -0.261)	-0.055 (-0.067 to -0.043)	0.219 (0.201 to 0.237)	0.719 (0.664 to 0.778)
Sex									
Male	3.9 (3.8 to 4.1)	3.0 (2.9 to 3.1)	2.0 (2.0 to 2.1)	1.8 (1.7 to 1.9)	1.2 (1.1 to 1.4)	-0.312 (-0.332 to -0.292)	-0.060 (-0.080 to -0.040)	0.252 (0.224 to 0.280)	0.692 (0.605 to 0.791)
Female	6.3 (6.1 to 6.5)	5.6 (5.4 to 5.8)	3.5 (3.4 to 3.7)	3.5 (3.4 to 3.7)	2.6 (2.4 to 2.8)	-0.255 (-0.272 to -0.238)	-0.052 (-0.066 to -0.037)	0.203 (0.181 to 0.225)	0.732 (0.667 to 0.803)
Grade, weighted % (95% CI)									
7th-9th grade (middle school)	5.3 (5.2 to 5.5)	4.9 (4.7 to 5.1)	3.4 (3.3 to 3.5)	3.2 (3.1 to 3.3)	2.0 (1.8 to 2.1)	-0.215 (-0.233 to -0.198)	-0.083 (-0.098 to -0.067)	0.132 (0.109 to 0.155)	0.603 (0.542 to 0.672)
10th-12th grade (high school)	4.7 (4.5 to 4.8)	3.6 (3.5 to 3.7)	2.2 (2.1 to 2.3)	2.1 (2.0 to 2.3)	1.9 (1.7 to 2.0)	-0.331 (-0.352 to -0.309)	-0.024 (-0.043 to -0.005)	0.307 (0.278 to 0.336)	0.867 (0.772 to 0.974)
Region of residence									
Rural	5.1 (4.9 to 5.3)	4.3 (4.2 to 4.5)	2.8 (2.6 to 2.9)	2.7 (2.6 to 2.8)	1.9 (1.7 to 2.1)	-0.280 (-0.300 to -0.260)	-0.060 (-0.076 to -0.045)	0.220 (0.195 to 0.245)	0.693 (0.624 to 0.769)
Urban	4.9 (4.8 to 5.1)	4.1 (4.0 to 4.3)	2.8 (2.7 to 2.9)	2.6 (2.4 to 2.7)	1.9 (1.7 to 2.2)	-0.268 (-0.287 to -0.250)	-0.047 (-0.065 to -0.028)	0.221 (0.195 to 0.247)	0.756 (0.670 to 0.851)

CI, confidence interval; KYRBS, Korea Youth Risk Behavior Web-based Survey; OR, odds ratio. ^a: Estimated β (95% CI) was derived using linear regression, and this analysis included the KYRBS cycle (2005-2008, 2009-2012, 2013-2016, 2017-2019, and 2020) as a continuous variable. ^b: Estimated OR (95% CI) was calculated using binary logistic regression, and this analysis included the KYRBS cycle (2017-2019 vs. 2020) as a categorical variable. Numbers in bold indicate a significant difference (p -value < 0.05).

Discussion

This study conducted a trend analysis of a national representative survey data of over one million South Korean adolescents from 2005 to 2020 and examined the 16-year trends in the prevalence of suicide-related behaviors in the early stages of COVID-19 compared to the pre-pandemic period. The observed prevalence of suicide attempts during the 2020 pandemic was higher than its expected prevalence. This was also seen in suicidal thoughts and sadness/despair. Furthermore, a similar tendency was found in the stratified analysis of age, sex, and area of residence. Comparing data for 2019 and 2020, the risk of suicide-related behaviors decreased. Therefore, trend analysis using long-term data can prevent the opposite evaluation of the pandemic's impact on adolescents' suicide risk. Contrary to the decline in suicide rates worldwide, including in South Korea during the early period of the pandemic, suicide attempts and mortality rate among South Korean adolescents and, for example, US adolescents, increased^{9,12,14}. Although the rate among the middle-aged to elderly in South Korea decreased¹², it increased among people aged 0 to 39 years during the pandemic¹⁰. This shows that the reported decrease in suicide risk during the pandemic does not apply to all subgroups; in fact, that of adolescents has increased¹⁰. Comparing the results and the national suicide mortality rate announced by the government, the number of adolescents who attempted suicide per death decreased from around 500 in 2017-2019 to 300 in 2020¹⁰. This suggests that the fatality of suicide attempts may have increased, so intensive social support and mental health experts' management for adolescents at high-risk for suicide are needed.

The increased risk of suicide among adolescents cannot be explained by a single principle. It is a result of the interaction of complex factors. These can be broadly divided into two categories, protective and risk factors; both can affect suicide risk. The reports on these factors that were investigated during the pandemic's early period among South Korean adolescents are as follows. Regarding the protective factors, according to previous studies, adolescents supported by their families had high psychological resilience, and school closures could reduce suicide risk if family intimacy increases²⁵. Moreover, sleep disturbance is a risk factor²⁶. Compared to the pre-pandemic period, the sleep duration of South Korean adolescents during the pandemic increased by 28 minutes a day on weekdays and 11 minutes a day on weekends²⁶. The proportion of South Korean adolescents having more than five hours of leisure

time a day increased significantly to 18.2% compared to 11.9% before the pandemic²⁶. Moreover, a decrease in the prevalence of smoking and drinking and the frequency of runaways over the past 30 days compared to the pre-pandemic period may also be associated with reduced suicide risk²⁷. Previous study²⁸ from Japan showed that the quality of peer relationships no longer correlated with the quality of life of adolescents during the pandemic. Considering the results of a previous study²⁸ from Japan, this suggests that the latter of those who experienced uncomfortable peer relationships before the pandemic may have improved after the pandemic began. Moreover, school shutdowns reduced stress levels caused by school bullying²⁹. Also, the loosening of adolescent social networks may have led to a decrease in behaviors that imitate the risky behaviors of close friends, leading to fewer suicides³⁰.

Regarding the risk factors, reduced exercise was a risk factor for suicide in adolescents, which may have increased the suicide risk^{10,31}. Academic stress is a risk factor for suicide in South Korea³². In peer relationships, negative changes were more frequent than positive ones, which may have increased the suicide risk in that it could cause isolation in social relationships and block the relieving of emotional pain through peer communications³².

Hence, it is difficult to say which one is dominant between the protective and the risk factors, thus evaluating other hidden factors influencing suicidal behavior is needed. One of them is thwarted belongingness and perceived burdensomeness, which is based on the framework of the interpersonal theory of suicide. These are known to be closer to suicide than underlying diseases, stressful life events, or other risk factors³³. In a disaster situation such as COVID-19, adolescents may experience a feeling of pulling together, solidarity, or belongingness, but conversely, those infected with COVID-19 or who experienced stigma for not following national measures may have felt great burdensomeness²⁹. Nonetheless, the result of previous studies³⁴ that therapist's active intervention was effective on the problem of thwarted belongingness and perceived burdensomeness in reducing suicide is hopeful.

This study's strengths are that it used nationally representative samples, including over one million adolescents, and examined data from 2005 to 2020 including COVID-19.

Limitations

It also has limitations. First, adolescents who did not attend school due to mental, physical, or developmental disabilities were not included.

Considering that the possibility of suicide due to their mental suffering is greater than that of adolescents who regularly attend school, suicidal ideation and attempt of South Korean adolescents may be higher than the results. Second, this study could not include races and cultures other than South Koreans. Further studies are needed on the pandemic's impact on adolescent suicidal behavior in other countries. Third, an error may exist because no clear criteria were provided to respondents as to whether self-harm constitutes a suicidal attempt. This is also because this study is self-reported. Fourth, because there was no information on the method of suicide attempt and the number of attempts, it was not possible to obtain a more detailed understanding of the high-risk group. These should be included in future epidemiological investigations of suicide.

Conclusions

This study found that the observed suicide risk during the pandemic was higher than expected through long-term trend analysis on the prevalence of sadness or despair and suicidal ideation and attempts among South Korean adolescents. These results may be associated with the increase in the adolescent suicide mortality rate in South Korea during the pandemic. Our results provide an improved psychological understanding of suicide-related behaviors during COVID-19 and suggest the need for the development of individual strategies to prevent suicide-related behaviors.

Conflicts of Interest

The authors declare no conflicts of interest.

Ethics Approval

The study protocol was approved by the Institutional Review Board of Sejong University (SJU-HR-E-2020-003) and KDCA.

Informed Consent

All participants provided written informed consent.

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Authors' Contributions

Dr Dong Keon Yon had full access to all of the data in the study and took responsibility for the integrity of the data and the accuracy of the data analysis. All authors approved the final version before submission. Study concept and design: NK, JYS, SWL, JIS, and DKY; Acquisition, analysis, or interpretation of data: SWL, JIS, and DKY; Drafting of the manuscript: NK, JYS, and DKY; Critical revision of the manuscript for important intellectual content: Namwoo Kim, Joo Young Song, Hwi Yang, Min Jung Kim, Kyeonghun Lee, Youn Ho Shin, Sang Youl Rhee, Jimin Hwang, Min Seo Kim, Guillaume Fond, Laurent Boyer, So Young Kim, Jae Il Shin, Seung Won Lee, Dong Keon Yon; Statistical analysis: SWL, JIS, and DKY; Study supervision: DKY. Dong Keon Yon is guarantor. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

ORCID ID

Namwoo Kim: 0000-0002-1684-5417;
Joo Young Song: 0000-0002-8635-8681;
Hwi Yang: 0000-0003-1310-9921;
Min Jung Kim: 0000-0002-0985-4024;
Kyeonghun Lee: 0000-0003-1610-8641;
Youn Ho Shin: 0000-0003-3227-5511;
Sang Youl Rhee: 0000-0003-0119-5818;
Jimin Hwang: 0000-0002-0253-0676;
Min Seo Kim: 0000-0003-2115-7835;
Guillaume Fond: 0000-0003-3249-2030;
Laurent Boyer: 0000-0003-1229-6622;
So Young Kim: 0000-0002-7361-4930;
Jae Il Shin: 0000-0003-2326-1820;
Seung Won Lee: 0000-0001-5632-5208;
Dong Keon Yon: 0000-0003-1628-9948.

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