Original Article

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Estimating Suicide Mortality in Thailand: A Comparison of Verbal Autopsy Data from 2005 and 2019

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Abstract:

Objective: An accurate cause of death is essential for establishing health planning and policies. Underreporting of suicide deaths has occurred, leading to the use of verbal autopsy to confirm the more accurate cause of death. This study estimated the number and rate of suicide deaths from two verbal autopsy (VA) data sources in 2005 and 2019.

Material and Methods: VA data were obtained from the International Health Policy Program (IHPP), Ministry of Public Health, Thailand, excluding deaths under 10 years, resulting in 9,452 deaths in VA 2005 and 8,848 deaths in VA 2019. A logistic regression was used to estimate the number of deaths. Linear regression was used to identify the patterns of death by age-gender and region.

Results: The suicide death rate among individuals aged 10 years and older increased significantly from 12.74 per 100,000 population in 2005 to 14.95 per 100,000 in 2019. Males, except 10 to 29, had higher rates than the average, with the highest in the 30 to 39 age group. The northern regions reported the highest rates in both 2005 and 2019.

Conclusion: The higher suicide rates observed in 2019 compared with 2005, especially among older individuals and populations in northern regions, highlight the importance of implementing targeted, culturally sensitive intervention strategies.

Keywords: estimated death, reported death, suicide death, triangulation method, verbal autopsy

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Introduction

Suicide is a significant global public health concern and the third leading cause of death among people aged 15–29 years[1]. Globally, there are more than 720,000 suicide deaths every year, with 73% occurring in low– and middle–income countries[1]. Most of the deaths occurred outside the hospital. The reported cause of death is commonly reported by relatives and is likely to be underreported, which is recorded as injury of underdetermined intent or accident to avoid social stigma[2]. Verbal autopsy (VA) is a method to verify the actual cause of death in the absence of valid medical records[3–4]. This method is derived from interviews with family members or caregivers to gather information about the deceased's symptoms and circumstances before death. VA has been employed to improve the accuracy of cause–of–death reporting[5–10].

In Thailand, approximately 70% of deaths occurred outside hospitals in 2022[11]. The suicide mortality rate was 8.8 per 100,000 population in 2019.[12] The validation of VA methods has been performed by several studies[7–9,13]. Thus, VA is considered the method that provides a more reliable and valid cause of death than the reported deaths from the vital registration (VR) database. Using verbal autopsy (VA) data to estimate suicide deaths in Thailand provides a substantial chance to enhance mortality rates, especially for deaths that take place outside of hospitals. Applying VA techniques has been demonstrated to improve the accuracy of mortality data by successfully reclassifying vague causes of death into specific groups. According to Polprasert et al.[14], a significant percentage of deaths in Thailand are not medically confirmed, making this strategy especially pertinent there.

The two latest VA studies were conducted in 2005 and 2019. The use of VA data to validate suicide in VR to estimate the number of suicide deaths and the rates is limited. Thus, this study estimated the number of suicide deaths in Thailand for the years 2005 and 2019 based on VA data to validate the reported deaths in these years. The information from this study will provide a more accurate estimate of suicide mortality, thereby informing public health strategies and interventions aimed at suicide prevention.

Material and Methods

Data source and management

The VA mortality data in 2005 and 2019, collected from 9 provinces, and VR data in 2005 and 2019 were obtained from the International Health Policy Program (IHPP), Ministry of Public Health. The population of Thailand in 2005 and 2019 was downloaded from the Department of Provincial Administration, Ministry of Interior.

The data from the VA data source were obtained by conducting a multistage stratified cluster sample of deaths from Thailand in 2005 and 2019. Two provinces in each of the four regions were sampled, with one province having a death rate greater than the median, one having a death rate less than the median, and Bangkok. The samples of VR 2005 and 2019 were drawn from the mortality database of the Bureau of Policy and Strategy, Ministry of Public Health. The cause of death of each death was assessed through the VA.

Children under the age of ten were excluded from this study. A total of 9,452 and 8,848 deaths from VA in 2005 and 2019, and a total of 382,292 and 488,503 deaths from VR data in 2005 and 2019 were used for further analysis. The population in 2005 and 2019, with 53.55 and 57.65 million, was used as the denominator for calculating mortality rates. The information in the VA data includes age group, gender, province, and suicide mortality from reported VR and suicide mortality verified by the VA method. Information in the VR data consists of gender, age group, province, and suicide death. For both the VA and VR datasets, gender includes male and female. Age was categorized into six categories: 10–29, 30–39, 40–49, 50–59, 60–69, and 70 or older. In the VA data, the causes of death specified in the

VR were categorized into two groups: suicide and other. Figure 1 displays the nine provinces sampled from the VA data in both 2005 and 2019.

Data management was performed. The International Statistical Classification of Diseases and Related Health Problems (ICD-10) of causes of death was grouped into 21 cause groups for VA 2005, and 19 cause groups for VA 2019. The ICD-10 codes for suicide in VA and VR data in the year 2005 are X60 to X84, which are classified as deaths from suicide. Deaths classified under other ICD-10 codes are categorized as deaths from other causes. For VA data in 2019, the cause of death is represented by a code based on the VA standard developed by the World Health Organization[15-16]. Suicide is categorized under the code "VAs 12.08," which corresponds to codes X60 to X84 in the ICD-10 classification. The age and gender were combined to create a new variable named "age-gender". The province was classified into 4 regions: central, north, northeast, and south.

Statistical analysis

Crosstabulations of VA and VR cause-of-death classifications for 2005 and 2019 were constructed, with percentages of VA classifications presented to identify misclassification of suicide as other causes in VR.

The logistic regression for VA data was developed using suicide as a binary outcome. The determinants included gender-age group, province, and the cause specified in VR. The coefficients derived from the logistic model corresponded to nine provinces. The coefficients for 67 provinces in 2005 and 68 provinces in 2019 were interpolated using the triangulation method, as shown in Figure 2. Several studies

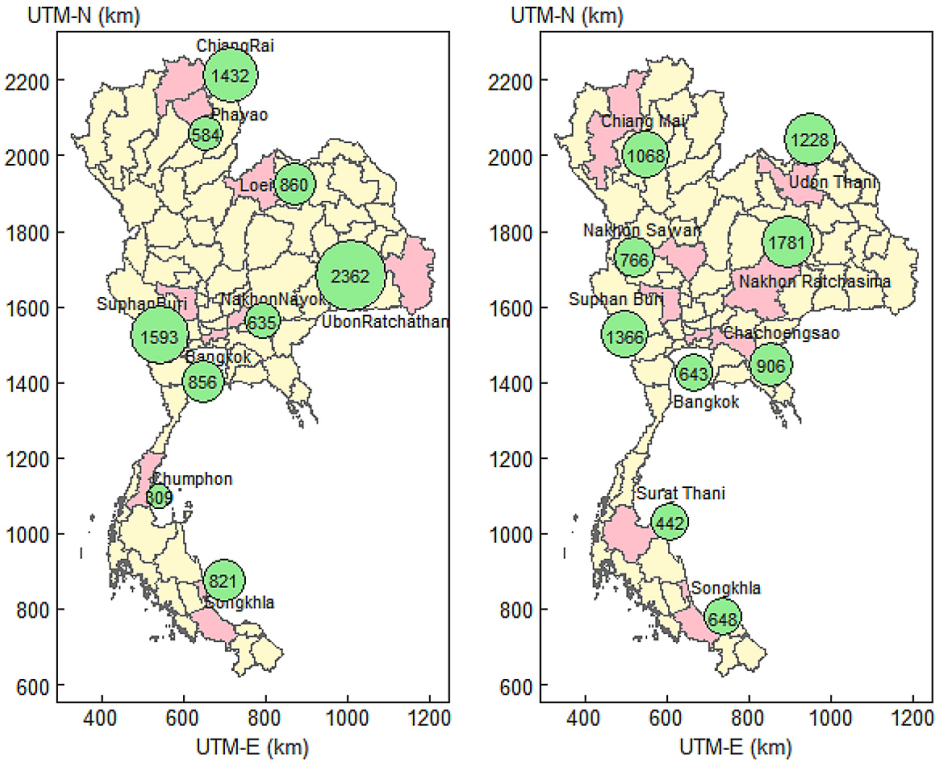

Figure 1 The sample provinces for VA 2005 and VA 2019

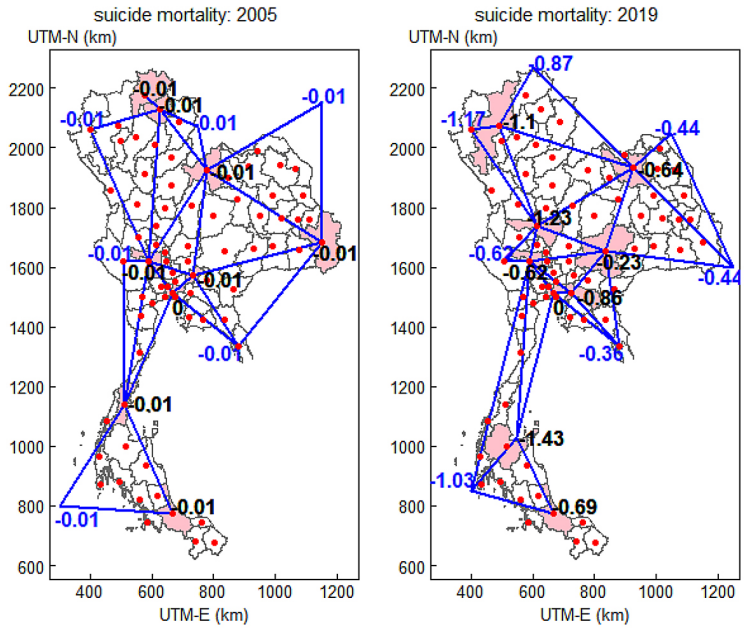

Figure 2 The coefficients from logistic regression for the provinces sample in verbal autopsy (VA) in 2005 and 2019

have explained these methods in detail[7,9]. The estimated number of deaths for the entire province was calculated by gender–age group. The death rate per 100,000 population was determined for both the adjusted number of deaths based on VA data and the unadjusted number of deaths. Estimated and reported numbers of suicide deaths, suicide rates per 100,000 population, and VA:VR inflation factors were calculated for both years. Estimated and reported suicide death rates in 2005 and 2019 were compared using the Mann–Whitney U test.

A linear regression analysis was conducted, using the death rates estimated from triangulation methods as the outcome variable and year, gender–age group, and region as independent variables. Coefficients from the linear model were converted to death rates per 100,000 population. Death rates for 2005 and 2019, and four regions, were presented using 95% confidence interval plots. To examine the spatial distribution of death rates by province, separate linear regression models were fitted for 2005 and 2019, with province included as the independent variable. Model coefficients were classified as below the mean, crossing the mean, or above the mean, and displayed using thematic maps. Differences in estimated death rates between 2019 and 2005 were calculated, categorized into four groups, and visualized on a map. All statistical analyses, graphs, and maps were generated using the R programming language[17].

Results

The crosstabulations between the causes of death reported by VA and VR for the VA data are illustrated in Table 1. In 2005, 57% of deaths classified as suicide by VA were also recorded as suicide in VR, compared with 72.5% in 2019. Misclassification in the opposite direction (other causes in VA recorded as suicide in VR) involved 17 deaths in 2005 and 16 deaths in 2019. The calculated ratio of VA to VR, referred to as the inflation factor, which accounts for underreporting due to suicide deaths being misclassified as other causes, was 1.5 in 2005 and 1.2 in 2019.

Table 2 summarizes the estimated and reported suicide deaths, mortality rates, and VA:VR inflation factors (IF) by age, sex, and region for 2005 and 2019. In 2005, the number of estimated male suicide deaths was highest at ages 30–39, while reported deaths were highest at ages 10–29; among females, both estimates and reports were highest at ages 10–29. In 2019, the number of estimated deaths shifted to males aged 40–49 and females aged 50–59, whereas reported male deaths were highest at ages 30–39 and 50–59 for females. Regionally, the northern region had the highest number of estimated and reported deaths in 2005, while in 2019, the central region had the

Table 1 Crosstabulation of cause-of-death classifications between verbal autopsy (VA) and vital registration (VR) data in 2005 and 2019

Year	VA classification	VR: suicide (%)	VR: Other (%)	Total
2005	Suicide	90 (57.0)	68 (43.0)	158
	Other	17 (100)	0 (0)	17
2019	Suicide	111 (72.5)	42 (27.5)	153
	Other	16 (100)	0 (0)	16

VA=verbal autopsy, VR=vital registration

Table 2 Estimated and reported numbers of suicide deaths, suicide death rates per 100,000 population, and inflation factors (VA:VR) in 2005 and 2019

Variable	Number of deaths in 2005 (death rate/100,000)		Ratio (IF)	Number of deaths in 2019 (death rate/100,000)		Ratio (IF)
	Estimated (VA)	Reported (VR)		Estimated (VA)	Reported (VR)	
Male						
10–29 years	1,690 (17.1)	895 (9.1)	1.89	999 (11.3)	868 (10.3)	1.15
30–39 years	1,703 (32.0)	796 (15.2)	2.14	1,131 (23.8)	1,096 (23.9)	1.03
40–49 years	678 (14.5)	573 (12.9)	1.18	1,212 (24.6)	1,025 (22.3)	1.18
50–59 years	470 (15.8)	350 (12.3)	1.34	1,047 (23.0)	813 (19.2)	1.29
60–69 years	328 (18.4)	211 (13.8)	1.55	938 (32.3)	536 (20.2)	1.75
≥70 years	273 (22.5)	190 (16.7)	1.44	612 (30.4)	399 (21.9)	1.53
Female						
10–29 years	533 (5.8)	218 (2.4)	2.44	175 (2.0)	142 (1.7)	1.23
30–39 years	456 (8.4)	206 (4.0)	2.21	221 (4.4)	184 (3.9)	1.20
40–49 years	105 (2.3)	205 (4.8)	0.51	259 (5.2)	226 (5.0)	1.15
50–59 years	99 (3.2)	122 (3.8)	0.81	306 (6.0)	273 (5.8)	1.12
60–69 years	158 (7.8)	80 (4.0)	1.98	291 (8.5)	170 (5.6)	1.71
≥70 years	85 (4.9)	71 (5.0)	1.20	220 (7.9)	137 (5.9)	1.61
Region						
Central	1,828 (11.8)	1,103 (8.7)	1.66	2,702 (16.3)	1,752 (11.6)	1.54
North	2,798 (23.7)	1,341 (13.9)	2.09	1,580 (17.3)	1,577 (17.1)	1.00
Northeast	1,521 (8.8)	1,055 (5.0)	1.44	2,394 (13.9)	1,773 (9.3)	1.35
South	429 (6.6)	418 (7.2)	1.03	735 (11.1)	767 (11.2)	0.96

p-value^{+1}<0.001, p-value^{+2}=0.014
^{1}=p-value from comparing estimated suicide death rate in 2005 and 2019, ^{2}=p-value from comparing reported suicide death rate in 2005 and 2019, $^{+}$=p-value from Mann-Whitney U test, VA=verbal autopsy, VR=vital registration

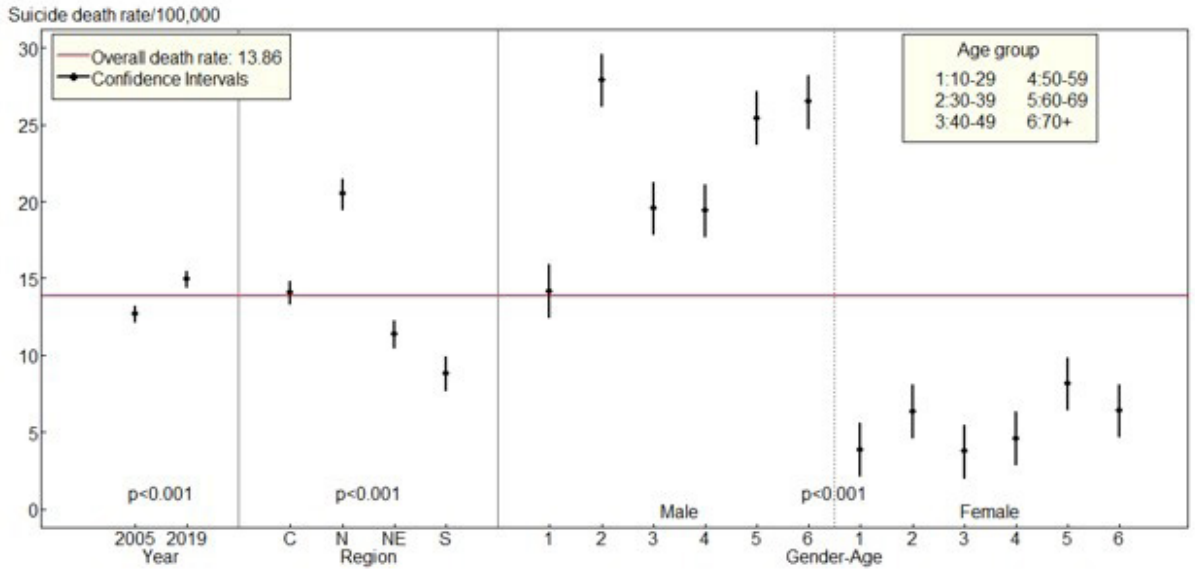

Figure 3 The 95% confidence interval plot of suicide death rates in 2005 and 2019, four regions, and gender–age group

highest number of estimated deaths, and the northeast had the highest reported deaths.

In 2005, reported suicide mortality rates were highest among individuals aged 70 years and older for both sexes; however, VA–adjusted estimates indicated that the highest rates occurred in the 30–39 age group for both sexes. In 2019, reported suicide mortality rates peaked among males aged 30–39 years and females aged 50 years and older, whereas VA–adjusted estimates showed the highest rates among individuals aged 60 years and older for both sexes. Across both study years, the northern region consistently exhibited the highest estimated and reported suicide mortality rates. Although the northeast recorded the lowest reported rates, VA–adjusted estimates identified the southern region as having the lowest suicide mortality rates.

In 2005, VA–to–VR inflation factors exceeded 2 in the northern region among males aged 30–39 years and females aged 10–39 years. By contrast, inflation factors in 2019 were generally lower, although values for both sexes aged 60–69 years approached 2. The estimated suicide death rate in 2019 was significantly higher than that in 2005 (p–value<0.01).

Results from the linear regression model are presented in Figure 3. The horizontal red line represents the overall death rate. The overall suicide death rate was 13.86 per 100,000 population, with rates of 12.74 in 2005 and 14.95 in 2019. The northern region exhibited the highest death rate, whereas the northeastern and southern regions had lower rates than the overall mean, with the lowest rate observed in the southern region.

The suicide death rates by province from VA data in 2005 and 2019, and the changes between the two years are illustrated in Figure 4. In 2005, most provinces with suicide mortality rates above the average were located in northern Thailand. Six northern provinces: Chiang Mai, Chiang Rai, Lamphun, Phrae, Phayao, and Mae Hong Son reported mortality rates exceeding the average. Additionally, Rayong in the central region exceeded the average rate in both 2005 and 2019. Chiang Rai had a higher–than–average mortality rate in 2005, but by 2019, it aligned with the average. In

contrast, Nan and Tak exhibited higher mortality rates than average in 2019, whereas they were not significantly different from the average in 2005. In 2019, Nakhon Ratchasima in the northeast, along with Chonburi, Chanthaburi, and Trat, reported higher mortality rates than the average. Two southern provinces, Phuket and Ranong, had higher mortality rates than the average in 2005; however, by 2019, their rates were not significantly different from the average. The three southernmost provinces (Pattani, Yala, and Narathiwat) consistently had significantly lower death rates than the average for both VA 2005 and 2019. Differences in suicide death rates are illustrated in Figure 4 (right panel). From 2005 to 2019, twenty-two provinces experienced a decrease in suicide death rates, with most of these (15 provinces) located in the northern region, followed by four in the central region, two in the northeast, and one in the southern region. The remaining 55 provinces experienced increases in suicide mortality rates. Among them, twenty provinces recorded increases exceeding 4 per 100,000 population, including ten in the central region (Samut Sakhon, Samut Prakan, Chonburi, Rayong, Chanthaburi, Trat, Sa Kaew, Prachin Buri, Nakhon Nayok and Saraburi), five in the northeast (Sakon Nakhon, Mukdahan, Ubon Ratchathani, Nakhon Ratchasima and Buri Ram), four in the south (Ranong, Phuket, Krabi and Songkhla), and one in the north (Tak).

Discussion

The suicide death rate for individuals aged 10 and older was 12.74 per 100,000 population in 2005 and increased to 14.95 per 100,000 in 2019. The suicide death rate in 2019 was significantly higher than that in 2005. Males, except for those aged 10–29, exhibited higher rates, with the highest in the 30 to 39 age group, while females had lower rates than the overall mean. The northern region reported the highest rates, whereas the southern region had the lowest rates in both 2005 and 2019.

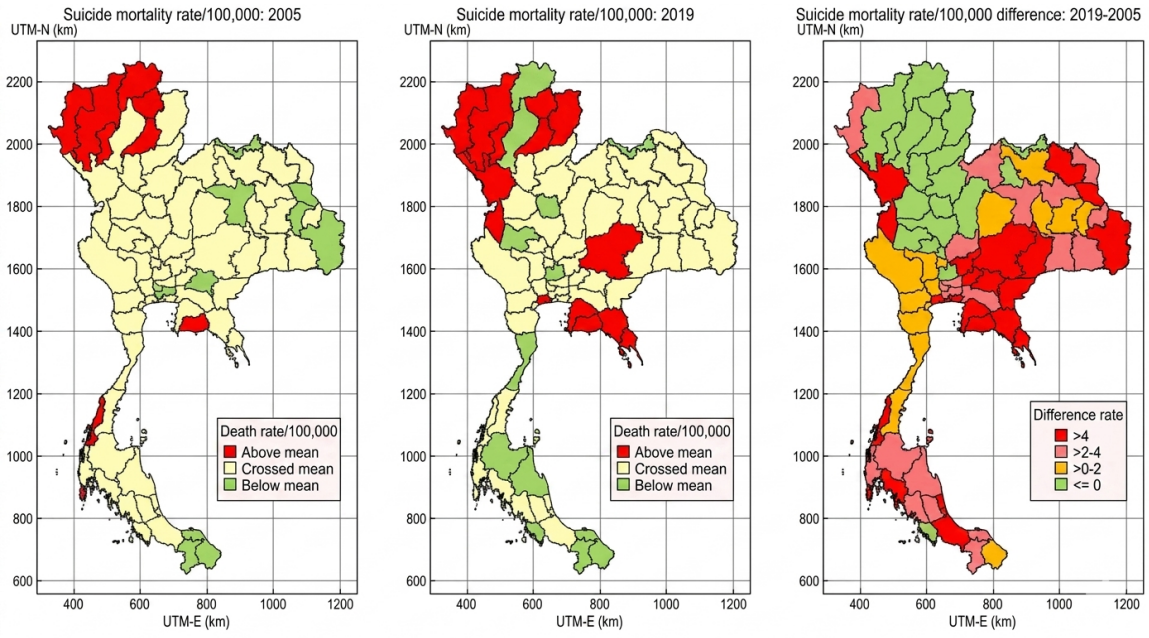

Figure 4 Suicide death rates by province in Thailand from vital registration (VR) data in 2005 and 2019, and the changes between the two years

Suicide death rate revealed the increase from 12.74 per 100,000 in 2005 to 14.95 per 100,000 in 2019 among individuals aged 10 and older. This finding aligns with the research conducted by Arunpongpaisal et al.[12] and Tirapat[18], which reported an increase in the suicide death rate over the year. This upward trend highlights a significant issue that may be linked to mental health challenges, substance abuse[19], economic difficulties, and social inequalities[20].

In our study, suicide was more prevalent among males across nearly all age groups, with the highest in age group 30–39 in 2005 and 60 and older in 2019. Notably, females consistently exhibited lower suicide rates than the overall mean for both 2005 and 2019. Our results support the findings by Arunpongpaisal et al.[12,19]. This indicates that individuals who commit suicide are predominantly males, as they tend to use more lethal methods such as firearms, hanging, drowning, using toxic substances, or jumping from heights, which are generally more effective than the methods typically used by females[12,21].

By 2019, a shift in age-related patterns emerged, with suicide rates increasing with age in both sexes. Our finding is in line with a study conducted by Arunpongpaisal et al.[12,19]. This suggests that older populations have become increasingly vulnerable over time, possibly due to factors like social isolation, chronic illness, or economic instability.

Geographically, the northern region consistently exhibited the highest suicide rates in both 2005 and 2019, while the southern region maintained the lowest. Our findings are consistent with a study conducted by Lotrakul[21], which found that the northern region had the highest suicide rate. However, the southern region, especially in the lower south, reported the lowest suicide death rate. The regional disparities mentioned may indicate differences in socioeconomic status[20], access to mental health services, cultural stigma, religious beliefs, or environmental factors[22]. Increases in suicide death rates from 2005 to 2019 were particularly evident in provinces characterized by urbanization, tourism, or industrial activity, where economic pressures may contribute to increased life stress.

The study has several limitations. The recorded suicide rates may have been affected by changes in death certification and reporting standards for both VA and VR data. The relatively small number of suicide deaths recorded in the VA data, particularly when stratified by age and sex, may have reduced the statistical power and precision of the corresponding estimates derived from the VR data. Although the geographical triangulation technique employed is methodologically sound, it may have further attenuated the variance of the estimates, potentially leading to conservative effect sizes. Additionally, the data used did not include information on mental health issues, health care access, employment rates, economic status, or family support. Future studies should analyze the influence of these risk factors on suicide.

Conclusion

The rising suicide death rate from 2005 to 2019 highlights an urgent and growing mental health crisis that disproportionately impacts specific demographic and geographic groups. The increasing vulnerability of older adults, along with persistently higher rates among males and residents of the northern region, emphasizes the necessity for nuanced, data-driven strategies for suicide prevention. Efforts should focus on enhancing access to mental health care, reducing stigma, and tackling the underlying social and economic factors.

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Conflict of interest

The authors do not have any conflicts of interest to report.

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