# RESEARCH



# A brief report of the economic burden and epidemiological finding of suicide attempts among the older adults in Korea from 2007 to 2021

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# Abstract

**Aim** Quantifying the increased personal and social losses following suicide attempts among the aging population presents a significant challenge. There is an urgent need to determine the economic burden of suicide attempts among older adults in Korea.

**Subjects and methods** The economic burden of suicide attempts from 2007 to 2021 was assessed using claim data from the Health Insurance Review & Assessment and Causes of Death Statistics in Korea. The analysis focused on individuals diagnosed with injuries, poisoning, and other consequences of external causes (S00-T98), intentional self-harm (X60-X84), sequelae of intentional self-harm (Y87.0), and personal history of self-harm (Z91.5). Economic impacts were analyzed by year, primary and secondary diagnoses in claim data, and Cause of Death Statistics.

**Results** The mean age of study participants was 72.86 years, with women accounting for 48.4% of the sample. The total cost of suicide attempts increased dramatically from \$0.167 million in 2007 to \$1.591 million in 2021. The most frequently observed ICD-10 codes associated with these attempts were toxic effects of substances chiefly nonmedicinal as to source (T51-T65), followed by poisoning by drugs, medicaments, and biological substances(T36-T50) for both genders. While the total number of suicidal attempts generally increased annually, there were declines noted in 2020 and 2021.

**Conclusion** This study informs the high level of economic costs of suicide attempts that were being neglected. By thoroughly understanding demographic characteristics, emerging trends, and cost classifications, policymakers can devise more effective strategies to prevent suicide attempts, provide timely support, and mitigate the associated economic and social burdens.

Keywords Suicidal attempt, Older adults, Economic burden, South Korea

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# Introduction

Across the lifespan, approximately 804,000 suicide deaths were recorded worldwide annually, with a global agestandardized mortality rate of 11.4 per 100,000 (15.0 men and 8.0 women) [1]. In the United States, the suicide rate in 2021 was 29.6 deaths per 100,000 population for men and 6.2 for women among older adults aged 55 years and older [2]. Although older adults account for a low proportion of the total number of suicides generally, they have higher suicide rates [2]. Several factors can lead to the substantial increase in suicide rates among older adults, including socioeconomic, regional, psychological, physical, and medical problems [3-6]. Considering the importance of this issue, the 66th World Health Assembly adopted the Mental Health Action Plan of the World Health Organization (WHO) in May 2013 to reduce the suicide rate by 2030 compared to that in 2013 [7].

The increase in suicide rates among older adults is becoming an increasingly serious problem, particularly in South Korea. According to the 2022 Causes of Death Statistics provided by the Korean Statistical Office, the number of suicides in Korea was 12,906, with a suicide rate of 25.2 per 100,000 people (35.3 men and 15.1 women), ranking fifth among the causes of death [8]. The Korea Suicide Prevention Center of the Ministry of Health and Welfare found that the suicide rate among older adults aged 65 years and older in Korea was 41.7 per 100,000 population in 2022, far above the average of 16.3 in member countries of the Organization for Economic Cooperation and Development (OECD) and significantly higher than Slovenia, the second-ranked country, with a rate of 39.3 [9, 10].

Suicide attempts among the aging population are particularly concerning as they are more likely to end fatally, and the negative impact of suicide attempts is greater in the age group of 60 years and older [11]. Suicide mortality rates tend to increase with age. The suicide rate per 100,000 people is 30.1 for those aged 60-69, 38.8 for those aged 70-79, and 62.6 for those aged 80 and older [9]. Previous studies have identified depression, physical illness, disability, and economic status as significant risk factors associated with suicidal ideation and behavior among older adults [12, 13]. Notably, financial strain has been consistently and strongly associated with suicide attempts among older adults compared to other age groups [12, 14]. Studies in high-income European countries have shown higher rates of suicidal ideation related to lower income among older adults [15], and the percentage of the population aged 65 and older eligible for basic pensions, a system designed for low-income older adults is positively correlated with suicide rates [16].

According to a 2016 survey, suicidal ideation was most common among men in their 60s and women in their 20s, 50s, and 60s [17]. The rate of suicidal ideation in the past year was reported to be 25.7%, while the rate of suicide attempts was 1.4% in the same population. This implies a potential overlap between suicidal ideation and attempts [6], indicating that suicidal ideation might lead to suicide attempts [18]. When a person dies by suicide, others are more likely to attempt the same; older people are particularly prone to copycat suicides when confronted with the suicidal loss of significant others or media reports of suicide [19, 20].

In addition to the unquantifiable harm caused by suicide and suicide attempts, the economic impacts are significant but often overlooked. The costs associated with hospitalization, long-term care, and rehabilitation for survivors of suicide attempts are substantial, causing a lasting burden on individuals and healthcare systems. Approximately 32% of serious suicide attempts require hospitalization [17]. Individuals who have attempted suicide incur an average of over \$33,000 in direct costs during hospitalization, often leading to permanent disability, long-term care, and lost income [21]. Palmer et al. (1995) noted that these costs could be reduced by preventing suicide, which also represents a significant loss in terms of family and community disintegration. Therefore, it is crucial to prevent suicide and address the economic aspects of suicide attempts, particularly among older adults.

While studies on the economic burden of suicide and suicide attempts have been conducted in some countries [21–23], few have accurately assessed the extent of suicide attempts in Korea, despite the urgency of the issue. Notably, few studies have focused on older adults, who have higher mortality rates after suicide attempts. This study examines a 20-year time series of older adults who have attempted suicide. This study aims to alleviate the disease burden caused by suicide attempts by estimating its impact.

# Methods

#### Data sources

This study used claims data covering nearly the entire population from the Health Insurance Review & Assessment (HIRA). Over 99% of the population is covered by the National Health Insurance (NHI) program, which is a hallmark of the South Korean healthcare system [24]. In the South Korean healthcare system, the payment structure is largely based on a fee-for-service model. The HIRA service evaluates reimbursement claims based on established guidelines and standards [25]. Medical institutions submit claims for reimbursement to the HIRA service, which evaluates the claims based on established guidelines and standards [25]. This system not only facilitates the reimbursement process but also provides a comprehensive database of healthcare utilization, which can be leveraged for health research and policy-making [24, 25]. The HIRA data repository contains extensive information on treatments, pharmaceuticals, and procedures, reflecting the healthcare services utilized by nearly 50 million beneficiaries [25]. The HIRA database provides information on demographic characteristics, inpatient and outpatient treatments and prescriptions [26]. Data collected from January 1, 2007, to December 31, 2021, from the HIRA were used for the analysis and are accessible upon request from the corresponding author but not public due to the conditions of data provision.

The number of participants in our study may differ from that in a study that classified suicide attempters using National Emergency Department Information System (NEDIS) data. HIRA data include national health insurance data on patients who received outpatient or inpatient treatment at all hospitals and clinics in Korea

Tab	le '	The d	letailed	codes	for	classify	/ing	the	part	ticipa	ant	2
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Codes	Detailed codes
X60-X84	Intentional self-harm
Y87.0	Sequelae of intentional self-harm
Z91.5	Personal history of self-harm
S00-S09	Injuries to the head
S10-S19	Injuries to the neck
S20-S29	Injuries to the thorax
S30-S39	Injuries to the abdomen, lower back, lumbar
	spine, and pelvis
S40-S49	Injuries to the shoulder and upper arm
S50-S59	Injuries to the elbow and forearm
S60-S69	Injuries to the wrist and hand
S70-S79	Injuries to the hip and thigh
S80-S89	Injuries to the knee and lower leg
S90-S99	Injuries to the ankle and foot
T00-T07	Injuries involving multiple body regions
T08-T14	Injuries to unspecified parts of the trunk, limb, or body region
T15-T19	Effects of foreign bodies entering through natural orifices
T20-T32	Burns and corrosions
T20-T25	Burns and corrosions of the external body surface, specified by site
T26-T28	Burns and corrosions confined to the eye and internal organs
T29-T32	Burns and corrosions of multiple and unspeci- fied body regions
T33-T35	Frostbite
T36-T50	Poisoning by drugs, medicaments, and biologi- cal substances
T51-T65	Toxic effects of substances chiefly nonmedicinal as to source
T66-T78	Other and unspecified effects of external causes
T79	Certain early complications of trauma
T80-T88	Complications of surgical and medical care, not elsewhere classified
T90-T98	Sequelae of injuries, of poisoning, and of other consequences of external causes

[27], whereas NEDIS, operated by the Ministry of Health and Welfare, is a government emergency information network that collects clinical and administrative data for all patients who visit emergency departments in Korea [28]. Information on diagnosis, treatment, and post-discharge except emergency department could not be identified using the NEDIS data. Thus, due to differences in the characteristics of the two datasets, the number of suicide attempters may appear different.

To further clarify, in this study, emergency department visits were categorized as either outpatient or inpatient cases. If a patient visited the emergency department without being admitted to the hospital, the case was classified as outpatient. Conversely, if the visit resulted in admission, it was categorized as an inpatient case. Given the HIRA dataset encompasses health insurance claims data for both inpatient and outpatient cases across all hospitals in Korea, emergency department visits, as categorized, were also integrated into the analysis, ensuring their inclusion.

# **Case definition**

Importantly, not all suicide attempts lead to death. In our study, older adults over 60 years of age who attempted suicide but did not die were selected as study participants. Those diagnosed with intentional self-harm (X60-X84) from HIRA data were classified as suicide attempt survivors for our analysis first. This definition represents the minimum criteria for classifying a suicide attempt. However, as HIRA data is based on insurance claims, it may underestimate the actual number of attempts. To address this limitation, we incorporated data from the Korea National Hospital Discharge In-depth Injury Survey to calculate a more accurate rate of suicide attempts each year. Our approach combined the S and T diagnostic codes for hospitalization with the X and Y cause codes. By determining the proportion of S and T codes specifically linked to suicide attempts (identified by X codes) in the Korea National Hospital Discharge In-depth Injury Survey and applying this ratio to the S and T codes in the HIRA data, we obtained an adjusted estimate for potentially underestimated suicide attempts. The specific codes used to classify participants are detailed in Table 1. This methodology is based on previous Korean burden of disease studies [11, 29].

# Estimation of economic burden

The economic burden of suicide attempt survivors in this study was calculated using data from HIRA, a nationally representative data source for South Korea. It was analyzed using years of suicide, the recipient's age, and primary and secondary diagnoses in the National health insurance claims data. This study estimated the economic burden using an approach based on prior research by previous studies [23, 30, 31]. The economic burden of disease is calculated as the sum of direct and indirect costs. Direct costs were calculated using HIRA data to separate medical and non-medical costs. Medical costs were measured as the sum of insured medical costs, which encompassed the medical and drug expenses of inpatients/outpatients, and uninsured medical costs not covered by insurance. In case of noninsured cost, proportion of non-covered services expenditure from national health insurance services [32]. Non-medical costs include transportation costs and caregiver expenses. Transportation costs are calculated as the average round-trip transportation cost based on the total number of outpatient visits and hospitalizations, using Korean Health Panel data. Caregiver costs are calculated as the average cost and utilization rate of paid caregivers by year, using data from the Korea Health Panel Survey. Indirect costs are typically calculated as the cost of lost productivity due to morbidity and mortality. The cost of lost productivity due to morbidity is the average daily earnings lost during an outpatient visit or hospitalization. The costs for lost productivity due to premature mortality were not calculated as the study participants were survivors of suicide attempts (Table 2). The above method of measuring the economic burden of disease based on the calculation of direct and indirect costs has been used in many studies, and detailed calculation methods can be found in the paper [30, 33]. The average exchange rate for the US dollar to Korean won, based on the mid-rate from Hana Bank's average rates for the period, was 1,144.19 won per dollar for the year 2021 (https://www.kebhana.com/cont/ mall/mall15/mall1502/index.jsp).

# Results

# Descriptive characteristics of the study participants

Table 3 presents the characteristics of the study participants classified by ICD-10 in 2021. The mean age of study participants was 72.86 years, with a standard deviation of 8.69; among them, 48.4% were women and 51.6% were men. Approximately 20.3% of the participants were in the

Table 2	Economic	disease	burden	variables
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Variables			Detailed variables
Direct cost	Medical cost	Insured medical cost	Inpatient, outpatient, drug cost
		Uninsured medi- cal cost	Proportion of non-covered services expenditure
	Non-medi- cal cost	Transportation cost	Number of outpatient visits Average transportation cost by disease category
		Caregiver cost	Hospitalization Average day caregiver cost
Indirect cost	Productivity morbidity	loss due to	Number of outpatient visits Hospitalization Average daily income

medical aid group, which is public assistance provided by the government to offer medical services to low-income individuals. Supplementary Tables 1-3 present the characteristics of the study participants from 2007 to 2020.

#### Economic burden of suicide attempts

The total, direct (medical and non-medical), and indirect costs from 2007 to 2021 were examined, as shown in Table 4. The total cost of suicide attempts increased significantly from \$0.167 million in 2007 to \$1.591 million in 2021. Similarly, the total number of suicide attempts exhibited a slight decrease in 2008 but continued to grow steadily from 2009 to 2021. Direct costs of suicide attempts increased significantly from \$0.142 million in 2007 to \$1.483 million in 2021. Whereas, indirect costs of suicide attempts, primarily attributed to productivity loss, dropped sharply from \$0.025 million in 2007 to \$0.005 million in 2008 and remained relatively stable with minimal fluctuations, reaching \$0.108 million in 2021. To analyze the trends in suicide attempt costs from 2018 to 2021, we categorized the data by gender (Fig. 1). Over the four-year period, the cost of suicide attempts gradually increased for both men and women. Men consistently incurred higher costs than women. In 2018, the cost of a suicide attempt was \$0.634 million for men and \$0.351 million for women. In 2019, the costs were \$0.633 million for men and \$0.365 million for women. In 2020, the cost increased to \$0.736 million for men and \$0.547 million for women, and by 2021, the cost reached \$0.967 million for men and \$0.623 million for women.

## Economic burden of suicide attempts classified by ICD-10

The total cost and cost-per-person of suicide attempts classified by ICD-10 in Korea in 2021 were identified (Table 5). The highest total cost was observed in the T51-T65 category, with \$631.702 thousand for men and \$311.703 thousand for women. Correspondingly, the cost per person in this category was also the highest, at \$3.998 thousand for men and \$3.463 thousand for women. The T36-T50 category followed, with total costs of \$240.612 thousand for men and \$263.228 thousand for women, and cost per person at \$2.644 thousand for men and \$1.698 thousand for women. In the T66-T78 category, although the total costs were relatively lower at \$12.326 thousand for men and \$4.479 thousand for women, the cost per person remained notable at \$1.761 thousand for men and \$0.560 thousand for women. Aside from the T categories, other ICD-10 codes, such as S30-S39 and S60-S69, also contributed to the overall economic burden although the total costs and cost-per-person of suicide attempts were comparatively lower. In addition, economic disease burden of suicide attempters classified by ICD-10 in Korea in 2021 by gender is shown in Fig. 2. The

 Table 3
 Characteristics of patients with suicide-related ICD-10

 codes, 2021
 Codes, 2021

Method by ICD-10	Age		Gender	Health insur- ance type
	Mean	± SD	Women (%)	Proportion of medical aid group (%)
S00-S09 (n=213)	74.1	±8.9	37.1	24.6
S10-S19 (n=88)	71.08	±7.91	38.6	14.8
S20-S29 (n=247)	73.96	±8.82	51.0	23.5
S30-S39 (n=375)	73.5	±8.52	53.6	18.9
S40-S49 (n=123)	72.21	±8.36	48.8	19.5
S50-S59 (n=97)	72.78	±8.79	53.6	20.6
S60-S69 (n = 180)	70.86	±8.32	40.0	23.5
S70-S79 (n=102)	75.62	±9.24	43.1	14.7
S80-S89 (n=163)	71.42	±8.07	52.2	22.1
S90-S99 (n=154)	71.6	±8.78	59.1	25.3
T00-T07 (n = 16)	70.69	±8.69	25.0	31.3
T08-T14 (n=54)	75.98	±8.21	44.4	20.8
T15-T19 (n = 77)	71.97	±9.02	49.4	26.0
T20-T32 (n=49)	73.94	±9.85	63.3	28.6
T33-T35 (n = 1)	76	NA	100.0	0.0
T36-T50 (n = 181)	73.7	±8.98	58.0	14.9
T51-T65 (n=207)	73.17	±8.44	35.8	13.0
T66-T78 (n=45)	72.33	±9.36	48.9	6.7
T79 (n=7)	70	±9.11	28.6	28.6
T80-T88 (n=61)	72.98	±7.96	54.1	25.0
T90-T98 (n = 15)	68.93	±7.58	60.0	33.3
X60-X84, Y87, Z91.5 (n = 366)	72.17	±9.26	42.1	16.7
Mean	72.86	±8.69	48.4	20.3

*Notes*: S00-S09 Injuries to the head, S10-S19 Injuries to the neck, S20-S29 Injuries to the thorax, S30-S39 Injuries to the abdomen, lower back, lumbar spine and pelvis, S40-S49 Injuries to the shoulder and upper arm, S50-S59 Injuries to the elbow and forearm, S60-S69 Injuries to the wrist and hand, S70-S79 Injuries to the hip and thigh, S80-S89 Injuries to the knee and lower leg, S90-S99 Injuries to the hip and thigh, S80-S89 Injuries involving multiple body regions, T08-T14 Injuries to unspecified part of trunk, limb or body region, T15-T19 Effects of foreign body entering through natural orifice, T20-T32 Burns and corrosions, T33-T35 Frostbite, T36-T50 Poisoning by drugs, medicaments and biological substances, T51-T65 Toxic effects of substances chiefly nonmedicinal as to source, T66-T78 Other and unspecified effects of surgical and medical care, not elsewhere classified, T90-T98 Sequelae of injuries, of poisoning and of other consequences of external causes, X60-X84 Intentional self-harm, Y87 Sequelae of intentional self-harm, Z91.5 Personal history of self-harm

total cost of suicide attempts classified by gender showed the same trend.

# Discussion

This study estimated the economic burden of suicide attempts among older adults in Korea using nationwide representative longitudinal data over 15 years (2007–2021). To the best of our knowledge, this is the first study to address the economic burden associated with suicide attempts in Korea, providing insight into the demographic characteristics of those affected, the evolution of costs over time, and the classification of suicide attempts

Variables			Suicide	attempts	total cost												
			2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total cost			0.167	0.044	0.104	0.093	0.125	0.100	0.177	0.292	0.508	0.545	0.792	0.985	0.998	1.283	1.591
Annual growth	հ rate (%)			-73.71	137.01	-10.78	34.29	-20.17	78.11	64.45	74.31	7.29	45.22	24.42	1.31	28.58	23.95
Total number			92	59	75	89	105	109	154	205	357	439	543	641	637	625	736
Direct cost	Total		0.142	0.039	0.097	0.089	0.117	0.093	0.163	0.273	0.463	0.512	0.745	0.924	0.932	1.194	1.483
	Medical cost	Insured	0.082	0.024	0.070	0.063	0.081	0.066	0.114	0.194	0.327	0.379	0.558	0.712	0.723	0.938	1.174
		Uninsured	0.020	0.007	0.017	0.016	0.022	0.017	0.031	0.048	0.075	0.085	0.125	0.137	0.134	0.162	0.197
	Non-medical cost	Transportation	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.003	0.004	0.006	0.007	0.006	0.007	0.008
		Caregiver	0.038	0.008	0.010	600.0	0.013	0.010	0.018	0:030	0.058	0.044	0.057	0.068	0.069	0.088	0.104

Table 4 Total cost of suicidal attempt survivors among older adults in Korea, 2007–2021 (Unit: \$1 million)

0.108

0.089

0.066

0.061

0.046

0.033

0.045

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0.014

0.006

0.008

0.004

0.007

0.005

0.025

Productivity loss cost

ndirect cost

Notes: Annual growth rate was calculated by {(Total cost of current year / Total cost of previous year)-1}\*100



Fig. 1 Total cost of suicide attempt survivors in Korea, 2018–2021 (Unit: \$1 million). M: Men, W: Women

by ICD-10 to determine hidden costs. It revealed that the economic burden of suicide attempts in Korea is consistently rising despite fluctuations in numbers of attempts. Among suicide attempt methods, T-code rated attempts - T51-65 (Toxic effects of substances) – considerably contribute to the economic burden.

First, this study provided the demographic details of survivors who attempts suicide, revealing a mean age of 72.86 years and a near-equal split between men and women. Notably, this study identified a significant percentage of individuals receiving medical aid, indicating the vulnerability of low-income groups to suicide. The proportion of recipients of medical benefits in Korea in 2021 was 2.9% of the total healthcare population, of which approximately 40% were aged 65 or older [34]. In other words, the proportion of medical recipients aged 65 or older accounted for about 1.2% of the total population. Table 3 shows that among the group of suicide attempt survivors, the proportion of those receiving medical aid is 20.3%, which indicates an extensively high rate. Moreover, financial problems have been commonly described as a stressor in older adults who engage in suicide attempts [35]. Previous studies have not been able to conclusively prove the association between suicide attempts and their economic burden among older people; however, when the results of previous studies were confirmed, we observed a high correlation between suicide rates and socioeconomic status [16, 36]. In the case of older adults who attempted suicide, economic factors were found to be very significant [12, 14, 35]. This suggests that social welfare support and appropriate medical follow-up measures should be implemented together.

Second, the economic burden of suicide attempts has been increasing even in cases where the number of attempts has fluctuated. The total cost of suicide attempts surged from \$0.167 million in 2007 to a staggering \$1.591 million in 2021, while the consumer price index (CPI) during the same period was approximately 15.2% [37]. This upward trajectory is mirrored in direct cost.

Recent findings from the OECD Health Statistics 2022 report highlight a notable trend in South Korea's healthcare expenditure over the past five years. According to the report, healthcare spending as a percentage of GDP in South Korea increased by 1.9%, from 6.9% in 2016 to 8.8% in 2021—the highest among all the countries in the OECD. In contrast, the United States and Japan experienced smaller increases of 1.0% and 0.4%, respectively, over the same period [38]. These figures emphasizes that South Korea's significantly faster growth rate in healthcare spending compared to other countries. As such, medical expenses increased rapidly, as well as the cost of suicide attempts. Indeed, our analysis showed that, from 2016 to 2021, the total cost of the suicide attempt costs increased by approximately 3 times greater (Table 4).

Moreover, a considerable increase in total cost was observed between 2020 and 2021. Although the total number of suicide attempts showed a modest increase during these years, the associated costs notably surged.

Table 5 T	otal cost and cost	per person of suicidal a	ttempt survivors classified b	y ICD-10 in Korea, 2021	(Unit: \$1 thousand)
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Method by	N			Total cost		Cost per p	erson
ICD-10	Total	Men	Women	Men	Women	Men	Women
S00-S09	-	-	-	-	-	-	-
S10-S19	-	-	-	-	-	-	-
S20-S29	-	-	-	-	-	-	-
S30-S39	11	5	6	0.635	0.597	0.127	0.099
S40-S49	-	-	-	-	-	-	-
S50-S59	-	-	-	-	-	-	-
S60-S69	5	5	0	0.406	0	0.081	0
S70-S79	-	-	-	-	-	-	-
S80-S89	-	-	-	-	-	-	-
S90-S99	-	-	-	-	-	-	-
T00-T07	-	-	-	-	-	-	-
T08-T14	0	0	0	0	0	0	0
T15-T19	0	0	0	0	0	0	0
T20-T32	-	-	-	-	-	-	-
T33-T35	-	-	-	-	-	-	-
T36-T50	246	91	155	240.612	263.228	2.644	1.698
T51-T65	248	158	90	631.702	311.703	3.998	3.463
T66-T78	15	7	8	12.326	4.479	1.761	0.560
T79	-	-	-	-	-	-	-
T80-T88	-	-	-	-	-	-	-
T90-T98	-	-	-	-	-	-	-
X60-X84, Y87, Z91.5	211	104	107	81.68	43.34	0.785	0.405

*Notes*: 500-509 Injuries to the head, 510-519 Injuries to the neck, 520-529 Injuries to the thorax, 530-539 Injuries to the abdomen, lower back, lumbar spine and pelvis, 540-549 Injuries to the shoulder and upper arm, 550-559 Injuries to the elbow and forearm, 560-569 Injuries to the wrist and hand, 570-579 Injuries to the hip and thigh, 580-589 Injuries to the knee and lower leg, 590-599 Injuries to the ankle and foot, T00-T07 Injuries involving multiple body regions, T08-T14 Injuries to unspecified part of trunk, limb or body region, T15-T19 Effects of foreign body entering through natural orifice, T20-T32 Burns and corrosions, T33-T35 Forstbite, T36-T50 Poisoning by drugs, medicaments and biological substances, T51-T65 Toxic effects of substances chiefly nonmedicinal as to source, T66-T78 Other and unspecified effects of external causes, T79 Certain early complications of trauma, T80-T88 Complications of surgical and medical care, not elsewhere classified, T90-T98 Sequelae of injuries, of poisoning and of other consequences of external causes, X60-X84 Intentional self-harm, Y87 sequelae of intentional self-harm, Z91.5 Personal history of self-harm

This could be an additional effect of the COVID-19 pandemic. The pandemic likely led self-isolation and disruption of psychiatric care which may have contribute to suicidal behaviors, highlighting the need for targeted mental health support during crisis periods [39]. Specifically, in this study, the medical costs per case may have increased due to the high expenses associated with COVID-19 testing and infection prevention, despite the reported decrease in suicide attempts. Also, during the early stages of the COVID-19 pandemic, concerns were raised about the impact of the virus on the aging population as older individuals were found to be more vulnerable to mental health crises and severe complications from COVID-19. This vulnerability could potentially lead to increased medical expenses for older adults' group [40].

Third, this study provides a classification of suicide attempts based on the ICD-10 with a comprehensive view of the distribution of costs across different categories. The highest costs were associated with specific codes, such as T codes, indicating potential areas where targeted interventions could yield substantial benefits. This trend corresponds to that of a previous study that explored suicide methods in Korea. The most common methods of suicide attempts involve psychotropics as ingested drugs and the use of pesticides [41]. Since suicide attempts using pesticides occurred frequently in India, highly hazardous pesticides were banned, which effectively reduced suicide attempts [42]. Although Korea has banned the sale of paraquat, a type of pesticide (herbicide), since 2012, efforts related to suicide prevention are continuously needed to reduce suicide attempts via drugs and substance-use-related methods. These insights can inform policy decisions, resource allocation, and the design of preventive measures tailored to specific risk factors.

This study has a few limitations. First, the coding for suicide attempts is often poorly implemented in clinical settings, primarily due to concerns about penalties from private insurance or job-related consequences associated with records of suicide or psychiatric illness. To address this issue, this study improves upon previous research by applying the methodology of redistributing suicide attempts data used in burden of disease studies. However, the low rate of reporting of suicidal attempts still presents challenges in establishing effective interventions. Second, this study might not have captured all potential variables



Fig. 2 Economic disease burden of suicide attempters classified by ICD-10 in Korea, 2021 in men (**A**) and in women (**B**); Unit: \$1 million. S30-S39 Injuries to the abdomen, lower back, lumbar spine and pelvis, S60-S69 Injuries to the wrist and hand, T08-T14 Injuries to unspecified part of trunk, limb or body region, T15-T19 Effects of foreign body entering through natural orifice, T36-T50 Poisoning by drugs, medicaments and biological substances, T51-T65 Toxic effects of substances chiefly nonmedicinal as to source, T66-T78 Other and unspecified effects of external causes, X60-X84 Intentional self-harm, Y87 sequelae of intentional self-harm, Z91.5 Personal history of self-harm

that contribute to suicide attempts and costs due to the limitations of the data. Factors such as individual mental health histories, socioeconomic conditions, area of residence (rural or urban areas) and access to mental health services could have played significant roles; however, these factors may not have been fully explored in the analysis because this study is based on administrative data. Similarly, whether or not individuals who attempted suicide later died by suicide was not measured. Therefore, the burden associated with suicide attempts was not fully assessed. Finally, we measured the economic cost of each episode based on the main diagnosis; thus, the precision of the cost estimates may be limited. Although this study provides significant insights into the economic burden of suicide attempts in Korea, it is important to interpret the results within the context of its strengths and limitations. Therefore, continued research, comprehensive data collection, and a multidimensional approach are necessary to understand and address the complex issue of suicide attempts and associated costs.

Despite these limitations, this study has several strengths, including being the first attempt to examine the economic burden associated with suicide attempts among older adults in Korea using national data. Second, this study conducted a longitudinal analysis from 2007 to 2021, allowing for the observation of trends and changes over a substantial period. This longitudinal approach provides a comprehensive view of the evolution of suicide attempts and the associated costs. The results are expected to significantly influence mental health policies and suicide prevention strategies in South Korea, underscoring the need for a multidisciplinary approach that includes robust mental health support, improved access to healthcare, targeted interventions for vulnerable groups, and awareness campaigns to reduce the stigma surrounding mental health issues. Third, the classification of suicide attempts based on ICD-10 displayed in this study would enhance the value of the findings, allowing for targeted interventions by identifying specific codes associated with higher costs, thereby helping policymakers to effectively allocate resource.

# Conclusions

A comprehensive analysis of the economic burden of suicide attempts has generally been neglected in Korea underscores the urgent need for addressing the suicide prevention among older adults due to significantly increasing economic burden. Multiciliary efforts including medical and social support tailored to the characteristics of the older adults' suicidal behaviors, could help reduce the economic burden associated with suicide and suicide attempts.

## **Supplementary Information**

The online version contains supplementary material available at https://doi.or g/10.1186/s12877-025-05793-0.

Supplementary Material 1

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#### Author contributions

Seoyoon Lee: Conceptualization, Methodology, Investigation, Data curation, Writing – Original draft preparation; Hyung Eun Shin: Conceptualization, Methodology, Investigation, Data curation, Writing – Original draft preparation; Rugyeom Lee: Formal analysis, Revision; Sooyeon Jo: Formal analysis, Revision; Seung Cheor Lee: Formal analysis, Data curation; Hyeon-Kyoung Cheong: Formal analysis, Data curation; Yong Joo Rhee: Data curation, Writing – Reviewing and Editing; In-Hwan Oh: Conceptualization, Methodology, Investigation, Data curation, Writing – Reviewing and Editing, Supervision, Project administration.

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#### Data availability

The data is not publicly available. Requests to access the datasets should be directed to In-Hwan Oh/parenchyme@gmail.com.

#### Declarations

#### Human ethics and consent to participate declarations

This study was conducted in accordance with the guidelines proposed by the Declaration of Helsinki (as revised in 2013). This study was exempt from institutional review board approval by the Clinical Research Ethics Committee of Kyung Hee University (IRB number KHSIRB-21-509). No informed consent

was acquired as this study used deidentified public data from the HIRA database.

#### **Consent for publication**

Not applicable.

#### **Clinical trial number**

Not applicable.

#### **Competing interests**

The authors declare no competing interests.

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