ORIGINAL PAPER

Factors Affecting Emergency Medical Utilization After Self-harm and Effectiveness of Community-Based Suicide Prevention Provisions in Preventing Self-harm: A Nationwide Registry-Based Study in Korea

Ae Kyung Gong[1] · Ji Hyun Yun[1] · In Soo Kim[1] · Min Ah Yuh[1] · Seon Hee Woo[2] · Jinwoo Kim[3] · Sungyoup Hong[1]

Abstract

In order to formulate and implement a community-based suicide prevention program, as well as evaluate the effectiveness of these programs, it is necessary to understand the epidemiological characteristics of self-harm. Clinical data were collected from the National Emergency Department Information System (NEDIS) data panel in Korea for patients seen after self-harm episodes. Socioeconomic factors were collected from Statistics Korea. Variables representing SP provisions (SPPs) were collected from the Korea Foundation for Suicide Prevention. Increasing the number of mental health providers resulted in lower annual emergency department visit rate after self-harm (VRSH) in the entire population, as well as in both the young and elderly populations. An increase in the mental health budget led to a significant reduction in VRSHs. However, the number of suicide prevention centers did not have any significant association with the VRSH. This study also provides substantial evidence that community-based SPPs are effective in preventing self-harm.

Keywords Self-harm · Suicide · Community health services · Emergency medical services

Introduction

According to statistics from the World Health Organization (WHO), more than 700,000 people die by suicide every year (World Health Organization, 2021). The suicide rate in South Korea is second highest in the world and the highest among members of the Organization for Economic Cooperation and Development (OECD) (Kim et al., 2016; Lee, et al., 2018). It is South Korea's fifth leading cause of death, with 26.9 deaths per 100,000 in 2019 and 34 suicides each day

✉ Sungyoup Hong
emhong@catholic.ac.kr

1 Department of Emergency Medicine, Daejeon St Mary's Hospital, College of Medicine, The Catholic University of Korea, 222, Banpo-Daero, Seocho-Gu, Seoul 06591, Republic of Korea

2 Department of Emergency Medicine, Incheon St Mary's Hospital, College of Medicine, The Catholic University of Korea, 222, Banpo-Daero, Seocho-Gu, Seoul 06591, Republic of Korea

3 Department of Emergency Medical Service, Daejeon Health Institute of Science, 21, Chungjeong-Ro, Dong-Gu, Daejeon 34504, Republic of Korea

(Statistics Korea, 2020). Thus, suicide is a growing public health problem that affects tens of thousands of family members and friends every year.

Self-harm is defined as nonfatal intentional self-injury or self-poisoning, regardless of the apparent motivation or suicidal intent (Kapur et al., 2013). Individuals who have self-harmed, however, have a considerably high risk of suicide in the future (Hawton et al., 2003).

The WHO promotes national and community engagement in suicide prevention (SP) programs including restricting access to the means of suicide, providing media guides for the responsible reporting of suicide, enhancing emergency medical services for patients who have made a suicide attempt, and management and follow-up by SP specialists (World Health Organization, 2018). The Korean government has established three comprehensive national SP strategies (2004, 2009, 2016) to reduce suicide and also announced the National SP Action Plan in January 2018. However, the suicide rate in Korea has continued to increase annually, with the highest suicide rate in the OECD in 2019 at 26.9 per 100,000 people (a total of 13,799 suicides).

As a result, community engagement has been strengthened since 2017. Community-based suicide prevention programs, including the welfare expenditures of local

governments and the availability of social and recreational organizations, have reduced suicide rates (J. Lee, 2020). These community-based SP programs emphasize several steps that are tailored to meet the specific needs of the community. A targeted prevention strategy is a method for addressing individuals at high risk who have demonstrated self-harm or suicide attempts including (1) public and professional education for the early identification of people who are at risk, (2) counseling connections, (3) the treatment of psychiatric disorders, (4) restricting access to lethal means, and (5) reporting guidelines for suicide in the media (Kleiman & Liu, 2013; Lapierre, et al., 2011). Previous studies indicated that community-based suicide prevention interventions reduced suicidal ideation and attempts in both young and elderly populations (Calear, et al., 2016; Lapierre, et al., 2011).

The emergency department (ED) is the primary treatment location for victims after a self-harm episode and those who have sustained acute injuries with a risk of subsequent suicide (Hadfield et al., 2009). A structured SP program needs to collect statistical and epidemiological data regarding patients who self-harm and present to ED, as well as suicidal deaths (Matsubayashi & Ueda, 2011). and evaluate the effectiveness of the program (Haroz, et al., 2020). Consequently, to strengthen the link between hospital care and community-based programs, it is imperative to establish an ED registry and analyze data including self-harm and completed suicides to provide systematic support to high-risk individuals.

Thus, this study had the following objectives: (1) to identify the socioeconomic risk factors associated with self-harm through an analysis of large-scale data from a nationwide emergency registry and (2) to determine whether a specific component of a community-based SP provision (SPP) was effective in reducing emergency medical resource utilization after self-harm among different age groups.

Methods

Data Acquisition

In Korea, there are 420 EDs across 16 provinces that are open to the public without restrictions. The Korean National Emergency Medical Center (NEMC) operates the Korean National ED Information System (NEDIS), which collects prospective data on all patients presenting to EDs. During the period from January 2014 to December 2018, we collected data from the NEDIS panel on patients who were treated in EDs for intentional self-injury or self-poisoning, regardless of the motivation or degree of suicide intent, and who survived when they were seen. The data from the NEDIS database included age, sex, onset of the event, the mechanism of injury, the route taken to the hospital, vital

signs upon arrival at the ED, and the outcome of emergency treatment. Based on ED utilization data, which could not verify individual identities, the number of times one person visited the ED was counted. Patients in which the time the event occurred was unknown, those who had been transferred from another hospital, and those who died at the ED were excluded from the study.

Socioeconomic variable including Gini index (index measuring the intensity of inequality in income or consumption expenditure distribution, with a perfect equality leading to a Gini index of zero and the maximum inequality leading to a Gini index of 100), employment rate, disposable income, crime rate, alcohol consumption, smoking rate, leisure time, and stress index for each province were collected from Statistics Korea (https://kostat.go.kr/portal/eng/index.action). Mid-population, population by age, and sex were also obtained from Statistics Korea.

According to the Mental Health and Welfare Act of Korea, both local and central governments are responsible for organizing and operating SP centers. The following SPP indicators were collected from the Korea Foundation for SP (https://kfsp.org): the number of regional SP centers (SPCs) per 1000 km^2, the number of community mental health providers including physicians, psychologists, and nurses per million population, and the mental health budget (Korean Won) per individual per year for each province.

Outcome Measures and Standardization

The main outcome of this study was the annual emergency department visit rate after self-harm (VRSH) per 100,000 population derived by dividing the number of self-harm patients who were treated in ED by the annual mid-year population for each province. We calculated the VRSH for the overall population by age for young (aged 15–34 years) and elderly (65 years and older) groups and by sex for males and females of each province.

Statistical Analysis

In this study, the general characteristics of self-harming patients were compared across years using the chi-square analysis of discrete variables and analysis of variance for continuous variables (blood pressure, pulse rate, respiration rate, and body temperature). The chi-square value is known to be affected by the strength of the relationship and the size of the sample. The large number of cases included in this study may overrepresent the chi-square value. Thus, we determined the strength of the association between the progression of the year and the change in variables using the contingency coefficient (CC).

This study also aimed to compare the ED VRSHs among different age groups. The analysis was conducted on two groups, a young group aged 15 – 34 years accounted for the largest proportion (40.3%, Table 1, Supplementary file Fig. 1a) and a group of elderly patients aged 65 and older with a higher VRSH (Supplementary file Fig. 1b). The provinces were divided into two groups based on their population size: 1) large metropolitan areas with a population of at least one million people and 2) rural provinces except for metropolitan areas. We compared the VRSH for young (15- to 34-year-old) and elderly (65 and older) populations across the two regions using analysis of covariance (ANCOVA) with the crude VRSH as a covariate for each province.

The socioeconomic risk factors associated with self-harm were also identified. The main outcome variable (VRSH) was calculated and the association with 11 independent variables was estimated across 14 provinces for five years. This study's primary outcome parameter was

Table 1 Demographic characteristics of research subjects who visited emergency departments after self-harm injuries

Variable		2014	2015	2016	2017	2018	p value (CC)
Sex (%)	Female	11,798 (54.0)	12,595 (54.2)	12,905 (54.6)	13,807 (55.7)	16,497 (56.1)	< 0.001 (0.114)
	Male	10,065 (46.0)	10,659 (45.8)	10,732 (45.4)	11,000 (44.3)	12,920 (43.9)	
Age (%)	15–24	4115 (18.8)	4405 (18.9)	4591 (19.4)	5307 (21.4)	7216 (24.5)	< 0.001 (0.017)
	25–34	4636 (19.1)	4685 (18.4)	4796 (18.5)	4784 (18.4)	5062 (17.7)	
	35–44	4266 (21.2)	4460 (20.1)	4371 (19.9)	4500 (19.3)	5165 (17.2)	
	45–54	4167 (19.5)	4271 (19.2)	4364 (18.6)	4564 (18.1)	5205 (17.6)	
	55–64	2118 (9.7)	2506 (10.8)	2612 (11.2)	2652 (10.7)	3307 (11.2)	
	65–74	1331 (6.1)	1467 (6.3)	1417 (6.7)	1403 (5.7)	1534 (5.2)	
	75–84	634 (5.1)	719 (5.0)	780 (5.7)	863 (5.0)	1024 (5.2)	
	85–94	588 (1.4)	719 (1.2)	685 (1.5)	718 (1.4)	880 (1.3)	
	95-	8 (0.0)	22 (0.0)	21 (0.0)	16 (0.0)	24 (0.0)	
Injury mechanism (%)	Poisoning	12,871 (58.9)	15,507 (58.9)	15,442 (57.8)	15,790 (56.8)	18,770 (57.5)	< 0.001 (0.059)
	Laceration/stabbing	4351 (19.9)	5316 (21.3)	5779 (22.9)	6396 (24.4)	7488 (24.1)	
	Struck	940 (4.3)	1131 (4.3)	1172 (4.4)	1129 (4.1)	1271 (3.9)	
	Choking/hanging	1815 (8.3)	1715 (7.4)	1683 (7.1)	1722 (6.9)	2021 (6.9)	
	Fall	547 (2.5)	621 (2.7)	623 (2.6)	578 (2.3)	749 (2.5)	
	Submersion	262 (1.2)	292 (1.3)	273 (1.2)	282 (1.1)	313 (1.1)	
	Burn	109 (0.4)	80 (0.3)	76 (0.3)	61 (0.2)	73 (0.2)	
	TA	87 (0.4)	97 (0.4)	76 (0.3)	68 (0.3)	85 (0.3)	
	Machine	22 (0.1)	21 (0.1)	6 (0.0)	7 (0.0)	8 (0.0)	
	Other	721 (3.3)	768 (3.3)	732 (3.1)	847 (3.4)	867 (2.9)	
	Unknown	138 (0.6)	126 (0.5)	158 (0.6)	108 (0.4)	215 (0.7)	
Route (%)	Direct	21,814 (99.8)	23,202 (99.8)	23,581 (99.8)	24,759 (89.1)	29,345 (89.8)	0.557 (0.009)
	Outpatient	34 (0.2)	34 (0.1)	39 (0.2)	33 (0.1)	58 (0.2)	
	Other	13 (0.0)	17 (0.1)	12 (0.1)	12 (0.0)	12 (0.0)	
	Unknown	2 (0.0)	1 (0.0)	5 (0.0)	3 (0.0)	2 (0.0)	
Mental status (%)	Alert	14,262 (65.2)	15,248 (65.2)	15,611 (65.4)	16,529 (66.6)	19,443 (66.1)	< 0.001 (0.040)
	Verbal	3533 (16.2)	3802 (16.4)	3903 (16.7)	4188 (16.9)	5109 (17.4)	
	Pain	2149 (9.8)	2391 (10.8)	2421 (10.7)	2436 (9.8)	2852 (9.7)	
	Unresponsive	1890 (8.6)	1808 (7.5)	1700 (7.1)	1652 (6.7)	2013 (6.8)	
	Unknown	29 (0.1)	5 (0.0)	2 (0.0)	2 (0.0)	0 (0.0)	
Vital signs (Mean ± SD)	SBP	119.2 ± 37.6	119.8 ± 37.5	121.7 ± 34.9	122.3 ± 31.3	122.8 ± 33.8	0.208
	DBP	73.3 ± 27.3	73.5 ± 28.2	74.8 ± 26.6	75.4 ± 22.8	75.6 ± 21.8	0.024
	PR	85.6 ± 30.5	86.4 ± 31.8	88.1 ± 29.7	88.7 ± 25.2	89.1 ± 24.9	< 0.001
	BT	35.2 ± 6.7	35.4 ± 6.2	35.8 ± 5.3	35.8 ± 4.9	36.0 ± 4.8	< 0.001
Total		21,863	23,254	23,637	24,807	29,417	

CC contingency coefficient, *TA* Traffic accident, *SD* standard deviation, *SBP* systolic blood pressure, *DBP* diastolic blood pressure, *PR* pulse rate, *BT* body temperature
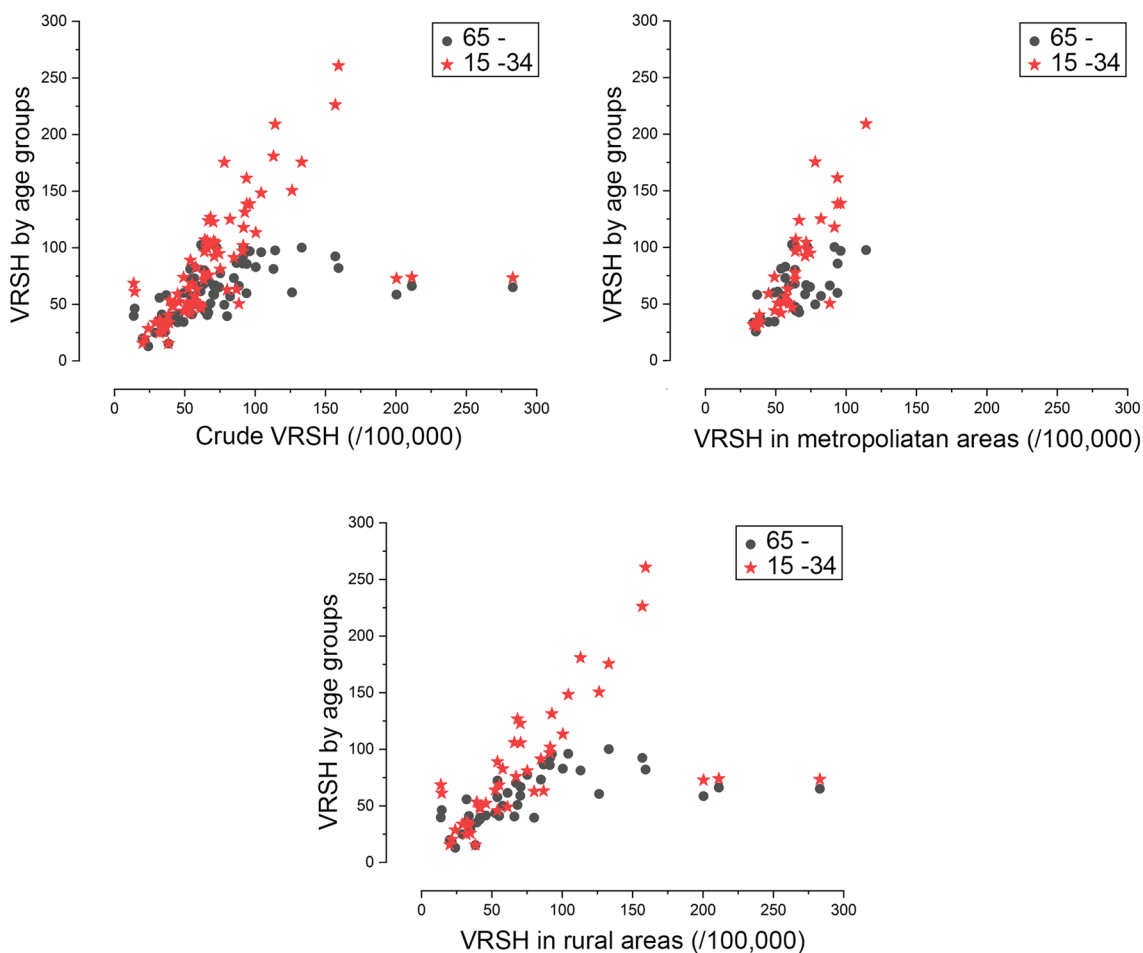
Fig. 1 Comparison of the annual emergency department visit rate after self-harm (VRSH) and the VRSH by age group in metropolitan and rural areas. The Y-axis indicates the VRSH for each age group corresponding to the crude VRSH (X-axis) in the two areas. Most areas with an VRSH above 100 per 100,000 people were rural areas. In these high incidence areas, the VRSH in the elderly population (65 years and older) has been stable. However, the VRSH in the young (15- to 34-year-old) population has been increasing

the VRSH standardized by the number of people (rather than the crude number of self-harm events) assuming a Poisson distribution (Supplementary file Fig. 2). A multivariate regression analysis was conducted for the two age groups using the VRSH as a dependent variable without considering interaction effects. A generalized linear model (GLM) with a Poisson distribution and log-link function was used to test the significance of the association between the VRSH and the independent variable. As independent variables, model 1 included socioeconomic determinants such as the Gini index, disposable income, employment rate, crime rate, alcohol consumption, smoking rate, leisure time, and stress index. Variables related to mental health services such as the number of regional SPCs, the number of mental health providers per million population, and the mental health budget were included as independent variables in model 2. When the regression analysis was conducted, the mean age of the population and the male-female ratio at each measurement point were set as control variables and analyzed. As a result of these analyses, ED visit rate ratios (VRRs) are presented. To assess the presence of collinearity among the independent variables, the variance inflation factor (VIF) was measured. All statistical analyses were conducted using the R statistics program version 4.1.1 (The R Foundation for Statistical Computing, Indianapolis, IN, USA).

Ethics Approval

The protocol of this study was reviewed and approved by the Institutional Review Board of Daejeon St Mary's Hospital, The Catholic University of Korea (No DC21ZIS10071). The requirement for informed consent was waived because of the retrospective nature of the study and the use of anonymous

data from the NEDIS database, which did not contain any personal identifiers.

Results

Within the study period, 146,965 patients visited the ED with self-harm injuries or poisoning. Of them, 122,978 patients were finally enrolled after excluding 816 patients whose onset of the self-harm was unclear and 15,348 patients who were transferred from other hospitals. A total of 7,823 patients were excluded from the study due to death on arrival at the ED.

Table 1 provides an overview of the characteristics of the included patients who visited the ED after self-harm according to year. There were 67,602 (54.9%) females among the enrolled patients. The proportion of females increased steadily throughout the years ($p < 0.001$, CC = 0.114). Patients aged 15–34 years were the most common (40.3%, n = 49,597, Supplementary Fig. 1). The age distribution did not change over time ($p = 0.001$, CC = 0.017). Poisoning represented the majority of injuries at 57.9%, followed by laceration/stabbing, being struck by an object, chocking/hanging, falling, and submersion. The number of injuries due to poisoning, choking, and being struck by an object decreased over time whereas stabbings increased ($p = 0.001$, CC = 0.104). The majority (88.7%) of the patients visited the ED directly from the scene of the event. The proportion of patients transported directly from the scene did not change significantly over time ($p = 0.557$, CC = 0.009). Approximately 65% of the patients arrived at the ED alert and conscious. The systolic blood pressure of the self-harming patients at the time of ED arrival did not differ from year to year ($p = 0.208$). However, the diastolic blood pressure, pulse rate, and respiration rate were significantly increased from year to year ($p < 0.024$).

Most observations of annual VRSHs greater than 100 per 100,000 people occurred in rural areas (Fig. 1). In these high prevalence areas, it was noteworthy that the VRSH for young adults increased over time while that for the elderly population did not change. ANCOVA was conducted between metropolitan and rural areas using the crude VRSH for each year as a covariate. The VRSH of the young population was not significantly different from that of the elderly in metropolitan areas ($p = 0.395$). However, in rural areas, the VRSH for 15- to 34-year-olds was significantly higher than that for the elderly considering covariates ($p < 0.001$).

The results of the analysis of the socioeconomic factors affecting the VRSH for the entire population are presented in Table 2. As the employment rate and disposable income decreased, the VRSH rose significantly in the general population ($p < 0.001$). In both the male and female groups, an increase in the Gini index, a decrease in employment rate,

and a decrease in disposable income significantly increased the VRSH ($p < 0.001$). Alcohol consumption had a greater effect on the VRSH in men, showing a 41% increase when alcohol consumption increased by one liter per person per year ($p < 0.027$). The analysis of leisure time and stress index as two psychosocial indicators indicated that the VRSH significantly increased with decreasing leisure time and increasing stress ($p < 0.001$). The crude VRSH of both males and females varied significantly with respect to leisure time and stress index ($p < 0.002$).

The VRSH was also closely related to socioeconomic factors in elderly male patients aged 65 and older (Table 3). The VRSH of the male subpopulation was influenced by economic factors such as a higher Gini index, a lower employment rate, and less disposable income as well as factors linked to social welfare, such as alcohol consumption, crime rate, and leisure time ($p < 0.001$). Elderly women aged 65 and older showed weaker associations with socioeconomic factors than the same-aged men. Only a higher Gini index, less leisure time, and a higher stress index were associated with an increase in the incidence of self-harm in the elderly female population.

Among those aged 15 to 34, socioeconomic factors had the strongest association with the VRSH, higher than among the older population (Table 4). In both men and women, the VRSH increased as the Gini index increased, whereas the employment rate and disposable income decreased ($p < 0.050$). In those aged 15–34 years, neither the crime rate, alcohol consumption, nor the smoking rate were related to the VRSH ($p = 0.050$, $p = 0.073$, and $p = 0.149$, respectively). However, increases in the crime rate and alcohol consumption were found to be significant risk factors for self-harm in both male and female subpopulations ($p < 0.050$). It was found that as leisure time decreased and stress increased, the VRSH in the young population increased ($p = 0.009$ and $p < 0.001$, respectively).

Based on the analysis of SPP indicators related to the VRSH (Table 2, model 2), increasing the number of mental health providers per million population significantly attenuated the risk of self-harm, resulting in a 3% decrease each time the number of community mental health providers increased by one (VRR = 0.97, $p = 0.009$). The number of community mental health providers per million population had a positive impact on both the young and the elderly populations, where the self-harm rate decreased by 4% for the elderly population (Table 3, model 2) and 2% for the young population (Table 4, model 2) with an increase in the number of providers. The effect was significant in both male and female populations. However, the effect size was greater in the male population than in the female population for all age groups. Furthermore, the relationship between the VRSHs and mental health budgets was significant across all age

Table 2 Effect of socioeconomic factors and regional suicide prevention programs on self-harm injuries in total population

Variable	Total		Male		Female	
	VRR (95% CI)	p value	VRR (95% CI)	p value	VRR (95% CI)	p value
Model 1						
Gini index	1.01 (0.83, 1.17)	0.793	1.01 (1.00, 1.03)	0.012	1.02 (1.00, 1.004)	0.006
Employment rate	0.97 (0.95—0.98)	<0.001	0.94 (0.93, 0.97)	<0.001	0.99 (0.98, 0.99)	<0.001
Disposable income	0.34 (0.02—0.86)	<0.001	0.98 (0.29, 440)	<0.001	2.55 (2.03, 3.20)	<0.001
Crime rate	1.01 (1.00, 1.02)	0.478	1.78 (0.14, 59.9)	0.881	1.12 (1.00, 1.24)	0.597
Alcohol consumption	1.01 (0.98, 1.04)	0.353	1.41 (0.00, 97.5)	0.027	1.02 (1.00, 1.05)	0.025
Smoking rate	0.98 (0.95, 1.01)	0.430	0.99 (0.96, 1.02)	0.710	0.99 (0.96, 1.02)	0.762
Leisure time	0.99 (0.99, 0.99)	0.002	0.99 (0.99, 1.00)	<0.001	0.99 (0.99, 1.00)	<0.001
Stress index	1.06 (1.04, 1.08)	<0.001	1.04 (1.02, 1.06)	<0.001	1.05 (1.03, 1.06)	<0.001
Model 2						
MH providers per MP	0.97 (0.90, 1.00)	0.009	0.96 (0.94, 1.01)	0.001	0.99 (0.98, 1.00)	<0.001
MH budget	1.00 (0.99, 1.00)	0.013	0.99 (0.99, 1.00)	0.001	0.99 (0.99, 1.00)	0.020
SPC per 1000 km²	0.13 (0.99, 0.14)	0.386	0.83 (0.35, 1.93)	0.290	1.00 (1.00, 1.00)	0.004

VRR emergency department visit rate ratio, *CI* confidence interval, *MH* mental health, *MP* million population, *SPC* suicide prevention center

groups and for both males and females ($p < 0.050$). An increase in the local government's mental health budget resulted in a decrease in VRSHs. However, statistical significance was higher among the elderly population than among youth. We regressed the number of SPCs per 1000 km² as a quantitative indicator of SPPs. The number of SPCs per 1000 km² did not show a significant association with the VRSH in the total population or in the subpopulations by age group ($p > 0.050$).

No significant collinearity was found among the independent variables in any of the multivariate regression models (VIF < 2.430; Table 5).

Discussion

Self-harm occurred most frequently in young people between the ages of 15 and 34, with a higher proportion in women. Poisoning was the most common cause of hospital visits after self-harm. Most of the areas with high VRSHs

were rural which was largely attributed to the high VRSH of young people in these areas. Inequality and economic problems were found to be strongly linked to self-harm among young adults. Based on the results of this study, it appears that committed community-based SPPs can result in a reduction in ED utilization after injury from self-harm. The most noteworthy finding of the study was that community-based SPPs were effective in preventing self-harm in both elderly and young/working-age populations. However, there was a greater impact on elderly adults aged 65 and older than on the young population. In this regard, a social safety net and SPPs must be tailored to meet the needs of different age groups.

The incidence and distribution of suicide and self-harm in this study were analyzed based on data from all self-harming patients who visited EDs and survived upon ED arrival in South Korea during a five-year period. In 2014, 2015, 2016, 2017, and 2018, a total of 21,863, 23,254, 23,637, 24,807, and 29,417 patients, respectively, visited the ED following injuries from self-harm. According

Table 3 Effect of socioeconomic factors and suicide prevention programs on self-harm in the elderly population aged 65 and older

Variable	≥ 65 years, total		≥ 65 years, male		≥ 65 years, female	
	VRR (95% CI)	p value	VRR (95% CI)	p value	VRR (95% CI)	p value
Model 1						
Gini index (%)	1.31 (0.00, 37.4)	0.432	2.01 (0.33, 2.54)	< 0.001	1.95 (1.47, 2.59)	< 0.001
Employment rate	0.93 (0.01, 9.75)	0.149	0.52 (0.43, 0.59)	0.001	0.98 (0.96–1.00)	0.100
Disposable income	0.02 (0.00, 768)	0.497	0.90 (0.72, 0.95)	< 0.001	0.90 (0.72, 1.12)	0.420
Crime rate	2.39 (0.55, 1.03)	0.047	1.02 (1.01, 1.03)	< 0.001	1.00 (9.94, 1.01	0.372
Alcohol consumption	1.00 (0.00, 4.32)	0.296	1.02 (1.01, 1.06)	< 0.001	0.98 (0.95, 1.02)	0.287
Smoking rate	1.00 (0.97, 1.02)	0.901	0.99 (0.96, 1.01)	0.452	1.01 (0.97, 1.05)	0.661
Leisure time	0.95 (0.93, 0.99)	< 0.001	0.95 (0.94, 0.99)	< 0.001	0.96 (0.93, 0.99)	0.002
Stress index	1.02 (1.00, 1.06)	0.002	1.01 (1.00, 1.03)	0.034	1.04 (1.02, 1.06)	< 0.001
Model 2						
MH providers per MP	0.96 (0.61, 1.11)	0.001	0.91 (9.88, 0.99)	< 0.001	0.98 (0.96, 0.99)	0.001
MH budget	0.99 (0.99, 1.00)	< 0.001	0.99 (0.99, 1.00)	< 0.001	0.99 (0.99, 1.00)	< 0.001
SPC per 1000 km^2	1.02 (1.00, 1.03)	0.846	0.96 (0.61, 1.48)	0.846	0.99 (0.43, 1.45)	0.460

VRR emergency department visit rate ratio, *CI* confidence interval, *MH* mental health, *MP* million population, *SPC* suicide prevention center

to Statistics Korea, there were 13,836, 13,513, 13,092, 12,463, and 13,670 suicides in 2014, 2015, 2016, 2017, and 2018, respectively, showing a self-harm-to-suicide ratio of 2.32:1. A study that merged data from the Korea National Health and Nutrition Examination and Korea's death statistics reported a self-harm-to-suicide ratio of 39:26.7 (Doo Woong, et al., 2020), which was greater than that of our study, whereas the self-harm-to-suicide ratio in the United States was estimated to be 12–15:1 (Claassen, et al., 2006). The high self-harm-to-suicide ratio in South Korea was due to the fact that patients used a method that was extremely lethal, or the fact that a majority of patients who sustained mild injuries from self-harm did not seek medical treatment. Hence, it is necessary to limit the use of suicide methods with high lethality and strengthen the surveillance systems for self-harm.

Suicide was the fourth leading cause of death for 15- to 34-year-olds worldwide in 2021 (World Health Organization, 2021). The rate of youth suicide is increasing globally (Fontanella, et al., 2015). Self-harm behavior is not only an important suicide risk factor, but also has peak incidence during adolescent and young adult years (Owens et al., 2002; Turecki & Brent, 2016). This study also found that the higher

crude VRSH was due to a higher VRSH among young adults aged 15–34 years in the total population (Fig. 1). A high crude VRSH was also found in rural areas, which was attributed to the high crude VRSH of young people in rural areas. Thus, different SP programs are needed depending on characteristics of the community.

Relationships Between Selected Demographic Factors and VRSH

The burden of adult responsibilities such as economic independence, employment, and family obligations are more apparent in young adults (Benson & Furstenberg Jr, 2006). A failure to fulfill these roles will result in feelings of economic failure and self-harm impulses (Lin, et al., 2020). The loss of young adults, who play a significant role in economic activities, is a tremendous loss for society. Furthermore, the mental health problems of young adults have the potential to negatively influence the mental health of the next generation. Therefore, mental health providers need to have accurate statistics regarding self-harm epidemiology and risk factors by age group when planning services, allocating resources, and conducting research (Rocha et al., 2015).

Table 4 Effect of socioeconomic factors and regional suicide prevention programs on self-harm of the young population aged 15 to 34 years

Variable	15–34, total		15–34, males		15–34, females	
	VRR (95% CI)	p value	VRR (95% CI)	p value	VRR (95% CI)	p value
Model 1						
Gini index	1.79 (1.51, 2.12)	< 0.001	1.65 (1.37, 1.99)	< 0.001	1.93 (1.65, 2.25)	< 0.001
Employment rate	0.93 (0.91, 0.94)	< 0.001	0.92 (0.91, 0.94)	< 0.001	0.93 (0.94, 0.98)	< 0.001
Disposable income	0.23 (0.20, 0.26)	< 0.001	0.34 (0.16, 0.22)	< 0.001	0.43 (0.38, 0.46)	< 0.001
Crime rate	1.01 (1.01, 1.02)	0.050	1.01 (1.00, 1.07)	< 0.001	1.01 (1.01, 1.03)	< 0.001
Alcohol consumption	1.03 (1.00, 1.05)	0.073	1.04 (1.01, 1.07)	0.047	1.02 (1.00, 1.97)	0.048
Smoking rate	1.02 (0.97, 1.05)	0.149	1.05 (1.01, 1.08)	0.027	1.00 (0.97, 1.02)	0.991
Leisure time	0.99 (0.98, 0.99)	0.009	0.52 (0.43, 0.61)	< 0.001	0.99 (0.99, 0.99)	0.007
Stress index	1.04 (1.02, 1.06)	< 0.001	1.04 (1.02, 1.06)	< 0.001	1.04 (1.02, 1.06)	< 0.001
Model 2						
MH providers per MP	0.98 (0.92, 0.99)	< 0.001	0.96 (0.91, 0.97)	< 0.001	0.99 (0.99, 1.00)	0.022
MH budget	0.99 (0.98, 0.99)	0.027	0.99 (0.98, 0.99)	0.033	0.99 (0.97, 0.99)	0.009
SPC per 1000 km^2	1.94 (0.64, 5.85)	0.382	1.00 (0.99, 1.00)	0.386	1.47 (0.58, 2.04)	0.220

VRR emergency department visit rate ratio, *CI* confidence interval, *MH* mental health, *MP* million population, *SPC* suicide prevention center

Table 5 Multi-collinearity test results

Model	Dependent variables	Independent variable	R-squared	VIF
Model 1	Gini index, disposable income, employment rate, crime rate, alcohol consumption, leisure time, stress index, smoking rate	VRSH (total population)	0.247	1.329
		VRSH (male population)	0.187	1.23
		VRSH (female population)	0.172	1.207
		VRSH (elderly population)	0.115	1.130
		VRSH (elderly male population)	0.151	1.178
		VRSH (elderly female population)	0.145	1.170
		VRSH (young population)	0.554	2.244
		VRSH (young male population)	0.588	2.430
		VRSH (young female population)	0.512	2.048
Model 2	Mental health workers per million population, mental health budget, suicide prevention center per km^2	VRSH (total population)	0.512	2.048
		VRSH (male population)	0.231	1.300
		VRSH (female population)	0.132	1.152
		VRSH (elderly population)	0.389	1.636
		VRSH (elderly male population)	0.442	1.792
		VRSH (elderly female population)	0.255	1.342
		VRSH (young population)	0.337	1.509
		VRSH (young male population)	0.343	1.521
		VRSH (young female population)	0.249	1.331

VIF variance inflation factor, *VRSH* emergency department visit rate after self-harm

The relationship between some independent variables and self-harm varied by sex. It is known that suicide rates are generally lower in women than in men. However, nonlethal self-harm is more common in women (Canner et al., 2018). This study also found that the number of self-harm events in women was 1.22 times higher than that in men. A previous study found that the overall suicide rate increased due to an increase in the suicide rate among males, while the suicide rate among females remained constant for decades (De Leo, 2002). In this study, the CC for sex was very low at 0.019, which indicated that little change occurred in the distribution of sex by year. However, the authors conducted an analysis that included sex as a covariate. Further research on gender differences in the incidence of self-harm is needed.

Risk Factors of ED Utilization After Self-harm

A recent study reported that men were more sensitive to economic recessions, resulting in a higher rate of suicide and self-harm in males than in females (Corcoran et al., 2015). Men are more likely to die by self-harm as a result of frustration with traditional masculine roles such as money-making and competition, as well as easy access to weapons. Even under conditions of severe life stress, men do not commonly ask for assistance due to the prejudice of masculinity (Coleman, 2015). Thus, strategies should be developed to more actively identify men in crisis and take preventative measures. To reduce the likelihood of an interaction effect, we performed a regression analysis using the mean age and male-female ratio as control variables, even though the CC for sex was very low in our study at 0.019, which implied that the distribution of sex by year did not change significantly.

A study conducted in India, a developing country, showed that social inequality was correlated with the self-harm rate (Sinha et al., 2021). Self-harm is more common among individuals in lower social classes than among those in higher social classes, according to the study. The relationship between the VRSH and social inequality was evaluated in the present study according to age and sex. Among both the total population and the young population, disposable income and the Gini index were significantly associated with self-harm risk. However, a significant relationship was found only in elderly men, suggesting that men might be more aware of issues related to poverty among elderly people. In contrast, a high health risk in women due to longer lifespans, continuous housework, and a high risk of degenerative diseases has been reported (Paltasingh & Tyagi, 2015).

According to previous reports, suicide ideation or suicide attempt increased as income declined (McMillan, Enns, Asmundson, & Sareen, 2010; Takeuchi et al., 2014). Our study also found that the VRSHs increased as disposable income and employment rates decreased. This tendency was prominent in 15- to 34-year-olds and elderly males aged 65 and older. The VRSH in elderly males was significantly related to socioeconomic deprivation according to results of the present study. However, such deprivation did not significantly affect the VRSH in elderly females. These findings are consistent with findings of previous studies showing increased suicides in elderly males during an economic recession (Coope, et al., 2015; El Ibrahimi, et al., 2021).

A study done by Miller et al. (Miller, et al., 2005) in New York City reported that young people who lived in areas with higher income inequality had a greater likelihood of suicide attempts. According to another study conducted in Japan, a high Gini index and income inequality were linked to a high suicide rate (Inagaki, 2010). In a similar manner, our study examined the risk factors related to self-harm by age group and found that for both sexes, a higher Gini index, lower employment rate, and lower income were associated with higher VRSHs in the young population. Increased working hours and decreased leisure time might have polycyclic impacts on the suicide rate. The VRSH showed an increase with a decrease in leisure time, and an increase in working hours, consistent with the findings of previous studies (Andres, 2005; Goldman-Mellor, et al., 2019; Inagaki, 2010; Kposowa, 2001). Alcohol consumption was significantly correlated with the VRSH of males aged 65 and older. This finding was consistent with previous studies suggesting that substance abuse such as alcoholism was associated with elderly suicide (Suresh Kumar et al., 2015; Waern, 2003). Research has shown that education on the harmful effects of excessive alcohol consumption may also contribute to reductions in suicides among people with alcohol use disorder (Sher, 2005; Zeppegno et al., 2019).

Effectiveness of Community-Based SPPs in Preventing ED Utilization After Self-harm

The WHO recommends that SP projects are carried out under the slogan "Think globally, plan nationally, act locally." (De Leo, 2002). We found that the impact of community-based SPPs might differ by age and sex. Matsubayashi et al. (Matsubayashi & Ueda, 2011) reported that male suicide rates were significantly reduced after the implementation of a national SP program. However, female suicide rates did not change. In more detail, suicide rates dropped by 1.384 per 100,000 for the entire population, but by 1.472 per 100,000 for males. The present study also found that each time mental health providers per million population increased, the number of self-harms was reduced by about 3% every year. In all age groups, the number of mental health providers per million population was a significant factor in reducing VRSHs in both men and women, but the effect size was greater in the male population. Increases in

mental health budgets contributed to a reduction in self-harm risk among both young and elderly populations, as well as in both males and females.

Among the OECD countries, South Korea had the highest suicide mortality rate of 31.7 per 100,000 in 2011, and the number of suicides increased to 13,092 in 2016, 12,463 in 2017, and 13,670 in 2018. In response to this, the South Korean government has promoted regionally tailored SP projects since the mid-to-late 2000s. Local governments have worked hard to develop effective models that incorporate local characteristics and resources. In 2013, the Ministry of Health and Welfare launched a pilot project for the post-management of suicide attempters who visited a hospital ED. It was expanded to cover the entire province in 2014 (H. Kim et al., 2018). After patients who attended the ED after self-harm were discharged from the ED, mental health professionals followed up with them on the telephone. If necessary, they referred patients to a psychiatric specialist for a clinical consultation.

As an indicator of the quantity of SP provision, the number of SPCs per 1,000 km^2 did not appear to have a significant effect on self-harm incidence. Conversely, the number of mental health providers per million population had a significant impact on the prevention of self-harm. This is in accordance with previous studies indicating that phone or video counseling could be effective in addressing a variety of mental health problems during the coronavirus disease 2019 (COVID-19) pandemic (Chan, 2020; Liu & Gao, 2021; Situmorang, 2020). Using online counseling is more effective since the requesters feel that they are in a secure, non-judgmental environment. In addition, they can contact the counselor at any time and disclose their problems sooner than might occur in a face-to-face communication (Liu & Gao, 2021).

Limitations

This study has some limitations. First, it was conducted in South Korea, a country with the highest suicide rate in the OECD. However, this study compared VRSHs between age groups based on changes in independent variables within the country. Thus, the highest suicide rate in South Korea was not considered an influential factor that might have affected results of this study. The second limitation was that it had a relatively short observation period of five years. A longer period of observation would be beneficial to observe changes in VRSH in relation to changes in SP provision. However, these shortcomings of the present study were reduced by considering differences between 14 provinces. More studies in countries with a variety of socioeconomic conditions and longer observation periods

are needed in the future. Moreover, this study intended to identify risk factors of self-harm-related emergency medical service utilization and effectiveness of community mental health program provisions for self-harm prevention. Thus, patients with mild self-harm who were treated at outpatient clinic and those who did not visit the hospital were excluded. It is necessary to conduct a comprehensive study on the effectiveness of community mental health services covering even mild patients. A further limitation of this study was that it failed to include qualitative indicators of SP programs such as the proportion of patients linked to community management and the number of counseling sessions provided to self-harming patients.

Conclusion

Results of this study offer new insights into risk factors associated with self-harm including economic inequality and poverty, especially in young people. Self-harm was associated with social stressors, the lack of leisure activity, alcohol consumption, and crime in young and elderly male populations. Community resources and efforts for suicide prevention could reduce the need for emergency medical care in the general population after a self-harm event. Thus, it is crucial to establish an SP program for identifying high-risk self-harming patients in the ED and connecting them with SP programs.

Declarations

References

Andres, A. R. (2005). Income inequality, unemployment, and suicide: A panel data analysis of 15 European countries. *Applied*

Economics, 37(4), 439–451. https://doi.org/10.1080/0003684042000295304

Benson, J. E., & Furstenberg, F. F., Jr. (2006). Entry into adulthood: Are adult role transitions meaningful markers of adult identity? *Advances in Life Course Research, 11*, 199–224.

Calear, A. L., Christensen, H., Freeman, A., Fenton, K., Busby Grant, J., van Spijker, B., et al. (2016). A systematic review of psychosocial suicide prevention interventions for youth. *European Child & Adolescent Psychiatry, 25*(5), 467–482. https://doi.org/10.1007/s00787-015-0783-4

Canner, J. K., Giuliano, K., Selvarajah, S., Hammond, E. R., & Schneider, E. B. (2018). Emergency department visits for attempted suicide and self harm in the USA: 2006–2013. *Epidemiology and Psychiatric Sciences, 27*(1), 94–102. https://doi.org/10.1017/S2045796016000871

Chan, G. H. (2020). A comparative analysis of online, offline, and integrated counseling among hidden youth in Hong Kong. *Children and Youth Services Review, 114*, 105042. https://doi.org/10.22283/qbs.2016.35.2.41

Claassen, C. A., Trivedi, M. H., Shimizu, I., Stewart, S., Larkin, G. L., & Litovitz, T. (2006). Epidemiology of nonfatal deliberate self-harm in the United States as described in three medical databases. *Suicide and Life-Threatening Behavior, 36*(2), 192–212. https://doi.org/10.1521/suli.2006.36.2.192

Coleman, D. (2015). Traditional masculinity as a risk factor for suicidal ideation: Cross-sectional and prospective evidence from a study of young adults. *Archives Suicide Research, 19*(3), 366–384. https://doi.org/10.1080/13811118.2014.957453

Coope, C., Donovan, J., Wilson, C., Barnes, M., Metcalfe, C., Hollingworth, W., et al. (2015). Characteristics of people dying by suicide after job loss, financial difficulties and other economic stressors during a period of recession (2010–2011): A review of coroners′ records. *Journal of Affective Disorders, 183*, 98–105. https://doi.org/10.1016/j.jad.2015.04.045

Corcoran, P., Griffin, E., Arensman, E., Fitzgerald, A. P., & Perry, I. J. (2015). Impact of the economic recession and subsequent austerity on suicide and self-harm in Ireland: An interrupted time series analysis. *International Journal of Epidemiology, 44*(3), 969–977. https://doi.org/10.1093/ije/dyv058

De Leo, D. (2002). Struggling against suicide: The need for an integrative approach. *Crisis, 23*(1), 23–31. https://doi.org/10.1027//0227-5910.23.1.23

Doo Woong, L., Junhyun, K., Jieun, Y., Yeong Jun, J., Eun-Cheol, P., & Sung-In, J. (2020). Suicide related indicators and trends in Korea in 2018. *Health Policy Manag, 30*(1), 112–119. https://doi.org/10.4332/KJHPA.2020.30.1.112

El Ibrahimi, S., Xiao, Y., Bergeron, C. D., Beckford, N. Y., Virgen, E. M., & Smith, M. L. (2021). Suicide distribution and trends among male older adults in the U.S., 1999–2018. *American Journal of Preventive Medicine, 60*(6), 802–811. https://doi.org/10.1016/j.amepre.2020.12.021

Fontanella, C. A., Hiance-Steelesmith, D. L., Phillips, G. S., Bridge, J. A., Lester, N., Sweeney, H. A., et al. (2015). Widening rural-urban disparities in youth suicides, United States, 1996–2010. *JAMA Pediatrics, 169*(5), 466–473. https://doi.org/10.1001/jamapediatrics.2014.3561

Goldman-Mellor, S., Kwan, K., Boyajian, J., Gruenewald, P., Brown, P., Wiebe, D., et al. (2019). Predictors of self-harm emergency department visits in adolescents: A statewide longitudinal study. *General Hospital Psychiatry, 56*, 28–35. https://doi.org/10.1016/j.genhosppsych.2018.12.004

Hadfield, J., Brown, D., Pembroke, L., & Hayward, M. (2009). Analysis of accident and emergency doctors' responses to treating people who Self-Harm. *Qualitative Health Research, 19*(6), 755–765. https://doi.org/10.1177/1049732309334473

Haroz, E. E., Decker, E., Lee, C., Bolton, P., Spiegel, P., & Ventevogel, P. (2020). Evidence for suicide prevention strategies with populations in displacement: A systematic review. *Intervention (amstelveen), 18*(1), 37–44.

Hawton, K., Zahl, D., & Weatherall, R. (2003). Suicide following deliberate self-harm: Long-term follow-up of patients who presented to a general hospital. *British Journal of Psychiatry, 182*, 537–542. https://doi.org/10.1192/bjp.182.6.537

Inagaki, K. (2010). Income inequality and the suicide rate in Japan: Evidence from cointegration and LA-VAR. *Journal of Applied Economics, 13*(1), 113–133. https://doi.org/10.1016/S1514-0326(10)60006-2

Kapur, N., Cooper, J., O'Connor, R. C., & Hawton, K. (2013). Non-suicidal self-injury v. attempted suicide: new diagnosis or false dichotomy? *British Journal of Psychiatry, 202*(5), 326–328.

Kim, H., Kim, S. G., Oh, H., & Choi, S. (2018). Case management of suicide attempters seen in emergency rooms: Result and factors affecting consent to follow-up. *Journal of the Korean Society of Emergency Medicine, 29*(2), 160–169. https://doi.org/10.0000/jksem.2018.29.2.160

Kim, Y. G., Kim, Y. T., Lee, S. K., & Ahn, J. J. (2016). A comparative analysis of suicide rate trends between Korea and other OECD countries. *Quantitative Biosciences, 35*(2), 41–44.

Kleiman, E. M., & Liu, R. T. (2013). Social support as a protective factor in suicide: Findings from two nationally representative samples. *Journal of Affective Disorders, 150*(2), 540–545. https://doi.org/10.1016/j.jad.2013.01.033

Kposowa, A. J. (2001). Unemployment and suicide: A cohort analysis of social factors predicting suicide in the US National Longitudinal Mortality Study. *Psychological Medicine, 31*(1), 127–138. https://doi.org/10.1017/s0033291799002925

Lapierre, S., Erlangsen, A., Waern, M., De Leo, D., Oyama, H., Scocco, P., et al. (2011). A systematic review of elderly suicide prevention programs. *Crisis, 32*(2), 88–98. https://doi.org/10.1027/0227-5910/a000076

Lee, J. (2020). Municipal-level determinants of suicide rates in South Korea: Exploring the role of social capital and local government policies. *Journal of Asian Public Policy, 13*(3), 277–294.

Lee, S. U., Park, J. I., Lee, S., Oh, I. H., Choi, J. M., & Oh, C. M. (2018). Changing trends in suicide rates in South Korea from 1993 to 2016: A descriptive study. *British Medical Journal Open, 8*(9), e023144. https://doi.org/10.1136/bmjopen-2018-023144

Lin, C. Y., Bickley, H., Clements, C., Webb, R. T., Gunnell, D., Hsu, C. Y., et al. (2020). Spatial patterning and correlates of self-harm in Manchester, England. *Epidemiology and Psychiatric Sciences, 29*, 1.

Liu, J., & Gao, L. (2021). Analysis of topics and characteristics of user reviews on different online psychological counseling methods. *International Journal of Medical Informatics, 147*, 104367. https://doi.org/10.1016/j.ijmedinf.2020.104367

Matsubayashi, T., & Ueda, M. (2011). The effect of national suicide prevention programs on suicide rates in 21 OECD nations. *Social Science & Medicine, 73*(9), 1395–1400. https://doi.org/10.1016/j.socscimed.2011.08.022

McMillan, K. A., Enns, M. W., Asmundson, G. J., & Sareen, J. (2010). The association between income and distress, mental disorders, and suicidal ideation and attempts: findings from the Collaborative Psychiatric Epidemiology Surveys. *Journal of Clinical Psychiatry, 71*(9), 1497. https://doi.org/10.4088/JCP.08m04986gry

Miller, J. R., Piper, T. M., Ahern, J., Tracy, M., Tardiff, K. J., Vlahov, D., et al. (2005). Income inequality and risk of suicide in New York City neighborhoods: A multilevel case-control study. *Suicide and Life-Threatening Behavior, 35*(4), 448–459. https://doi.org/10.1521/suli.2005.35.4.448

Owens, D., Horrocks, J., & House, A. (2002). Fatal and non-fatal repetition of self-harm: Systematic review. *The British Journal of Psychiatry, 181*(3), 193–199.

Paltasingh, T., & Tyagi, R. (2015). *Gender sensitive intervention for elderly women*. SAGE.

Rocha, T. B. M., Graeff-Martins, A. S., Kieling, C., & Rohde, L. A. (2015). Provision of mental healthcare for children and adolescents: A worldwide view. *Current Opinion in Psychiatry, 28*(4), 330–335. https://doi.org/10.1097/YCO.0000000000000169

Sher, L. (2005). Alcohol consumption and suicide. *QJM, 99*(1), 57–61. https://doi.org/10.1093/qjmed/hci146

Sinha, D., Srivastava, S., Mishra, P. S., & Kumar, P. (2021). Predictors of deliberate self-harm among adolescents: Answers from a cross-sectional study on India. *BMC Psychology, 9*(1), 1–10.

Situmorang, D. D. B. (2020). Online/cyber counseling services in the COVID-19 outbreak: Are they really new? *Journal of Pastoral Care & Counseling, 74*(3), 166–174. https://doi.org/10.1177/1542305020948170

Statistics Korea. (2020). Annual report on the causes of death statistics; 2020. Retrieved Feb 14, 2022 from https://kostat.go.kr/portal/eng/pressReleases/1/index.board?bmode=read&aSeq=414516.

Suresh Kumar, P. N., Anish, P. K., & George, B. (2015). Risk factors for suicide in elderly in comparison to younger age groups. *Indian Journal of Psychiatry, 57*(3), 249–254. https://doi.org/10.4103/0019-5545.166614

Takeuchi, A., Sakano, N., & Miyatake, N. (2014). Combined effects of working hours, income, and leisure time on suicide in all 47 prefectures of Japan. *Indian Health*. https://doi.org/10.2486/indhealth.2013-0182

Turecki, G., & Brent, D. A. (2016). Suicide and suicidal behaviour. *Lancet, 387*(10024), 1227–1239. https://doi.org/10.1016/S0140-6736(15)00234-2

Waern, M. (2003). Alcohol dependence and misuse in elderly suicides. *Alcohol, 38*(3), 249–254. https://doi.org/10.1093/alcalc/agg060

World Health Organization. (2018). World Health Organization. National suicide prevention strategies: Progress, examples and indicators. Retrieved Feb 14, 2022 from https://apps.who.int/iris/handle/10665/279765

World Health Organization. (2021). Mental Health: Suicide Prevention. Retrieved Feb 14, 2022 from https://www.nimh.nih.gov/health/statistics/suicide

Zeppegno, P., Gattoni, E., Mastrangelo, M., Gramaglia, C., & Sarchiapone, M. (2019). Psychosocial suicide prevention interventions in the elderly: A mini-review of the literature. *Frontiers in Psychology, 9*(2713), 1–7. https://doi.org/10.3389/fpsyg.2018.02713