



## Risk Prediction of Fatal Suicide in Ilam Province, Iran

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### Abstract

**Background:** Suicide is a major public health challenge, with Ilam province in Iran exhibiting a concerning upward trend and one of the highest rates in the country.

**Objectives:** This study aimed to determine the prevalence of fatal suicide in Ilam province and to develop and validate a multivariable predictive model to identify individuals at high risk.

**Methods:** This retrospective case-control study included all fatal suicide cases recorded by the Legal Medicine Organization from May 2024 to June 2025. Age- and gender-matched controls were selected from the primary health care registry. A multivariable logistic regression model was constructed, and its performance was evaluated using the Area Under the Curve (AUC) and the Hosmer-Lemeshow test.

**Results:** The incidence rate of fatal suicide was 18.1 per 100,000 population (95% CI: 14.7 - 21.4). The final model identified a history of psychiatric disorder (OR = 2.7), unemployment (OR = 1.9), and a family history of suicide (OR = 2.1) as significant predictors. The model demonstrated excellent discrimination (AUC = 0.81) and good calibration (Hosmer-Lemeshow P = 0.48).

**Conclusions:** The high incidence of suicide in Ilam necessitates targeted interventions. The validated model provides a robust, evidence-based tool for the early identification of high-risk individuals, which can guide preventive strategies and optimize resource allocation.

**Keywords:** Suicide, Risk Factors, Mortality, Mental Disorders

### 1. Background

Suicide is a critical public health challenge globally, threatening lives and impacting families and communities (1). The World Health Organization (WHO) identifies suicide as a leading cause of death among youth, particularly in regions with socioeconomic challenges (2, 3).

In Iran, suicide patterns vary significantly by province. Ilam province, however, presents a critical case study. As a border region, it faces a distinct combination of severe economic deprivation, one of the nation's highest unemployment rates, and unique socio-cultural pressures rooted in its tribal structures and border dynamics. This specific context has resulted in Ilam

consistently reporting one of the highest suicide mortality rates in the country (4), rendering national-level prevention strategies insufficient and creating an urgent need for a localized, evidence-based risk model. Recent data from the Legal Medicine Organization confirm an alarming upward trend in Ilam (5), raising serious concerns for policymakers and healthcare providers (6). This trend suggests that current preventive measures are insufficient (7) and reflects a complex interplay of individual, structural, and social factors, including high rates of poverty, unemployment, and inadequate mental health services, which create a distinct risk environment not fully captured by national-level data (8, 9).

Previous regional research has often been limited to descriptive epidemiology, such as studying suicide by specific methods (10), lacking comprehensive models that integrate clinical and socioeconomic factors. Although some efforts have been made to document suicide causes (11), a critical gap remains in developing predictive tools for risk stratification. Furthermore, most existing risk models, often developed in Western or other Iranian contexts (12), may possess limited external validity in deprived regions like Ilam. They frequently fail to account for local cultural constructs and social stigma. Therefore, there is an urgent clinical and public health imperative to move beyond descriptive analysis and develop a predictive model tailored to the specific context of Ilam province.

## 2. Objectives

This study has two primary objectives. First, to determine the current incidence rate of fatal suicide in Ilam province. Second, to develop and validate a multivariable predictive model capable of identifying the most significant local risk factors. The ultimate goal is to provide a practical, evidence-based tool for primary healthcare providers to facilitate early risk stratification and guide targeted preventive strategies.

## 3. Methods

This retrospective case-control study investigated all confirmed fatal suicide cases among residents of Ilam province, as registered by the Legal Medicine Organization between June 2024 and June 2025. A census approach was used for cases. A control group was selected from the same source population. For each case, two controls who were alive during the study period were selected using frequency matching based on gender and age group (5-year strata). Frequency matching was performed solely on gender and 5-year age strata. Controls were selected from the same source population and were not excluded based on psychiatric history or other medical conditions, in order to minimize the risk of selection bias and ensure representativeness of the general population. The final sample included 112 cases and 208 controls.

Data on demographic, socioeconomic, and clinical variables were extracted from standardized post-mortem files maintained by the Legal Medicine Organization for all cases, and from the SIB-based Primary Health Care Information System (PHC/HIS) for

controls. Both datasets were independently retrieved by two trained research assistants under the supervision of the principal investigator, using a standardized checklist to ensure consistency and comparability between groups.

A complete case analysis (listwise deletion) was employed for the multivariable logistic regression, as missing data were minimal (<5%).

Descriptive statistics were used to summarize population characteristics. Chi-square tests and *t*-tests were used for bivariate comparisons. Although the study utilized a matched design, an unconditional logistic regression model was employed instead of a conditional one. This approach was chosen because frequency matching (rather than individual matching) was used, and the matching variables (age and gender) were included as covariates directly in the model to control for their potential confounding effects. Model performance was assessed using the area under the receiver operating characteristic curve (AUC) for discrimination and the Hosmer-Lemeshow test for calibration. All analyses were performed using SPSS version 26 and Stata version 15. The study was approved by the Ethics Committee of Ilam University of Medical Sciences ([IR.MEDILAM.REC.1404.081](https://IR.MEDILAM.REC.1404.081)).

## 4. Results

The incidence rate of fatal suicide in Ilam province was found to be 18.1 per 100,000 population (95% CI: 14.7 - 21.4). The mean age was similar between cases ( $31.7 \pm 13.5$  years) and controls ( $32.9 \pm 12.1$  years). As shown in Table 1, significant differences were observed across several key characteristics. Single individuals were more prevalent in the case group (57.1%) compared to controls (43.3%), and lower educational attainment was more common among cases (56.2% vs. 44.2%).

Furthermore, unemployment was significantly higher in the case group (63.4%) than in controls (41.8%). A history of psychiatric disorder, a family history of suicide, and substance or alcohol use were also all significantly more common among fatal suicide cases compared to the control group ( $P < 0.001$  for all). The most common methods of suicide were drug/poisoning (35.0%), hanging (27.0%), and self-immolation (20.5%).

The final multivariable logistic regression model identified three strong independent predictors of fatal suicide: A history of psychiatric disorder ( $OR = 2.7$ ), unemployment ( $OR = 1.9$ ), and a family history of suicide

**Table 1.** Comparison of Demographic, Socioeconomic, and Clinical Characteristics of Study Population <sup>a</sup>

Characteristic	Cases (n = 112)	Controls (n = 208)	P-Value
<b>Demographics</b>			
Age	31.7 ± 13.5	32.9 ± 12.1	0.42
Male	59.8	58.2	0.78
Single	57.1	43.3	0.02
Urban residence	67.9	70.7	0.64
Diploma or lower	56.2	44.2	0.03
<b>Predictive factors</b>			
Unemployed	63.4	41.8	< 0.001
History of psychiatric disorder	41.0	18.8	< 0.001
Family history of suicide	20.5	8.2	0.001
Substance/alcohol use	25.9	11.5	< 0.001

<sup>a</sup>Values are expressed as percent or mean ± SD.

(OR = 2.1). Male gender showed a borderline significant association with increased risk. The complete regression estimates are presented in Table 2. The model demonstrated strong predictive performance with an AUC of 0.81, indicating excellent discrimination, and good calibration confirmed by a non-significant Hosmer-Lemeshow test (P = 0.48).

## 5. Discussion

This study's primary contribution is a validated, localized risk prediction model for fatal suicide in Ilam province, a region with a disproportionate health burden. A key strength is its use of verified data from the Legal Medicine Organization for all fatal cases. The model identified a history of psychiatric disorder as the most significant predictor, which is consistent with national and international research and reinforces findings from other studies in western Iran (8). Notably, substance or alcohol use, despite being significant in the univariate analysis (Table 1), was excluded from the final multivariable model. This decision was made due to its strong collinearity with a history of psychiatric disorder; as the latter demonstrated a more robust and independent predictive power, it was retained to ensure a more parsimonious and stable model. This underscores the urgent need to integrate mental health services into regional suicide prevention strategies.

Unemployment also emerged as a powerful predictor, a finding supported by recent studies in the region (7). This association likely reflects not just financial hardship but also the resulting social isolation

and diminished sense of purpose, creating a powerful pathway to despair. Our model quantifies this risk, providing actionable evidence for policymakers. This underscores the necessity of context-specific models, as risk factors can vary significantly across different cultural and national settings.

A family history of suicide was another key risk factor, aligning with previous work that identified this link through registry data (11). This confluence of economic and social factors is further corroborated by advanced machine learning analyses in western Iran, which found income level to be a top determinant of suicide fatality (13). Male gender was also associated with a higher risk, a pattern consistent with other local studies in Ilam that have linked male gender to more violent and lethal suicide methods (14). This finding also aligns with broader research in southern Iran (15). The statistical performance of our model (AUC = 0.81) is robust and comparable to other regional models that used more complex techniques (5), confirming the utility of logistic regression for risk stratification.

Furthermore, the consistency of our identified risk factors (psychiatric, economic, familial) with findings from diverse Iranian provinces like Kerman (16) and other parts of western Iran (11, 13) highlights a potential nationwide pattern, which aligns with large-scale global analyses (17).

From a policy perspective, this model offers a pragmatic triage tool. Primary healthcare providers can be trained to screen for this trio of risk factors – psychiatric history, unemployment, and family history of suicide – during routine visits. This would allow for a

**Table 2.** Determinants of Fatal Suicide Estimated by Multivariable Logistic Regression Model

Variable	OR	95% CI	P-Value
History of psychiatric disorder	2.7	1.4 - 5.1	< 0.01
Unemployment	1.9	1.1 - 3.4	0.02
Family history of suicide	2.1	1.07 - 4.53	0.001
Male gender	1.6	0.94 - 2.8	0.074
Age	1.03	0.99 - 1.06	0.112
Bachelor's degree or higher	0.91	0.48 - 1.73	0.782
Urban residence	1.05	0.57 - 1.93	0.868

Abbreviation: OR, odds ratio; CI, confidence interval.

more targeted and cost-effective allocation of scarce mental health resources.

Limitations of this study include its retrospective case-control design, which precludes definitive causal inference, and potential under-reporting in official data. Future research should focus on the external validation of this model in similar provinces. Moreover, prospective cohort studies are needed to track the trajectory of at-risk individuals, and qualitative research is crucial to unpack the cultural mechanisms behind “family history” as a risk factor. For instance, a recent qualitative study conducted in Ilam explored the perspectives of families and highlighted that “Family and marital conflicts” and “social stressors” were central themes perceived as contributors to suicide (18), suggesting that the “family history” variable in our model may act as a proxy for a complex web of inherited or shared familial and social vulnerabilities.

Nonetheless, this model provides an evidence-based foundation for implementing effective community-level interventions in Ilam. Moving forward, while our model provides a tool for identification, effective prevention will require multidimensional interventions. As systematic reviews in the field suggest, future strategies should look beyond traditional approaches and incorporate novel methods such as eHealth applications and greater parental involvement, calling for more advanced and theoretically grounded preventive programs (19).

## Footnotes

**AI Use Disclosure:** The authors declare that no generative AI tools were used in the creation of this article.

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**Conflict of Interests Statement:** The authors declare no conflict of interests.

**Data Availability:** The dataset presented in the study is available on request from the corresponding author during submission or after publication.

**Ethical Approval:** This study was approved by the Ethics Committee of Ilam University of Medical Sciences, Ilam, Iran (ethics code: IR.MEDILAM.REC.1404.081). All procedures performed in this study were in accordance with the ethical standards of the institutional research committee and the 1975 Helsinki Declaration and its later amendments.

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