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Rising suicide mortality and premature mortality burden in northeastern Iran, 2013–2024: a registry-based repeated cross-sectional study

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Abstract

Purpose

Sub-national trend data combining suicide mortality rates, method lethality, and premature mortality burden remain scarce in the Eastern Mediterranean Region. This study quantified suicide mortality trends, premature mortality burden, and method-specific patterns in northeastern Iran over a 12-year period.

Methods

This registry-based repeated cross-sectional study included all registered suicide deaths (ICD-10 codes X60–X84) among residents aged ≥ 15 years in the Mashhad University of Medical Sciences catchment area, Iran, from 2013 to 2024 (n = 2,352). Crude and age-specific mortality rates per 100,000 were calculated with exact Poisson 95% confidence intervals. Years of potential life lost (YPLL) were computed using life expectancy at birth. Methods were classified as highly violent (X70–X84) or less violent (X60–X69). Temporal trends were estimated using log-linear Poisson regression with population offset; associations between method lethality and demographic factors were assessed with chi-square tests.

Results

Crude suicide mortality rose 76%, from 3.95 to 6.95 per 100,000 (2013–2024; APC 5.6%, 95% CI 4.4–6.9; $p < 0.001$). The 15–24 age group showed the steepest increase (+ 128%). YPLL nearly doubled (165.0 to 305.9 per 100,000; APC 7.0%, 95% CI 5.7–8.3; $p < 0.001$). Men accounted for 75.6% of deaths. Highly violent methods were used in 70.3% of cases, with hanging alone representing 53.0%. Method lethality was significantly associated with sex ($p < 0.001$) and residence ($p < 0.001$).

Conclusion

Suicide mortality in northeastern Iran rose substantially over 12 years, with premature-death burden nearly doubling and increasingly concentrated among young adults. The predominance of hanging underscores the need for targeted prevention, including means restriction, youth-focused interventions, and improved post-discharge follow-up.

Introduction

Suicide accounted for an estimated 727,000 deaths worldwide in 2021, approximately 1.1% of all deaths, and 73% of these occurred in low- and middle-income countries[1]. Between 2000 and 2021 the global age-standardized suicide rate fell by about 35%, and the Eastern Mediterranean Region (EMR) recorded a decline of roughly 30%. These aggregate improvements, however, conceal considerable heterogeneity between and within countries. National averages can mask sub-national populations in which mortality is stable or rising, and it is precisely at that level that prevention services are planned and delivered.

Suicide is disproportionately a cause of premature death. It was the third leading cause of death among people aged 15–29 years globally in 2021, and more than half of all suicide deaths occurred before the age of 50 [1]. Mortality counts alone therefore understate the population impact, and indicators such as years of potential life lost (YPLL) capture the burden more faithfully. Beyond the deaths themselves, suicide imposes substantial economic costs in low- and middle-income settings [2] and is followed by measurably elevated psychiatric and physical morbidity among bereaved relatives [3].

The method used is one of the strongest determinants of whether an act of self-harm proves fatal. Methods are conventionally grouped into highly violent (hanging and other forms of suffocation, firearms, jumping from height, sharp

force injury, self-immolation) and less violent categories, of which self-poisoning by medicines or other substances is the most common [4]. In long-term follow-up of people presenting to hospital after non-fatal self-harm, the method used at the index episode strongly predicted subsequent suicide, with highly lethal methods carrying by far the greatest risk [5]. Consequently, restricting access to lethal means remains one of the best-evidenced components of population-level suicide prevention [6], and surveillance of the method mix is as important for prevention planning as counting deaths.

Iran is one of the few countries in the EMR to have developed a national suicide prevention program, integrated into primary health care since 2010 [7]. Nationally, registered suicidal behavior has increased over the past two decades, although published estimates differ substantially between data sources, reflecting real differences in case ascertainment as well as stigma-related under-reporting [8]. Method use is strongly gendered: Iranian men more often use hanging or sharp force injury, whereas women more often use self-poisoning or self-immolation [9]. Regional burden-of-disease analyses place self-harm rates in the Middle East and North Africa below the global average but with marked variation by country and sex [10, 11], and provincial studies from Fars [12] and southeastern Iran [13] have reported rising trends. What remains scarce are sub-national series that span both the pre-pandemic and post-pandemic years and that combine rate trends with method lethality and premature mortality burden in a single population.

We therefore analyzed 12 consecutive years of death registration data (2013–2024) from the catchment area of Mashhad University of Medical Sciences (MUMS) in northeastern Iran, in order to (i) quantify trends in suicide mortality overall and by age and sex, (ii) describe the burden of premature mortality using YPLL, (iii) examine how method lethality varies by sex, age, and residence, and (iv) map county-level variation to identify areas of concentrated need.

Methods

Study design and setting

This was a registry-based repeated cross-sectional study of all suicide deaths registered over a 12-year period in the population served by MUMS, Khorasan Razavi province, northeastern Iran. The study period covered 21 March 2013 to 20 March 2024, corresponding to the complete Iranian calendar years 1392–1402; throughout this paper each period is labelled by the Gregorian year in which it began.

The MUMS catchment area comprises eleven counties: Mashhad, Chenaran, Binalud, Quchan, Dargaz, Sarakhs, Fariman, Kashmar, Bardeskan, Taybad and Khaf. Counties of Khorasan Razavi served by other medical universities (Sabzevar, Neyshabur, Torbat-e Heydarieh, Torbat-e Jam, Gonabad and Bajestan) lie outside the registration system used here and were not included. The catchment population aged 15 years and over ranged from approximately 3.5 to 3.9 million during the study period. Mashhad, the provincial capital, is the second most populous city in Iran and a major destination for domestic and international religious travel; the area also hosts one of the country's largest Afghan migrant communities and includes several sparsely populated districts on the eastern border. The population is therefore socially and economically heterogeneous, encompassing a large metropolitan centre, rapidly urbanising peri-urban districts and remote rural border areas.

Data sources

Death records were obtained from the MUMS death registration system, the local component of Iran's national system for the registration and classification of causes of death. The system consolidates information from legal medicine (forensic) reports, hospital records, burial permits and death certificates, and assigns an underlying cause of death coded to the tenth revision of the International Classification of Diseases (ICD-10). Suicide deaths were identified by the codes for intentional self-harm, X60–X84. Entry of age, sex, place of residence, date of death and underlying cause is mandatory in the

registration software, so no record was excluded because of missing data on these fields, with the single exception of one decedent for whom sex was not recorded.

Denominators were annual mid-year population estimates disaggregated by age group, sex and county, obtained from the Statistical Centre of Iran. These estimates are anchored on the 2016 national population and housing census, with inter-censal and post-censal years derived from the Centre's official population projections.

Variables and case definition

For every suicide death the following were extracted: age at death in completed years, sex, county of residence, urban or rural residence, and the ICD-10 code for the method of self-harm. Methods were classified into two categories of physical violence following the convention used in earlier registry studies [4]:

- • Less violent methods (X60–X69) — intentional self-poisoning by and exposure to drugs, medicaments and biological substances, pesticides, gases, solvents and other chemical substances.
- • Highly violent methods (X70–X84) — hanging, strangulation and suffocation; drowning; firearms and explosives; smoke, fire and flames; sharp and blunt objects; jumping from a height; jumping or lying before a moving object; crashing of a motor vehicle; and other specified means.

Mortality indicators

Five indicators were computed for each study year. The crude suicide mortality rate was the number of suicide deaths divided by the mid-year population aged 15 years and over, expressed per 100,000. Age-specific rates were calculated for six age bands (15–24, 25–34, 35–44, 45–54, 55–64 and 65 years and over). Proportional mortality was the number of suicide deaths as a percentage of all deaths registered in the same catchment area and year. Years of potential life lost were calculated as $YPLL = \Sigma\ (L - a) \times D_i$, where L is the life expectancy at birth for each year, a is the actual age at death, and Di is the number of deaths at age a; YPLL was expressed per 100,000 population overall and separately for men and women. For this study, life expectancy at birth (L), according to UN World Population Prospects 2024, was used rather than remaining life expectancy at the age of death. This approach aligns with commonly used population-level YPLL methods but may slightly overestimate premature mortality compared with methods using age-specific life expectancy.

Statistical analysis

Categorical variables are summarized as counts and percentages, and continuous variables as mean ± standard deviation. Associations between method lethality and sex, age group, place of residence were assessed with Pearson chi-square tests, using Fisher's exact test where any expected cell count was below five. Ninety-five per cent confidence intervals for annual rates were derived from the exact Poisson distribution.

Temporal trends were quantified by log-linear Poisson regression of the annual number of suicide deaths on calendar year, with the natural logarithm of the corresponding mid-year population entered as an offset. The annual percent change (APC) was calculated as $(\exp(\beta) - 1) \times 100$ with 95% confidence intervals derived from the model standard error, and the adequacy of the Poisson assumption was assessed using the Pearson dispersion statistic, which gave no evidence of over dispersion (dispersion 0.45). Trends in YPLL rates were estimated by log-linear regression of the annual rate on calendar year. The same modelling approach was applied separately within each county, and the resulting annual changes were mapped using ArcGIS (version 10.8.2). All tests were two-sided with $\alpha = 0.05$, and analyses were performed in Stata 18.0. (StataCorp, College Station, TX, USA).

Use of AI-assisted technology

During the preparation of this manuscript the authors used Claude (Anthropic, San Francisco, CA, USA), a large language model, accessed in August and September 2026, for three purposes: checking the internal consistency of the reported results against the source data, checking adherence to the journal's formatting requirements and to the STROBE reporting guideline, and language and grammar editing. The study was conceived and designed, and the data were obtained, analysed and interpreted, by the authors. All stages of the work were carried out by the authors, who verified every figure reported here against the source data, reviewed and edited all AI-assisted output, performed the final review of the manuscript and take full responsibility for the content of the publication.

Result

Characteristics of decedents

A total of 2,352 suicide deaths among residents aged 15 years and over were registered between 2013 and 2024. The mean age at death was 35.9 ± 15.4 years. Sex was recorded for 2,351 decedents, of whom 1,778 (75.6%) were men and 573 (24.4%) were women, a male-to-female ratio of 3.1:1. Urban residents accounted for 1,986 deaths (84.4%) and rural residents for 366 (15.6%), broadly mirroring the urban predominance of the catchment population. The annual number of registered suicide deaths rose from 147 in 2013 to 274 in 2024. The proportion of deaths occurring in women varied between 17.7% (2015) and 31.0% (2024), the latter being the highest value in the series (Table 1).

Table 1
Characteristics of people aged 15 years and over who died by suicide in the Mashhad University of Medical Sciences catchment area, by year, 2013–2024

Year	Deaths (n)	Age at death (mean ± SD*, years)	Men n (%)	Women n (%)	Urban n (%)	Rural n (%)
2013	147	33.6 ± 14.7	111 (75.5)	36 (24.5)	118 (80.3)	29 (19.7)
2014	144	37.2 ± 16.8	112 (77.8)	32 (22.2)	123 (85.4)	21 (14.6)
2015	158	35.6 ± 16.0	130 (82.3)	28 (17.7)	126 (79.7)	32 (20.3)
2016	166	37.5 ± 17.3	131 (79.4)	34 (20.6)	136 (81.9)	30 (18.1)
2017	172	41.5 ± 17.9	125 (72.7)	47 (27.3)	154 (89.5)	18 (10.5)
2018	190	37.2 ± 15.7	137 (72.1)	53 (27.9)	153 (80.5)	37 (19.5)
2019	171	35.9 ± 14.2	127 (74.3)	44 (25.7)	147 (86.0)	24 (14.0)
2020	207	35.7 ± 14.5	153 (73.9)	54 (26.1)	177 (85.5)	30 (14.5)
2021	228	34.7 ± 14.1	173 (75.9)	55 (24.1)	183 (80.3)	45 (19.7)
2022	236	36.1 ± 15.4	186 (78.8)	50 (21.2)	202 (85.6)	34 (14.4)
2023	259	34.4 ± 13.4	204 (78.8)	55 (21.2)	229 (88.4)	30 (11.6)
2024	274	33.6 ± 14.9	189 (69.0)	85 (31.0)	238 (86.9)	36 (13.1)
Total	**2,352**	**35.9 ± 15.4**	**1,778 (75.6)**	**573 (24.4)**	**1,986 (84.4)**	**366 (15.6)**

**Percentages for men and women are calculated among the 2,351 decedents with sex recorded; sex was not recorded for one decedent in 2016. Percentages for residence are calculated among all 2,352 decedents. *SD, standard deviation.*

Trends in suicide mortality

The crude suicide mortality rate increased from 3.95 per 100,000 (95% CI 3.34–4.64) in 2013 to 6.95 per 100,000 (95% CI 6.15–7.82) in 2024, a relative increase of 76%. According to age-specific mortality rate, the rate rose from 3.88 to 7.31 per

100,000, an increase of 88% (Table 2, supplementary Fig.S1). Log-linear Poisson regression gave an annual percent change of 5.6% (95% CI 4.4–6.9; p < 0.001). The rise was close to monotonic, interrupted only by a fall in 2019 (4.71 per 100,000), and it continued without attenuation after 2021; the increase was therefore not confined to the pandemic period.

Table 2
Annual suicide mortality indicators in the Mashhad University of Medical Sciences catchment area, 2013–2024

Year	Population aged ≥ 15 years	All-cause deaths	Suicide deaths	Crude rate per 100,000 (95% CI)	Age-specific mortality rate per 100,000	Proportional mortality (%)	YPLL per 100,000 (total)	YPLL per 100,000 (men)	YPLL per 100,000 (women)
2013	3,723,697	16,947	147	3.95 (3.34–4.64)	3.88	0.87	165.01	238.61	84.15
2014	3,773,043	16,580	144	3.82 (3.22–4.49)	3.82	0.87	147.43	219.46	67.51
2015	3,534,513	17,171	158	4.47 (3.80–5.22)	4.63	0.92	180.17	273.70	74.86
2016	3,612,530	17,564	166	4.60 (3.92–5.35)	4.78	0.95	178.65	255.98	87.68
2017	3,562,680	19,826	172	4.83 (4.13–5.61)	5.04	0.87	170.19	242.42	89.13
2018	3,573,471	19,240	190	5.32 (4.59–6.13)	5.45	0.99	209.97	278.76	132.19
2019	3,632,468	20,022	171	4.71 (4.03–5.47)	4.65	0.85	193.30	259.84	118.17
2020	3,655,918	26,870	207	5.66 (4.92–6.49)	5.75	0.77	217.75	304.59	120.79
2021	3,702,318	30,663	228	6.16 (5.38–7.01)	6.10	0.74	241.67	340.53	132.01
2022	3,687,729	21,093	236	6.40 (5.61–7.27)	6.40	1.12	250.68	368.48	120.20
2023	3,886,343	20,962	259	6.66 (5.88–7.53)	6.71	1.24	288.36	418.78	144.66
2024	3,944,592	21,877	274	6.95 (6.15–7.82)	7.31	1.25	305.91	426.80	209.70

Crude rates are per 100,000 population aged 15 years and over, with exact Poisson 95% confidence intervals. Proportional mortality is suicide deaths as a percentage of all registered deaths in the same year. Annual percent change in the crude rate, from log-linear Poisson regression with a population offset, was 6.1% (95% CI 4.9–7.3; p < 0.001); the corresponding annual percent change in total YPLL was 7.0% (95% CI 5.7–8.3; p < 0.001). CI, confidence interval; YPLL, years of potential life lost.

Proportional mortality due to suicide rose from 0.87% of all registered deaths in 2013 to 1.25% in 2024. This indicator fell transiently to 0.77% in 2020 and 0.74% in 2021, but this reflects the denominator rather than the numerator: all-cause deaths in the catchment area rose to 26,870 and 30,663 in those two years, compared with approximately 17,000 to 20,000 in adjacent years, during successive waves of COVID-19 mortality. Suicide deaths themselves increased in both years.

Age-specific patterns

The 15–24year age group recorded the highest mortality rate in most study years and by far the steepest increase, from 5.76 per 100,000 in 2013 to 13.11 per 100,000 in 2024, a rise of 128% (Table 3). Rates in the 25–34 group also increased substantially, from 3.10 to 8.02 per 100,000. In contrast, rates in the 55–64 and 65 years and over groups fluctuated without a consistent direction. Averaged across the study period, mean annual rates were 7.18 per 100,000 at ages 15–24, 5.27 at 25–34, 5.32 at 35–44, 4.90 at 45–54, 4.02 at 55–64 and 4.10 at 65 years and over; the mean rate in the oldest group was thus 43% lower than in the youngest.

Table 3
Mortality Rate per 100,000 Population by Age Group (2013–2024)

Age group (years)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
15–24	5.76	3.54	5.43	5.31	3.62	6.96	5.43	8.38	8.80	9.17	10.68	13.11	86.19
25–34	3.10	4.09	3.68	3.83	4.71	5.01	5.33	4.88	6.76	6.93	6.91	8.02	63.25
35–44	4.57	4.28	4.57	3.79	4.98	4.49	5.31	6.73	6.68	6.01	6.69	5.75	63.85
45–54	3.22	2.51	4.69	5.85	5.94	6.48	4.23	3.72	5.12	5.33	5.92	5.78	58.79
55–64	2.96	3.58	4.99	4.71	4.66	4.26	3.24	5.49	2.78	4.31	4.05	3.16	48.19
65-max	2.24	5.18	4.52	5.81	7.86	4.68	2.74	3.56	3.13	4.06	2.17	3.19	49.14

Premature mortality burden

Suicide accounted for 95,550 years of potential life lost over the twelve years, 74.2% of them among men. Years of potential life lost to suicide rose from 165.0 per 100,000 in 2013 to 305.9 per 100,000 in 2024, an increase of 85%, corresponding to an annual percent change of 7.0% (95% CI 5.7–8.3; $p < 0.001$). YPLL was higher in men than in women in every year of the series, peaking at 426.8 per 100,000 for men in 2024 and at 209.7 per 100,000 for women in 2024. However, the female YPLL rate rose considerably faster than the male rate (APC: 8.6% vs. 5.4%), increasing from 84.15 to 209.70 per 100,000 among women and from 238.61 to 426.80 per 100,000 among men over the study period. This suggests a narrowing of the gender gap in premature mortality from suicide (Table 2).

Method lethality

In this sample, highly violent methods accounted for 1,653 deaths (70.3%) and less violent methods for 699 (29.7%). Hanging, strangulation and suffocation (X70) alone accounted for 1,246 deaths, 53.0% of all suicide deaths and three-quarters of those by highly violent means. The next most frequent methods were poisoning by unspecified drugs and medicaments (X64, 11.1%) and by narcotics and psychodysleptics (X62, 6.5%). The share of deaths involving highly violent methods showed no significant linear trend across the study period (− 0.8 percentage points per year, $p = 0.33$), so the rise in mortality cannot be attributed to a shift towards more lethal means (Supplementary Fig.S2).

both sex and place of residence were significantly associated with the violence level of suicide methods. Highly violent methods were used more frequently by men than women (73.9% vs 59.2%; $\chi^2 = 44.73$, $df = 1$, $p < 0.001$) and by urban rather than rural residents (68.7% vs 78.7%; $\chi^2 = 14.67$, $df = 1$, $p < 0.001$). On the other hand, because 84.4% of all decedents were

urban residents, the fact that 82.6% of highly violent deaths occurred in urban areas does not indicate an urban excess; within residence strata, the proportion of highly violent deaths was in fact higher in rural areas (78.7%) than in urban areas (68.7%). These findings indicate that male sex and rural residence are associated with a greater likelihood of employing highly violent suicide methods. It also varied by age ($\chi^2 = 14.18$, df = 5, $p = 0.015$), being lowest among those aged 65 years and over, although highly violent methods still accounted for the majority of deaths in that group (56.9%), and highest at ages 25–34 (72.3%) (Fig. 1). Overall, 70.3% of suicides involved highly violent methods.

Geographic variation

County-level analysis showed increasing suicide mortality rates in ten of the eleven counties, with statistically significant increases in five: Mashhad, Chenaran, Quchan, Sarakhs and Khaf (all $p < 0.05$). The steepest annual increases were recorded in Sarakhs (+ 0.89 per 100,000 per year) and Chenaran (+ 0.85 per 100,000 per year). Dargaz was the only county to show a decline, which was small and not statistically significant (− 0.09 per 100,000 per year) (Fig. 2).

Discussion

In this population of approximately 3.9 million adults in northeastern Iran, suicide mortality rose by 76% in crude terms and by 88% after age specification over twelve years, an average of 5.6% per year with no sign of levelling off. Our findings are consistent in direction with provincial Iranian studies, including analyses from Fars province [12] and southeastern Iran [13], suggesting that the drivers of rising suicide mortality are not local to one region. In absolute terms the rate we observed is close to, rather than above, national estimates: Iran's Legal Medicine Organization registered 6,244 suicides nationally in 2021, equivalent to 7.43 per 100,000 population of all ages [7], whereas our 2024 rate of 6.95 per 100,000 applies to the population aged 15 years and over and would correspond to a lower all-age figure. The concern raised by these data is therefore the direction and steepness of the trend rather than an exceptional absolute level. Part of the increase may reflect improving completeness of death registration and cause-of-death coding over the study period, a possibility that cannot be excluded and that has been highlighted in comparisons of Iranian suicide data sources [8].

The concentration of risk in young adults is the most striking feature of these data. The rate at ages 15–24 more than doubled, and this group carried the highest rate in most years, in contrast to settings such as Brazil where suicide rates are highest in older adults [14], and to the age-progressive pattern seen in many global burden-of-disease analyses. However, the simultaneous increase in YPLL and stability in mean age at death suggests a bipolar shift in the age distribution of suicide deaths: a disproportionate rise among younger age groups (driving YPLL upward) alongside an increase among older adults (preventing a decline in mean age). This pattern indicates a widening of the age range affected by suicide, rather than a simple shift toward younger or older ages. Also, our findings are consistent with post-pandemic evidence of rising suicidal behavior among adolescents and young adults elsewhere, including the United States [15]. The pressures plausibly relevant to young and older Iranian adults — educational competition, constrained labour-market entry, the rising cost of housing and marriage, economic contraction and intensive social-media exposure — could not be measured in these registry data, and identifying their relative contribution is a priority for further work.

The male-to-female ratio of 3.1:1 is consistent with the well-described gender paradox in suicidal behaviour, in which women report more non-fatal self-harm while men account for the majority of deaths [16]. Our data indicate that differential method lethality contributes to this pattern, with highly violent methods used in 64.1% of male and 52.2% of female deaths. Two observations nevertheless suggest that the gap may be narrowing: YPLL rose considerably faster in relative terms among women than men, and the female share of registered suicide deaths reached its highest value of the series (31.0%) in the final year. Sex-specific monitoring and prevention responses are therefore warranted rather than a single, undifferentiated strategy.

The dominance of hanging is the single most important finding for prevention. It accounted for 53.0% of all suicide deaths, and the share of deaths by highly violent means showed no significant trend over the period, so the rise in mortality reflects

an increase in the number of suicidal acts rather than a shift towards more lethal means. Because the lethality of the method largely determines whether an episode of self-harm ends in death [5], a method mix that shifts towards hanging and other highly violent means will raise mortality even if the underlying frequency of self-harm is unchanged. Means restriction is among the most robustly supported population interventions [6], but it is intrinsically more difficult to implement for hanging than for pesticides or medicines. Where highly violent methods dominate, prevention must lean correspondingly more on early identification of people at risk, accessible crisis response and systematic follow-up after any presentation for self-harm, given that the index method is itself a strong predictor of subsequent suicide [4]. We would caution against interpreting the association between method lethality and residence as evidence of an urban excess of violent methods: it is explained by the urban composition of the population, and within residence strata the share of highly violent deaths was in fact somewhat higher in rural districts, where secure storage of pesticides and firearms remains a tractable target.

Suicide mortality accelerated during 2020 and 2021, consistent with meta-analytic evidence of increased suicidal behaviour during the COVID-19 pandemic attributed to prolonged restrictions, social disconnection, health anxiety and bereavement [17]. The rise in our data, however, both preceded and outlasted the pandemic, so structural rather than purely pandemic-related determinants are implied. The transient fall in proportional mortality during those two years is a useful reminder that proportional indicators are sensitive to changes in all-cause mortality and should not be read as a decline in suicide risk.

Depression remains the most intensively studied clinical risk factor, but the pooled predictive strength of depression and hopelessness for suicide death in longitudinal studies is modest (weighted odds ratio approximately 1.3) [18], which underlines that clinical screening alone cannot carry a prevention strategy and must be combined with population-level measures. This does not diminish the importance of treating depressive disorders, which carry substantially elevated all-cause and cause-specific mortality [19]. Regional analyses of the burden of self-harm and of mental disorders in the Middle East and North Africa provide the wider context within which these national and sub-national trends should be interpreted [10, 11].

The near-doubling of YPLL quantifies a societal cost that death counts alone do not convey, and is consistent with earlier national analyses of years of life lost to suicide in Iran [20]. Suicide deaths concentrated in early adulthood remove people from the workforce at the start of their productive lives, impose long-term economic costs in low- and middle-income settings[21], and leave bereaved relatives at measurably increased risk of psychiatric and physical illness[22]. The significant county-level increases we identified include both rapidly urbanising districts adjacent to Mashhad (Chenaran, Binalud) and sparsely populated eastern border counties (Sarakhs, Khaf, Taybad), which differ markedly in their service infrastructure and social profile and are unlikely to respond to a single, uniform intervention.

Strengths and limitations

The principal strengths of this study are its completeness and duration. It covers every registered suicide death in a defined population of nearly four million adults across twelve consecutive years, drawn from a single registration system with mandatory core fields and consistent ICD-10 coding, and it spans both the pre-pandemic and post-pandemic periods. Combining rate trends, method lethality and YPLL within one population allows the epidemiological picture to be assessed more completely than by counts alone.

Several limitations should be borne in mind. First, suicide is under-ascertained in most registration systems, and social and religious stigma in Iran makes misclassification as accidental or undetermined death likely; under-ascertainment may also be differential, affecting self-poisoning and self-immolation more than hanging, and women more than men. The absolute rates reported here should therefore be regarded as lower bounds, and if registration completeness improved over the study period some part of the observed trend would be attributable to better ascertainment rather than to a genuine increase in risk. Second, the registry holds no individual-level data on psychiatric history, previous self-harm, employment, marital status, substance use or physical illness, so we could not examine determinants and no causal inference is

possible; psychological autopsy studies would be far better suited to that question. Third, denominators rely on inter-censal and post-censal projections, and administrative changes to catchment boundaries during the period introduce some year-to-year instability into the rates. Fourth, method coding in the first study year appears incomplete: only 4.8% of deaths in 2013 were coded to self-poisoning, against 25–40% in every subsequent year, which almost certainly reflects under-coding rather than a real change, and comparisons of the method mix involving 2013 should be treated with caution. Fifth, the registry does not record nationality, so we could not examine suicide among the large migrant population in the catchment area, and the binary classification of methods, while useful for describing lethality, obscures distinctions between specific means that matter for intervention design. Sixth, the use of crude mortality and YPLL rates represents an important limitation. Because age-standardized population denominators were not available for all provinces and years, age-standardized mortality rates could not be calculated. Seventh, county-level estimates in the less populous districts rest on small numbers and should be interpreted cautiously. Finally, the study describes one region and its generalisability to other Iranian provinces is uncertain.

Implications

Implications

These findings support a prevention response that is locally targeted rather than uniform, and that is weighted towards young people. Priorities include strengthening the delivery of Iran's existing national suicide prevention programme within primary health care in the counties showing significant increases; gatekeeper training and mental-health literacy programmes in schools and universities; systematic, protocol-driven follow-up of every person presenting to health services after self-harm; culturally adapted means restriction, including secure storage of pesticides in rural districts and controls on access to highly lethal medicines; and safe media reporting practices, which are of particular importance where hanging predominates. Improving the completeness and accuracy of suicide registration is a precondition for evaluating any of these measures.

Conclusion

Suicide mortality in northeastern Iran increased steadily and substantially between 2013 and 2024, at a time when global and regional age-standardised rates were falling. The burden of premature death rose by 76%, and the steepest relative increase in mortality was among people aged 15–24 years, while hanging accounted for more than half of all deaths. Sustained, locally targeted and youth-focused prevention, together with better death registration, is needed if this trajectory is to be reversed.

Declarations

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki and its later amendments. Approval was granted by the Ethics Committee of Mashhad University of Medical Sciences (approval code IR.MUMS.FHMPM.REC.1404.220).

Data availability

The data that support the findings of this study were obtained under licence from the death registration system of Mashhad University of Medical Sciences and are not publicly available because of registry restrictions and confidentiality requirements. Aggregated data underlying the tables and figures are available from the corresponding author on reasonable request and with the permission of the registry custodian. The data usage policy of the registry was fully adhered to.

Author Contribution

Conceptualisation: KS, EMF. Methodology: KS, EMF. Formal analysis and investigation: KS. Data curation: EMF. Writing — original draft preparation: KS. Writing — review and editing: EMF. Funding acquisition: EMF. Supervision: EMF. Both authors read and approved the final manuscript.

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Figures

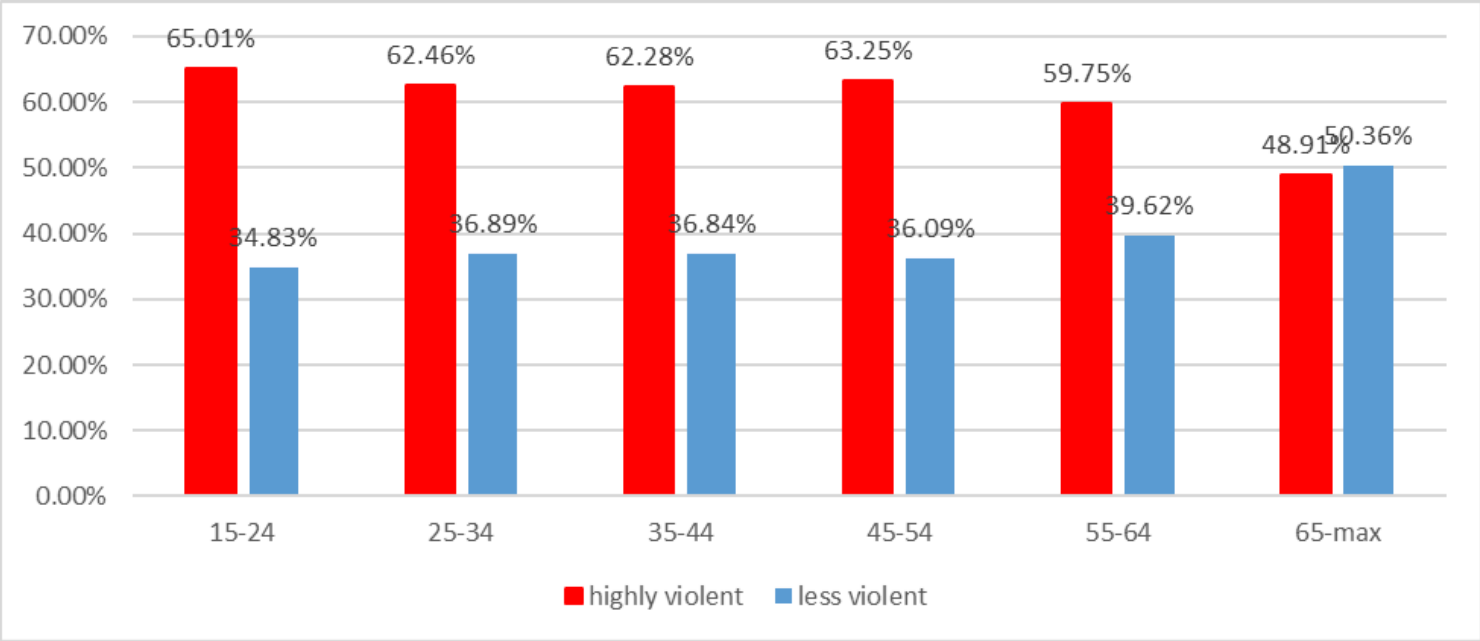


Figure 1

Distribution of suicide method violence severity across age groups, Mashhad University of Medical Sciences catchment area, 2013–2024

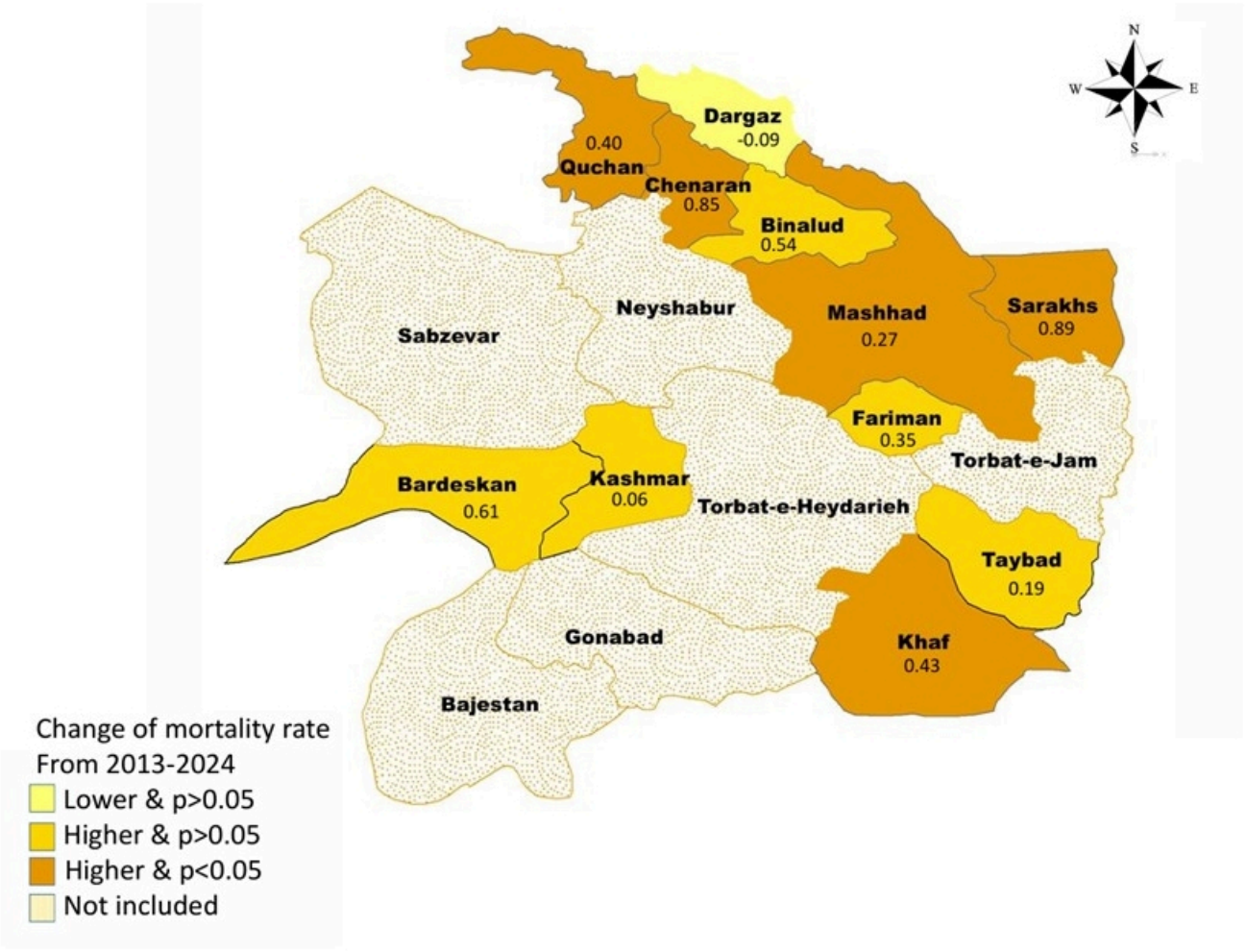


Figure 2

Suicide mortality rate by county in Khorasan Razavi province, Mashhad University of Medical Sciences catchment area, 2013–2024. Values within each county give the change in the mortality rate over the 12-year study period (2013–2024). Shading indicates the direction and statistical significance of the change ($p<0.05$ vs. $p>0.05$); counties of Khorasan Razavi province that lie outside the catchment area are stippled and were not included in the analysis. The map was produced in ArcGIS.

Supplementary Files

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