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Assessment and analysis of factors influencing suicidal ideation in young adults: a large cohort study using an elastic network logistic regression model

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Abstract

Objectives This study aims to review and analyze factors associated with suicidal ideation to provide a rationale for subsequent effective interventions.

Methods Data from this study were obtained from the Assessing Nocturnal Sleep/Wake Effects on Risk of Suicide (ANSWERS). The University of Arizona evaluated 404 young adults aged 18–25 years using different scales. Then, general demographic data was recorded. An elastic network (EN) was used to optimize feature selection, combined with logistic regression, to determine the influencing factors associated with SI in young adults.

Results The EN regression retained 11 potential influencing factors with nonzero coefficients. In the multivariate logistic regression analysis, INQ-15 perceived burdensomeness (PB) scores (OR: 1.10, 95% CI: 1.04–1.17), CESD depression mood scores (OR: 1.16, 95% CI: 1.07–1.26), and age (OR: 0.72, 95% CI: 0.55–0.94) were significant factors for SI.

Conclusions This is the first study to use an Elastic Network logistic regression model to assess the factors affecting suicidal ideation in young adults. Perceived Burdensome, depression, and age play an important risk role and are the best predictor combination of suicidal ideation in young adults, with depression being the most significant risk factor. Increased focus on Perceived Burdensome and negative emotions, along with simultaneous interventions for other potentially influential factors, can be more effective in preventing suicidal behavior in young adults.

Keywords Suicidal ideation, Young adults, Elastic network, Depression, Perceived burdensomeness, Nomogram

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Introduction

Suicide among young adults is a serious public health issue. While significant differences in suicide rates are observed across countries, young adults were consistently found to be overrepresented in these statistics [1]. Over 800,000 people die from suicide worldwide each year. Suicide accounts for 1.4% of global deaths. Among youth aged 15–29 years, suicide was the second leading cause of death [2]. Suicide is defined as the behavior of deliberately ending one's life [3]. There are three specific forms, namely, suicidal ideation (SI), suicide attempt, and suicide completion [3–5]. The strongest predictor of attempted suicide and suicide death is SI, which is an individual's current desire and plan to commit suicide without any actual attempt [3–5]. The lifetime prevalence of SI for young adults is estimated to be 12.1–37.9% [6, 7]. Not only does suicide have serious physical and emotional effects on individuals, but it also causes great economic losses to society [8]. Increasing attention to young adults' SI, timely assessment, and early intervention are important to reduce their suicidal behavior effectively.

SI causes are complex and are the result of the interaction of multiple factors [9]. Social factors are strong predictors of SI, such as age, gender, sexual orientation, education, income, and substance abuse [10, 11]. Most studies identified age as a risk factor for SI [12, 13], owing to the dramatic physical and mental changes and immature psychological development in young adults [14]. Gender and sexual orientation have also been considered important variables associated with SI in many studies [15, 16]. Despite a gender disparity, with men having higher suicide rates than women, SI was higher in women [13]. The prevalence of SI in young women was double that of men [17, 18]. A national survey conducted in the United States found an increased association between specific sexual orientation and SI in young people, making it a risk factor for SI among young adults [16]. Socioeconomic inequalities are another factor that contributes to suicide mortality, and suicide risk rises with increasing socioeconomic disadvantage and household poverty [11, 19]. Moreover, substance abuse is a significant risk factor for SI among young people, including smoking and alcohol abuse [20]. It is widely believed to be linked to mental disorders, despair, and painful experiences caused by chronic substance abuse [21]. In addition to social factors, mental health problems and mental disorders were found to be independent risk factors for SI [21]. According to the Interpersonal-Psychological Theory of Suicide (IPTS), SI occurs when individuals experience thwarted belongingness (TB) and perceived burdensomeness (PB) [22]. Previous studies demonstrated that TB and PB may be associated with psychological and emotional problems such as depression and anxiety [23]. Anxiety disorders and depression mood are important predisposing factors for SI, positively predicting current or subsequent SI in young adults [21, 24, 25]. Therefore, the psychological problems of young adults require our undivided attention.

SI is a high-risk factor for suicide and is predictive of suicidal behavior [3–5]. Understanding the influencing factors associated with SI is crucial for assessing suicide risk and developing intervention strategies. Previous studies on SI mainly used traditional regression analysis methods to study and analyze related comprehensive factors, which requires each factor to be independent of each other. However, collinear characteristics exist among variables such as age, socioeconomic factors, mental health problems and mental disorders. For example, epidemiological studies in different cultures consistently show that in women, major depression, dysthymia and anxiety are 2–3 times more common than men [26], from the beginning of adolescence, and the negative effects of poverty on emotion in the sociology of mental health. Previous studies have also shown that PB and TB in ITPS may be related to psychological and emotional problems such as depression and anxiety [23]. The collinearity of these variables violates the premise of traditional regression independent variables, which may bias the results [27], so the adoption of machine learning algorithm will be the key to improve the accuracy and robustness of model prediction. The Elastic Network (EN) regression algorithm adopted in this study can effectively solve the screening of feature variables with collinearity, as well as compress the selection of variables to avoid the problem of model overfitting, prevent the model from being too complex while maintaining stability, and significantly improve the quality of results and quantity reliability. Therefore, this study used Assessing Nocturnal Sleep/Wake Effects on Risk of Suicide (ANSWERS) data were collected between May 2020 to May 2021 from 885 students aged 18–25 at the University of Arizon [28], exploring the influencing factors associated with SI through EN logistic regression models, focusing on SI in young people to prevent the occurrence of suicidal events.

Materials and methods

Data sources

In this study, data on the impact of ANSWERS were obtained from the US National Sleep Research Resource (NSRR). Data were collected between May 2020 to May 2021 from 885 students aged 18–25 at the University of Arizona (both undergraduates and graduate students were included). These data were obtained as part of a Phase I survey to assess the impact of nocturnal sleep/wake effects on the risk of suicide, known as the Assessing Nocturnal Sleep/Wake Effects on Risk of Suicide (ANSWERS) project [28]. The cross-sectional

survey included demographic and questionnaire data from young adult participants. This study aimed to assess continuity, timing, quality, and barriers to sleep, as well as general mental health and suicidal thoughts and behaviors, and ultimately guide subsequent longitudinal studies of undergraduate sleep and suicidal thoughts and behaviors. The data Recruitment occurred either through participation in an undergraduate psychology course or in response to flyers and emails sent through departmental list-servs [28], and participants provided informed consent using an electronic consent framework before completing the survey. The study was approved by the IRB at the University of Arizona (Protocol#: 2005675654). Information about the ANSWERS can be accessed at https://doi.org/10.25822/0vvb-6t89. The NSRR is supported by the National Institutes of Health and the National Heart, Lung, and Blood Institute (R24 HL114473,75N92019R002).

Study methods

Study subjects

Figure 1 illustrates the collation and exclusion process of the NSRR ANSWERS database in this study. Our exclusion criteria included the following: (1) self-reported current substance use; (2) self-reported neurological organic disorder; (3) self-reported clinician-confirmed psychiatric illness (schizophrenia, posttraumatic stress disorder, bidirectional affective disorder, anxiety, or depression); (4) self-reported as transgender (Transgender people have more anxious feelings due to hormonal levels and social disapproval, which may increase the level of SI [29], so we excluded transgender individuals from our study); (5) age over 25 (WHO data defines young adults as 18–25); (6) self-reported former/current use cannabis/marijuana; (7) subjects with missing data. Ultimately, 404 individuals were included in our study.

Survey of demographic variables

The demographic survey included age, gender (male and female), sexual orientation (heterosexual and others), education (high school or less and college or more), and income (<$25,000, >$25,000, and not reported).

Behavioral characteristics were comprised of drinking alcohol (yes or no), drinking alcohol to help sleep (yes or no), and drinking alcohol at a certain time (5–11 a.m.; 11 a.m.–5 p.m.; 5 p.m.–11 p.m.; 11 p.m.–5 a.m.); drinking caffeinated products (yes or no) and drinking caffeinated products at a specific time (5 a.m.–11 a.m., 11 a.m.–5 p.m., 5 p.m.–11 p.m., 11 p.m–5 a.m.); currently smoking (yes or no), often smoking (yes or no), smoking frequency (never smoker/former smoker, occasionally or every day), smoking to help relax at night (yes or no), and smoking at specific times (5 a.m.–11 a.m.; 11 a.m.–5 p.m.; 5 p.m.–11 p.m.; 11 p.m.–5 a.m.).

Research tools

Center for Epidemiologic Studies Depression (CESD): It is a 20-item self-report questionnaire [30]. Individual items are reported on a four-point Likert scale ranging from 0 to 3, with scores from 0 to 60; the higher scores indicate severe depressive symptoms [30]. The CESD measures included four dimensions: depressed affect, positive affect, somatic symptoms/retarded activity, and interpersonal problems [31]. Those with points greater than 16 have definite depressive symptoms [32]. CESD is an effective screening measure for detecting depressive symptoms. It is an efficient screening tool for detecting depressive symptoms, with Kronbach $\alpha=0.85$ for the general population [33]. In this study, the overall reliability and validity of the CESD was 0.77 and 0.91. The reliability and validity of the depressed affect were 0.85 and 0.86, positive affect reliability and validity were 0.81 and 0.75, somatic symptoms/retarded activity reliability and validity were 0.70 and 0.79, interpersonal problem reliability and validity were 0.57 and 0.50.

Short Urgency, Premeditation, Perseverance, Sensation Seeking, Positive Urgency, Impulsive Behavior Scale (S-UPPS-P): The S-UPPS-P was created by selecting the four entries with the highest factor load in each dimension from the full UPPS-P [34]. It is a 20-item impulsivity assessment scale, and all items were scored using the Likert scale, from 1 (I strongly agree) to 4 (I strongly disagree) [35]. Five different impulsive aspects were assessed: negative urgency, positive urgency, sensory seeking, lack of foresight, and lack of adherence [36]. Higher scores indicate stronger impulsivity [36]. The internal consistency of each subscales is good, with Cronbach α range of 0.74–0.88 [34]. The overall reliability validity of S-UPPS-P was 0.68 and 0.84. The reliability and validity of the negative urgency were 0.71 and 0.73, positive urgency reliability and validity were 0.78 and 0.78, sensory seeking reliability and validity were 0.65 and 0.67, lack of foresight reliability and validity were 0.76 and 0.73, lack of adherence reliability and validity were 0.60 and 0.68.

Pittsburgh Sleep Quality Index (PSQI): The PSQI design was primarily used to assess the patients' overall sleep quality. The scale has 19 self-rated items belonging to seven components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disorders, sleep medication use, and daytime dysfunction [37]. The frequency of sleep problems in the past month and overall sleep quality were assessed [37]. Each question had a score ranging from 0 to 3, with higher scores representing more severe sleep disturbance [37]. The seven component scores of the PSQI had an overall reliability coefficient Cronbach's α of 0.83, indicating a high degree of internal, consistency [37]. In this study Kronbach $\alpha=0.76$ and validity was 0.78.

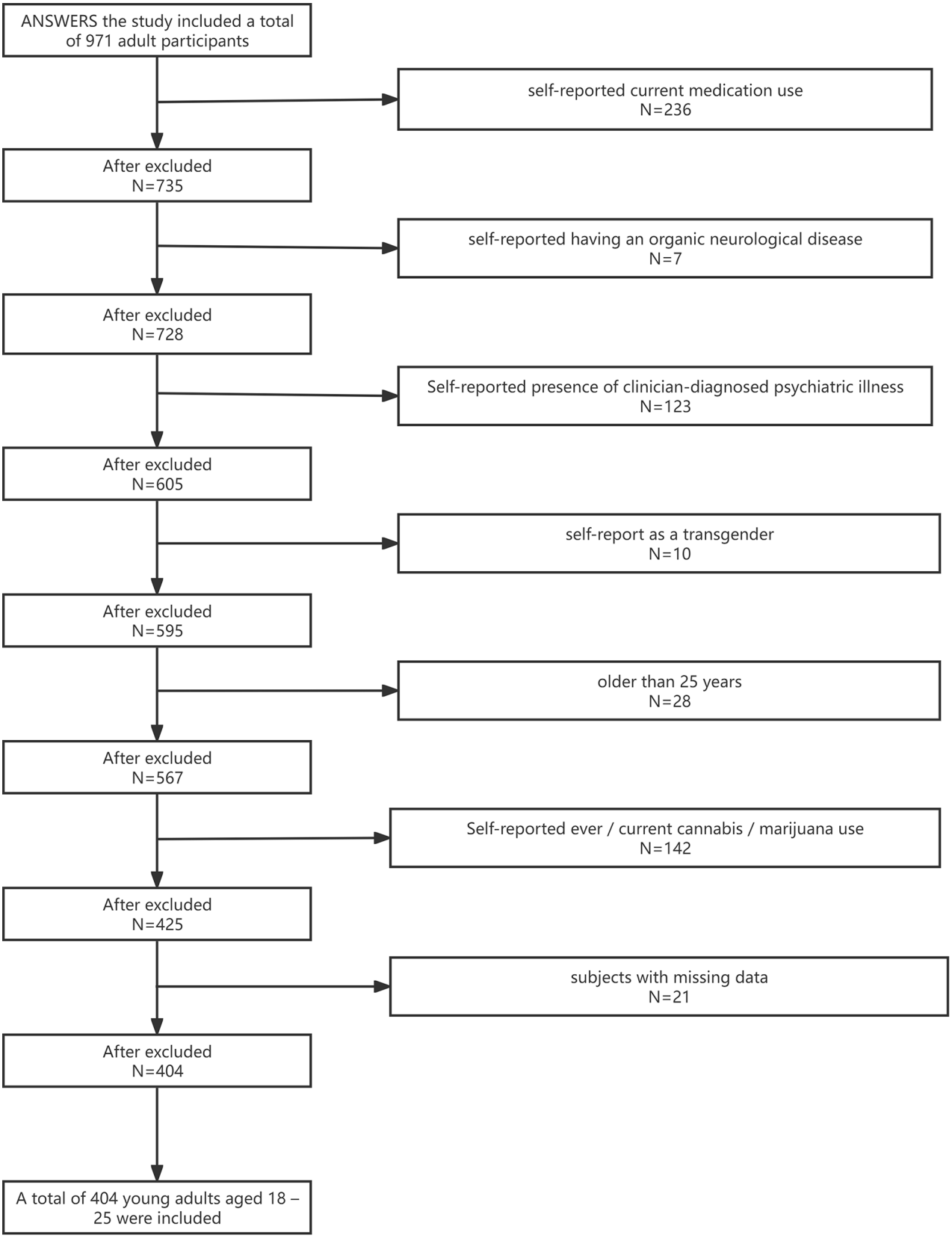

Fig. 1 Flowchart of the population included in our final analysis

Interpersonal Needs Questionnaire-15 (INQ-15): The original questionnaire developed and revised by the Kimberly A. Van Orden Suicide Interpersonal Theory Research Group includes 25 items [38]. Due to the multicollinearity problem, Van Orden et al. revised it several times, forming four revised versions. The INQ-15 was found to truly and effectively reflect the interpersonal needs of college students [39, 40]. It includes two dimensions: perceived burden summary and thwarted belonging summary [40]. There are 15 items in total, including six reverse-scoring questions. Using seven comments, "1" is completely incorrect, and "7" is completely correct [40]. After the reverse-scoring processing of the corresponding items, the higher the score, the higher the level of frustration attribution and self-burdensome perception, that is, the greater the frustration of interpersonal needs [40]. The INQ-15 scale showed good internal consistency for TB and PB, with a Kronbach α of 0.88 and 0.78, respectively [41]. The total reliability validity of INQ-15 was 0.69 and 0.91. The perceived burden summary reliability validity was 0.95 and 0.90, and the thwarted belonging summary reliability validity was 0.74 and 0.86.

Columbia-Suicide Severity Rating Scale (C-SSRS): The C-SSRS was originally developed by researchers at Columbia University, the University of Pennsylvania, and the University of Pittsburgh [42]. It is recommended for clinical use by the Food and Drug Administration for clinical trials and adopted by the Centers for Disease Control and Prevention for defining and stratifying SI and behaviors [43, 44]. This scale was used to assess SI and suicidal behavior over the past three months and throughout one's lifetime. SI had five items and suicidal behavior three items, with "0" indicating "no" and "1" meaning "yes," and the SI severity was the sum of five questions. The C-SSRS internal consistency was very high Cronbach α of 0.94 [42]. The reliability and validity in this study were 0.88 and 0.81, respectively.

Insomnia Severity Index (ISI): This seven-item scale is a simple tool for screening insomnia to assess the nature and symptoms of sleep disorders in subjects [45]. Subjects used the Likert scale to score each item on the scale with a range of 0–4 and a total score of 0–28 [45]. A higher score indicated more severe insomnia symptoms, and clinically significant insomnia was detected when the total score was >14. ISI exhibited excellent internal consistency α=0.84 [46]. The reliability and validity of ISI in this study were 0.78 and 0.81, respectively.

Generalized Anxiety Disorder-7 Questionnaire (GAD-7): It is a scale based on the seven diagnostic criteria for anxiety disorders in the Diagnostic and Statistical Manual of Psychiatric Disorders developed by the American Psychiatric Society [47]. The patients answered the contents of the questionnaire according to their psychological status in the last two weeks. The questionnaire contains seven questions, using the Likert scoring method, scoring 0–3 [47]. The total score for the seven questions was 21 points, with a higher score indicating a greater likelihood of anxiety and a deeper level of anxiety [47]. GAD-7 has been validated in a large sample of patients in primary care settings and in a large general population sample in Germany, reporting high internal consistency Cronbach α=0.92 [48]. The reliability and validity of GAD-7 in this study were 0.91 and 0.90, respectively.

Disturbing Dream and Nightmare Severity Index (DDNSI): It consists of five questions and self-retrospective measures of the frequency and severity of current nightmares [49]. It has two parts that address the frequency and number of nightmares per unit of time and the severity and intensity of the nightmare problem. Moreover, the measure assessed the frequency of nightmares [49]. The total score was calculated by adding the number of nightmares per week, number of nights per week, wake frequency associated with nightmares, severity score of nightmares, and intensity of nightmares. The total score ranged from 0 to 37, as previous studies had determined that a score>10 generally indicated a nightmare disorder [49, 50]. The scale is derived from the Nightmare Frequency questionnaire and revised with a Cronbach α of 0.80, indicating excellent internal consistency [51]. The reliability and validity of DDNSI in this study were 0.88 and 0.80, respectively.

The BRief Index of Sleep Control (BRISC): This questionnaire consisted of four items derived from the literature, asking individuals how much control they have over (1) when they go to sleep, (2) when they wake up, (3) how much they sleep, and (4) how well they sleep. Each item is rated on a 0–4 Likert scale, with 0=none at all; 1=a little control; 2=some control; 3=a lot of control; 4=complete control. A total score is computed by taking the mean of all four items (range: 0–4) [52]. The BRISC demonstrated high internal consistency Cronbach α=0.8 [52]. The reliability and validity of BRISC in this study were 0.70 and 0.69, respectively.

Statistical analysis

Data for this study were obtained using the R (version 4.3.1) glmnet package (R Foundation for Statistical Computing, Vienna, Austria), JASP (version 0.18.3) and IBM SPSS version 22.0 (IBM, Armonk, New York, USA). The R software pROC package presents curves, and the nomogram is plotted by the R software GLM function package.

First, we analyzed the general demographic variables and the scores of the nine scales. We conducted the Kolmogorov–Smirnov normality test and Levene's homogeneity of variance test for all continuous variables. All continuous variables were not normally distributed.

Therefore, the Mann–Whitney rank sum test was used to compare the differences between different groups; the statistical description was performed using the median, lower quartile (Q1), and upper quartile (Q3). Categorical variables were tested using the chi-square test, and frequency and percentage were used to describe categorical variables.

Statistical inference plays a key role in scientific research. Many researchers rely totally on null-hypothesis significance testing (NHST), to analyse the results of their quantitative research [53]. A *P*-value is the probability of obtaining results at least as extreme as those observed in the research data, given that the null hypothesis is true [54]. The null hypothesis is rejected if the *P*-value is less than the pre-set (decision-point) type I error rate [55, 56]. As the most commonly used Null hypothesis significance test (NHST) is abused or misuse, some researchers have proposed the use of Bayes factors (BF) as an alternative and (or) complementary statistical method. BF is the method used in Bayesian statistics to perform model comparison and hypothesis testing. In hypothesis testing, it represents the ratio between the strength of the current data supporting the null hypothesis (H_0) and the alternative hypothesis (H_1). BF are able to quantify the extent to which current data support individual hypotheses. In hypothesis testing, Bayes factors have some advantages over NHST, such as not relying on an unknown sampling plan, which can monitor the strength of the data as the data accumulates and the supporting evidence that both H_0 and H_1 can be considered simultaneously. Reporting a BF to complement a *P*-value adds interpretive value to the reporting of healthcare research and should enhance decisionmaking in healthcare [57].If evidence from the NHST and Bayesian models leads to similar conclusions, there is greater confidence in the statistical results [58]. But if significance testing and Bayesian analysis lead to different conclusions, preference should be given to the Bayesian conclusion [59]. We performed Bayesian statistical analysis for all variables, with the H_0 indicating no demographic difference between the groups with SI and no SI, and the H_1 indicates the demographic difference between the two groups. We first with descriptive statistics and box plot tests, each box plot is approximately symmetric and no extreme outliers are observed. The Bayesian independent sample T-test was used for continuous variables and the Bayesian ANOVA test for categorical variables. $BF_{10}>1$ supports the H_1 hypothesis, and $BF_{10}<1$ supports the H_0 hypothesis.

Moreover, With the presence of SI as the outcome, general demographic variables and the scores of the nine scales were included in the model, and influential factors with $p<.05$ were selected in the univariate analysis. Then, the significant variables in one-way ANOVA were included in the EN analysis, the optimal model was chosen using cross-validation, and the key variables were screened according to the principle of minimum mean square error. The prediction effect of the model was evaluated according to the receiver operating curve (ROC) area under curve (AUC). Finally, the key variables selected by EN analysis were included in the multivariable logistic regression model, and the significant variables were constructed as nomograms.

All tests were two-sided, and the significance threshold was set at $p<.05$.

Results

Demographics

Table 1 lists the demographic data. Of the 404 young participants, 105 (26%) self-reported the presence of SI in the past three months. More than half of the subjects included in this study were male (67.8%), and the vast majority were heterosexual (90.6%). SI was significantly higher among men than women ($\chi^2=5.65$; $p=.017$). In the specific sexual orientation, more participants were without SI than those with SI ($\chi^2=9.97$; $p=.002$). Participants who had SI were younger ($z=-3.05$; $p=.002$). No statistical difference in education or income was observed between the two groups (all $p>.05$).

In terms of behavioral characteristics, more participants who drank caffeinated products at 11 a.m.–5 p.m. and smoked at 5–11 a.m. and 11 a.m. −5 p.m. had SI ($\chi^2=4.61$, $p=.032$; $\chi^2=4.78$, $p=.029$; $\chi^2=5.42$, $p=.020$). Participants drinking caffeine products and smoking at 5 p.m. −11 p.m. had less SI than nondrinkers and nonsmokers ($\chi^2=10.19$, $p=.001$; $\chi^2=5.22$, $p=.022$). No significant differences were observed in other behavioral characteristics (all $p>.05$).

The CESD positive mood scores and BRISC scores were higher in the non-SI group ($z=-7.79$, $p<.001$; $z=-3.00$, $p=.003$). In the SI group, all scale scores were higher than those in the normal group (all $p<.05$), except for the S-UPPS-P lack of perseverance, positive urgency, and sensation seeking and PSQI sleep medication.

We performed a Bayesian statistical analysis for all variables, H_0 indicates no demographic difference between the SI and no SI groups, and H_1 indicates a demographic difference between the two groups. By Bayesian statistical analysis, very strong evidence supporting the H_1 hypothesis in CESD depression mood scores, positive mood scores, somatic symptoms and delayed activity, INQ-15 PB, TB, GAD-7 scores and ISI scores ($BF_{10}>100$). Strong evidence supports the H_1 hypothesis in the CESD interpersonal relationship and S-UPPS-P negative Urgency scores ($30<BF_{10}<100$). In sexual orientation, Drink caffeinated products at 5 PM-11 PM and BRISC scores have moderate evidence supporting the H_1 hypothesis ($3<BF_{10}<30$). Weak evidence for age, gender, smoking at 5 AM-11PM, Drink caffeinated products

Table 1 Characteristics of participants with/without SI ($n=404$)

Variables	Over all ($n=404$) Median (Q1, Q3) / (n%)	Without SI ($n=299$) Median (Q1, Q3) / (n%)	With SI ($n=105$) Median (Q1, Q3) / (n%)	Z/χ^2	p	BF10
Part one: Demographic Questionnaire						
Age(years)	19.18 (18.77, 19.98)	19.28 (18.82, 20.13)	19.02 (18.56, 19.47)	-3.05	0.002**	**2.34**
Gender (%)				5.65	0.017*	**1.80**
Male	274 (67.8)	193 (47.8)	81 (20.0)			
Female	130 (32.2)	106 (26.2)	24 (5.9)			
Sexual orientation (%)				9.97	0.002**	**7.10**
Heterosexual	366 (90.6)	279 (69.1)	87 (21.5)			
Others	38 (9.4)	20 (5.0)	18 (4.5)			
Education (%)				0.42	0.517	**0.01**
High school or less	386 (95.5)	284 (70.3)	102 (25.2)			
College or more	18 (4.5)	15 (3.7)	3 (0.7)			
Income(%)				4.07	0.131	**0.02**
<25,000 dollars	242 (59.9)	172 (42.6)	70 (17.3)			
>25,000 dollars	46 (11.4)	39 (9.7)	7 (1.7)			
No report	116 (28.7)	88 (21.8)	28 (6.9)			
Part two: Behavior characteristics						
Drink alcohol (%)				1.32	0.250	**0.21**
No	223 (55.2)	160 (39.6)	63 (15.6)			
Yes	181 (44.8)	139 (34.4)	42 (10.4)			
Drink alcohol to help sleep (%)				1.18	0.278	**0.56**
No	387 (95.8)	284 (70.3)	103 (25.5)			
Yes	17 (4.2)	15 (3.7)	2 (0.5)			
Drink alcohol at 5 AM-11 AM (%)				0.00	1.00	**0.43**
No	400 (99.0)	296 (73.3)	104 (25.7)			
Yes	4 (1.0)	3 (0.7)	1 (0.2)			
Drink alcohol at 11 AM-5 PM (%)				2.07	0.082	**0.95**
No	389 (96.3)	285 (70.5)	104 (25.7)			
Yes	15 (3.7)	14 (3.5)	1 (0.2)			
Drink alcohol at 5 PM-11 PM (%)				0.57	0.450	**0.15**
No	257 (63.6)	187 (46.3)	70 (17.3)			
Yes	147 (36.4)	112 (27.7)	35 (8.7)			
Drink alcohol at 11 PM-5 PM (%)				0.62	0.432	**0.17**
No	308 (76.2)	225 (55.7)	83 (20.5)			
Yes	96 (23.8)	74 (18.3)	22 (5.4)			
Drink caffeinated products (%)				0.01	0.939	**0.17**
No	47 (11.6)	35 (8.7)	12 (3.0)			
Yes	357 (88.4)	264 (65.3)	93 (23.0)			
Drink caffeinated products at 5 AM-11 AM (%)				0.30	0.585	**0.13**
No	187 (46.3)	136 (33.7)	51 (12.6)			
Yes	217 (53.7)	163 (40.3)	54 (13.4)			
Drink caffeinated products at 11 AM-5 PM (%)				4.61	0.032*	**1.03**
No	198 (49.0)	156 (38.6)	42 (10.4)			
Yes	206 (51.0)	143 (35.4)	63 (15.6)			
Drink caffeinated products at 5 PM-11 PM (%)				10.19	0.001**	**17.06**
No	291 (72.0)	228 (56.4)	63 (15.6)			
Yes	113 (28.0)	71 (17.6)	42 (10.4)			

Table 1 (continued)

Variables		Over all (*n* = 404) Median (Q1, Q3) / (*n*%)	Without SI (*n* = 299) Median (Q1, Q3) / (*n*%)	With SI (*n* = 105) Median (Q1, Q3) / (*n*%)	Z/χ^2	*p*	BF10
Drink caffeinated products at 11 PM-5 AM (%)					1.32	0.250	**0.43**
No		384 (95.0)	282 (69.8)	102 (25.2)			
Yes		20 (5.0)	17 (4.2)	3 (0.7)			
Current smoking (%)					2.11	0.147	**0.49**
No		368 (91.1)	276 (68.3)	92 (22.8)			
Yes		36 (8.9)	23 (5.7)	13 (3.2)			
Often smoking (%)					0.72	0.398	**0.30**
No		380 (94.1)	283 (70.0)	97 (24.0)			
Yes		24 (5.9)	16 (4.0)	8 (2.0)			
Smoking frequency (%)					3.63	0.163	**0.42**
Never smoker/ Former smoker		380 (94.1)	283 (70.0)	97 (24.0)			
Occasionally		17 (4.2)	13 (3.2)	4 (1.0)			
Every day		7 (1.7)	3 (0.7)	4 (1.0)			
Smoking to help relax at night (%)					1.30	0.254	**0.40**
No		382 (94.6)	285 (70.5)	97 (24.0)			
Yes		22 (5.4)	14 (3.5)	8 (2.0)			
Smoking at 5 AM-11 AM (%)					4.79	0.029*	**2.12**
No		393 (97.3)	294 (72.8)	99 (24.5)			
Yes		11 (2.7)	5 (1.2)	6 (1.5)			
Smoking at 11 AM-5 PM (%)					5.42	0.020*	**2.71**
No		391 (96.8)	293 (72.5)	98 (24.3)			
Yes		13 (3.2)	6 (1.5)	7 (1.7)			
Smoking at 5 PM-11 PM (%)					5.22	0.022*	**2.24**
No		380 (94.1)	286 (70.8)	94 (23.3)			
Yes		24 (5.9)	13 (3.2)	11 (2.7)			
Smoking at 11 PM-5 AM (%)					1.63	0.202	**0.50**
No		386 (95.5)	288 (71.3)	98 (24.3)			
Yes		18 (4.5)	11 (2.7)	7 (1.7)			
Part three: Scale scores							
CESD	Depression mood	5 (2, 10)	4 (1, 7)	10 (7, 13)	9.34	< 0.001***	**96200.70**
	Positive mood	8 (5, 10)	8 (6, 10)	5 (3, 8)	-7.79	< 0.001***	**2141.81**
	Somatic symptoms and delayed activity	5 (3, 8)	5 (2, 7)	8 (5, 10)	6.63	< 0.001***	**18719.75**
	Interpersonal relationship	1 (0, 2)	0 (0, 2)	2 (1, 3)	5.72	< 0.001***	**98.50**
S-UPPS-P	Lack of Perseverance	7 (5, 8)	7 (5, 8)	7 (6, 9)	1.90	0.058	**0.36**
	Lack of Premeditation	7 (5, 8)	6 (5, 8)	7 (5, 9)	3.06	0.002**	**2.82**
	Negative Urgency	9 (7, 11)	8 (7, 11)	10 (8, 12)	4.40	< 0.001***	**32.67**
	Positive Urgency	7 (6, 9)	7 (5, 9)	8 (6, 10)	1.89	0.059	**0.43**
	Sensation Seeking	11 (9, 13)	11 (9, 13)	10 (8, 13)	-1.08	0.282	**0.17**
PSQI	Sleep Quality	1 (1, 1)	1 (1, 1)	1 (1, 2)	4.68	< 0.001***	**3.83**
	Sleep Latency	1 (1, 2)	1 (1, 2)	1 (1, 2)	3.16	0.002**	**1.47**
	Sleep Duration	0 (0, 0)	0 (0, 0)	0 (0, 1)	2.05	0.04*	**0.26**
	Sleep Efficiency	1 (0, 2)	1 (0, 2)	1 (1, 2)	3.74	< 0.001***	**2.34**
	Sleep Disturbance	1 (1, 1)	1 (1, 1)	1 (1, 1)	2.46	0.014*	**0.30**
	Sleep Medication	0 (0, 0)	0 (0, 0)	0 (0, 0)	1.03	0.304	**0.18**
	Daytime Dysfunction	0 (0, 1)	0 (0, 1)	1 (0, 1)	2.14	0.033*	**0.43**

Table 1 (continued)

Variables		Over all (*n* = 404) Median (Q1, Q3) / (*n*%)	Without SI (*n* = 299) Median (Q1, Q3) / (*n*%)	With SI (*n* = 105) Median (Q1, Q3) / (*n*%)	Z/χ^2	*p*	BF10
INQ-15	Perceived Burdensome	6 (6, 9)	6 (6, 7)	10 (6, 21)	9.36	< 0.001***	**7790.88**
	Thwarted Belongingness	24 (15, 34.75)	20 (13, 31)	34 (26.5, 40.5)	7.39	< 0.001***	**25973.52**
ISI Scores		7 (4, 11)	6 (3, 10)	10 (5, 13)	4.85	< 0.001***	**239.77**
GAD-7 Scores		5 (2, 9)	4 (1, 7)	8 (6, 14)	8.17	< 0.001***	**68048.82**
DDNSI Scores		3 (0, 7)	2 (0, 7)	5 (0, 10)	3.26	0.001**	**1.86**
BRISC Scores		2.25 (1.75, 2.75)	2.25 (1.75, 3.00)	2.00 (1.50, 2.75)	-3.00	0.003**	**3.48**

Note: First, the Kolmogonov-Smirinov normality test and the Levene test for homogeneity of variance were used for all continuous variables. All of the continuous variables are not normally distributed. Therefore, Man-Whitney rank sum test was used to compare the group differences between different groups, and the median (Q1, Q3) was used for statistical description. Categorical variables were compared using Chi-square tests, using frequency and percentage descriptions. *p < .05, ** p < .01, ***p < .001

at 11 AM-5 PM, S-UPPS-P lack of Premeditation, PSQI sleep quality, sleep latency, sleep efficiency, and DDNSI scores supports H_1 ($1 < BF_{10} < 3$). The remaining variables were analyzed by Bayesian statistics to indicate no differences between the two groups.

Univariate logistic regression analysis of the variables and SI

We ran a univariate logistic regression analysis with general demographic variables, behavioral characteristics, and scale scores as independent variables and the presence of SI as a dependent variable. The classification variables were set in the independent variables, code 0 was specified as the reference group (Table 2), and the Enter Input Method was selected to build the model. Table 3 lists the 27 contributing factors that were significantly associated with SI in the univariate logistic regression analysis.

Factors influencing SI under the EN model

The 27 variables in Table 3 that were significantly associated with SI were included in the EN model established through cross-validation. When the partial likelihood binomial deviation reached the minimum value (Fig. 2A), the most appropriate key parameter value for the EN ($\lambda = 0.02737$; $\alpha = 0.74$) was selected, retaining 11 variables with nonzero coefficients (Fig. 2B). The 11 potential influencing factors were as follows: age (–0.1841); sexual orientation (0.2057); drinking caffeinated products at 5 p.m.–11 p.m. (0.0461), smoking at 5 a.m. −11 a.m. (0.2769), 11 a.m.–5 p.m. (1.0401), and 5 p.m.–11 p.m. (0.5958); CESD depression mood scores (0.1268); CESD positive mood scores (–0.0373); INQ-15 PB scores (0.0729); INQ-15 TB scores (0. 0219); GAD-7 total scores (0.0186) (Table 4). The AUC of the present EN model is 0.860, which proves that the current model has a relatively good prediction effect (Fig. 2C).

Construction of the nomogram

The 11 potential influencing variables were included in the multivariate logistic regression model analysis. Omnibus Tests of Model Coefficients p<.05 and Hosmer–Lemeshow Test p=.524 prove that the present model construction is meaningful and has a high degree of fit. Among them, CSED depression mood scores (OR: 1.16, 95% CI: 1.07–1.26), INQ-15 PB scores (OR: 1.10, 95% CI: 1.04–1.17), and age (OR: 0.72, 95% CI: 0.55–0.95) were significant predictors of SI in young adults (Table 5). Therefore, we selected these three variables to construct the nomogram (Fig. 3).

Discussion

To the best of our knowledge, this is the first to develop a EN logistic regression model examining a large cohort to analyze influencing factors associated with SI in younger adults. Multivariate logistic regression analysis showed that the interaction of INQ-15 PB score, CESD depressive mood score and age played an important role in SI in young adults, which was the best predictor of SI in young adults. The younger the age, the more severe the self-burden feeling and depression, the more significant the suicidal ideation, among which depression was the most important risk factor. In addition to the above three independent factors, the EN model retained eight potential factors: sexual orientation, caffeine product use, smoking, CESD positive mood score, INQ-15 TB score, and GAD-7 score. Taken together, identifying these influencing factors can help provide a scientific basis for early screening of suicide risk, focusing on PB and negative emotions in younger adults, while intervening with other potentially influencing factors to prevent suicidal behaviors more effectively.

In this study, INQ-15 PB scores and CESD depression mood scores were significant independent risk factors for SI, increasing by 1.10 and 1.16 times, respectively. PB is defined as a mental state characterized by the perception

Table 2 Variable assignments

Risk / Protective factors		Assignment
Part one: Demographic Questionnaire		
Age		continuous variable
Gender		Male = 0 (reference group), female = 1
Sexual orientation		Heterosexual = 0 (reference group), Others = 1
Education		High school or less = 0 (reference group), College or more = 1
Income		<25,000 dollars = 0 (reference group), >25,000 dollars = 1, No report = 2
Part two: Behavior characteristics		
Drink alcohol		No = 0 (reference group), Yes = 1
Drink to help sleep		No = 0 (reference group), Yes = 1
Drink alcohol at 5 AM-11 AM		No = 0 (reference group), Yes = 1
Drink alcohol at 11 AM-5 PM		No = 0 (reference group), Yes = 1
Drink alcohol at 5 PM-11 PM		No = 0 (reference group), Yes = 1
Drink alcohol at 11 PM-5 AM		No = 0 (reference group), Yes = 1
Drink caffeinated products		No = 0 (reference group), Yes = 1
Drink caffeinated products at 5 AM-11 AM		No = 0 (reference group), Yes = 1
Drink caffeinated products at 11 AM-5 PM		No = 0 (reference group), Yes = 1
Drink caffeinated products at 5 PM-11 PM		No = 0 (reference group), Yes = 1
Drink caffeinated products at 11 PM-5 AM		No = 0 (reference group), Yes = 1
Current smoking		No = 0 (reference group), Yes = 1
Often smoking		No = 0 (reference group), Yes = 1
Smoking frequency		Never smoker/ Former smoker = 0 (reference group), Occasionally = 1, Every day = 2
Smoking to help relax at night		No = 0 (reference group), Yes = 1
Smoking at 5 AM-11 AM		No = 0 (reference group), Yes = 1
Smoking at 11 AM-5 PM		No = 0 (reference group), Yes = 1
Smoking at 5 PM-11 PM		No = 0 (reference group), Yes = 1
Smoking at 11 PM-5 AM		No = 0 (reference group), Yes = 1
Part three: Scale scores		
CESD	Depression mood	continuous variable
	Positive mood	continuous variable
	Somatic symptoms and delayed activity	continuous variable
	Interpersonal relationship	continuous variable
S-UPPS-P	Lack of Perseverance	continuous variable
	Lack of Premeditation	continuous variable
	Negative Urgency	continuous variable
	Positive Urgency	continuous variable
	Sensation Seeking	continuous variable
PSQI	Sleep Quality	continuous variable
	Sleep Latency	continuous variable
	Sleep Duration	continuous variable
	Sleep Efficiency	continuous variable
	Sleep Disturbance	continuous variable
	Sleep Medication	continuous variable
	Daytime Dysfunction	continuous variable
INQ-15	Perceived Burdensome	continuous variable
	Thwarted Belongingness	continuous variable
ISI Scores		continuous variable
GAD-7 Scores		continuous variable
DDNSI Scores		continuous variable
BRISC Scores		continuous variable

Table 3 Univariate logistic regression analysis of the study factors and SI ($n=404$)

Factors	Wald χ^2	B	OR (95%CI)	*p*
Part one: Demographic Questionnaire				
Age(years)	7.97	-0.31	0.73 (0.59, 0.91)	0.005**
Gender				
Male		1.00		
Female	5.55	-0.62	0.54 (0.32, 0.90)	0.018*
Sexual orientation				
Heterosexual		1.00		
Others	9.31	1.06	2.89 (1.46, 5.70)	0.002**
Education				
High school or less		1.00		
College or more	0.83	-0.59	0.56 (0.16, 1.96)	0.362
Income(%)				
<25,000 dollars	3.94	1.00		
>25,000 dollars	3.55	-0.82	0.44 (0.19, 1.03)	0.059
No report	0.90	-0.25	0.78 (0.47, 1.30)	0.342
Part two: Behavior characteristics				
Drink alcohol (%)				
No		1.00		
Yes	1.32	-0.27	0.77 (0.49, 1.21)	0.251
Drink alcohol to help sleep (%)				
No		1.00		
Yes	1.73	-1.00	0.37 (0.08, 1.64)	0.189
Drink alcohol at 5 AM-11 AM (%)				
No		1.00		
Yes	0.00	-0.05	0.95 (0.10, 9.22)	0.964
Drink alcohol at 11 AM-5 PM (%)				
No		1.00		
Yes	2.45	-1.63	0.20 (0.03, 1.51)	0.117
Drink alcohol at 5 PM-11 PM (%)				
No		1.00		
Yes	0.57	-0.18	0.84 (0.52, 1.33)	0.450
Drink alcohol at 11 PM-5 PM (%)				
No		1.00		
Yes	0.62	-0.22	0.81 (0.47, 1.38)	0.432
Drink caffeinated products (%)				
No		1.00		
Yes	0.01	0.03	1.03 (0.51, 2.06)	0.939
Drink caffeinated products at 5 AM-11 AM				
No		1.00		
Yes	0.30	-0.12	0.88 (0.57, 1.38)	0.585
Drink caffeinated products at 11 AM-5 PM				
No		1.00		
Yes	4.57	0.49	1.64 (1.04, 2.57)	0.033*
Drink caffeinated products at 5 PM-11 PM				
No		1.00		
Yes	9.96	0.76	2.14 (1.33, 3.43)	0.002**
Drink caffeinated products at 11 PM-5 AM				
No		1.00		
Yes	1.27	-0.72	0.49 (0.14, 1.70)	0.260
Current smoking (%)				
No		1.00		
Yes	2.07	0.53	1.70 (0.83, 3.48)	0.150
Often smoking (%)				

Table 3 (continued)

Factors		Wald χ^2	B	OR (95%CI)	*p*
No			1.00		
Yes		0.71	0.38	1.46 (0.61, 3.52)	0.400
Smoking frequency					
Never smoker/ Former smoker		3.15	1.00		
Occasionally		0.03	-0.11	0.90 (0.29, 2.82)	0.853
Every day		3.09	1.36	3.89 (0.86, 17.69)	0.079
Smoking to help relax at night (%)					
No			1.00		
Yes		1.28	0.52	1.68 (0.68, 4.12)	0.258
Smoking at 5 AM-11 AM					
No			1.00		
Yes		4.25	1.27	3.56 (1.06, 11.93)	0.039*
Smoking at 11 AM-5 PM					
No			1.00		
Yes		4.83	1.25	3.49 (1.15, 10.63)	0.028*
Smoking at 5 PM-11 PM					
No			1.00		
Yes		4.91	0.95	2.57 (1.12, 5.94)	0.027*
Smoking at 11 PM-5 AM					
No			1.00		
Yes		1.58	0.63	1.87 (0.71, 4.96)	0.208
Part three: Scale scores					
CESD	Depression mood	71.76	0.25	1.29 (1.22, 1.37)	< 0.001***
	Positive mood	51.91	-0.31	0.74 (0.68, 0.80)	< 0.001***
	Somatic symptoms and delayed activity	42.69	0.24	1.27 (1.18, 1.36)	< 0.001***
	Interpersonal relationship	29.30	0.46	1.59 (1.34, 1.87)	< 0.001***
S-UPPS-P	Lack of Perseverance	4.26	0.12	1.13 (1.01, 1.27)	0.039*
	Lack of Premeditation	10.75	0.18	1.19 (1.07, 1.33)	0.001**
	Negative Urgency	19.18	0.19	1.20 (1.11, 1.31)	< 0.001***
	Positive Urgency	3.92	0.08	1.08 (1.00, 1.17)	0.048*
	Sensation Seeking	1.16	-0.05	0.96 (0.88, 1.04)	0.282
PSQI	Sleep Quality	20.02	0.79	2.21 (1.56, 3.13)	< 0.001***
	Sleep Latency	10.20	0.40	1.50 (1.17, 1.92)	0.001**
	Sleep Duration	2.99	0.25	1.28 (0.97, 1.70)	0.084
	Sleep Efficiency	13.53	0.43	1.54 (1.22, 1.94)	< 0.001***
	Sleep Disturbance	5.60	0.60	1.82 (1.11, 2.99)	0.018*
	Sleep Medication	2.62	0.24	1.28 (0.95, 1.71)	0.105
	Daytime Dysfunction	6.96	0.43	1.54 (1.12, 2.13)	0.008**
INQ-15	Perceived Burdensome	56.54	0.19	1.21 (1.15, 1.27)	< 0.001***
	Thwarted Belongingness	49.80	0.08	1.08 (1.06, 1.10)	< 0.001***
ISI Scores		24.55	0.13	1.13 (1.08, 1.19)	< 0.001***
GAD-7 Scores		55.90	0.18	1.20 (1.14, 1.26)	< 0.001***
DDNSI Scores		8.56	0.05	1.06 (1.02, 1.09)	0.003**
BRISC Scores		9.61	-0.47	0.63 (0.47, 0.84)	0.002**

Note: *$p<.05$, ** $p<.01$, ***$p<.001$

that "if I am not here, others will live better", which may be related to family discord, unemployment, and functional impairment, as these factors may impose a burden on others [40]. In IPTS, PB is the core motivational variable of SI [40]. This theory has been studied primarily in the elderly and people with chronic diseases, with little attention paid to other populations [60, 61]. In our study, PB is significantly associated with SI, even in normal young adults, which can positively predict SI. Joiner, in his monograph, demonstrated from both conceptual and empirical research that people of any age may have a sense of burden, whether it is the burden of the family or the burden of society; this "redundant" feeling clearly includes the sense of burden [40]. This theory was

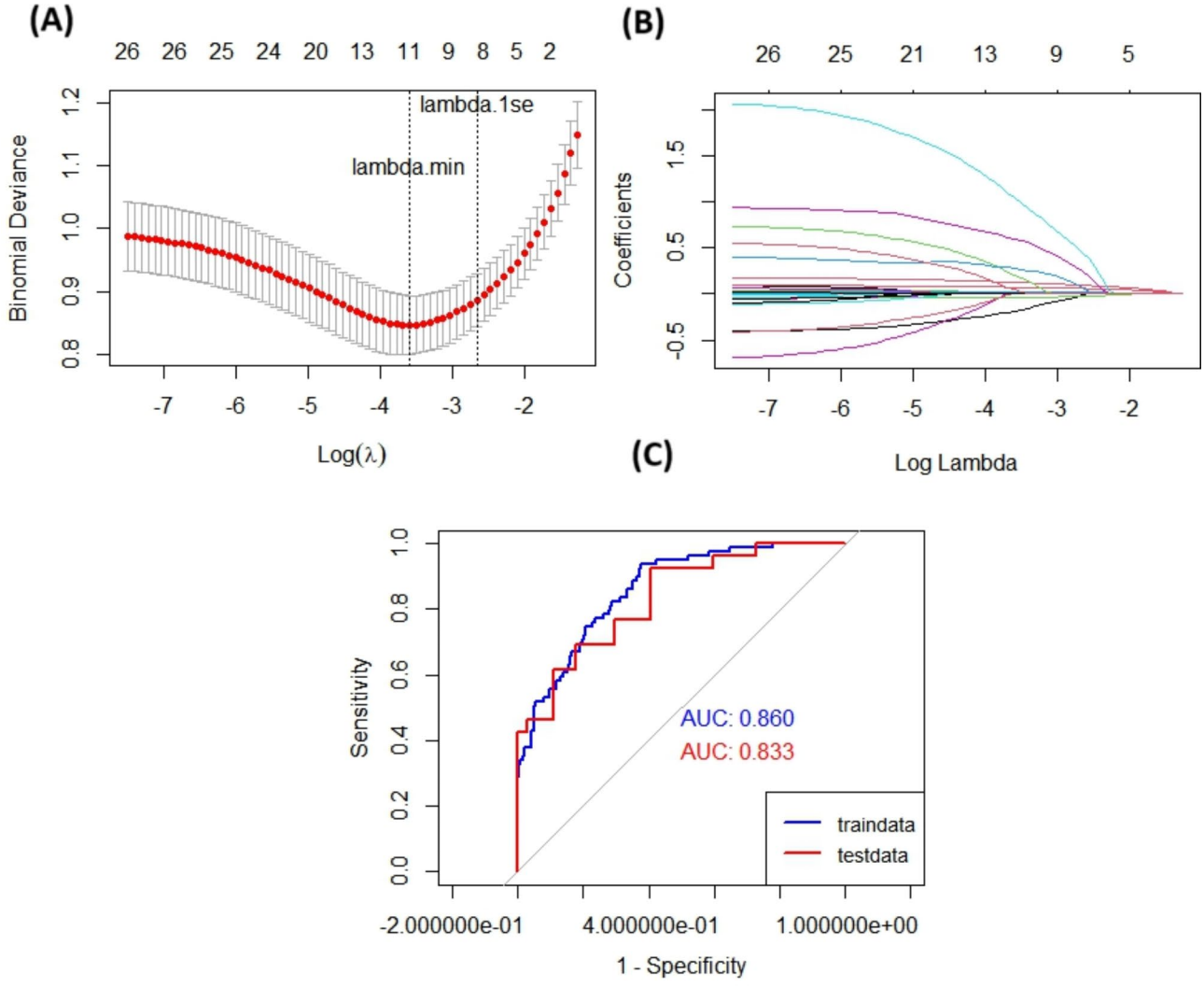

Fig. 2 Elastic Net regression. (**A**) The cross-validation results. The value in the middle of the two dotted lines is the range of the positive and negative standard deviations of log(λ). The dotted line on the left indicated the value of the harmonic parameter log(λ) when the error of the model is minimized. (**B**) Elastic Network (EN) coefficient profiles of the 27 variables. As the value of log(λ) increased, the degree of model compression increased and the function of the model to select important variables increased. (**C**) The AUC (area under curve) of the EN (Elastic Network) model

Table 4 Factors selected by Elastic Net logistic regression model ($n=404$)

Risk / Protective factors	Coefficient
Age (years)	-0.1841
Sexual orientation	0.2057
Drink caffeinated products at 5PM-11PM	0.0461
Smoking at 5AM-11AM	0.2769
Smoking at 11AM-5PM	1.0401
Smoking at 5PM-11PM	0.5958
CESD Depression mood	0.1268
CESD Positive mood	-0.0373
INQ-15 Perceived Burdensome	0.0729
INQ-15 Thwarted Belongingness	0.0219
GAD-7 Scores	0.0186

also validated in our study. Youth is the most important period of life, with many challenges and changes. Teenagers try to seek more care and support from others, whether in the family or society. When their psychological needs are not met, feelings of relative loneliness, alienation, and lack of contact with others will emerge. Most young people self-report that they will hide their feelings, worry about the reactions of others, and feel burdened [62]. The satisfaction degree of basic psychological needs is directly related to the level of individual mental health. From the perspective of self-determination theory, the sense of PB may be caused by the frustration of basic psychological needs such as relationship needs, independent needs and competence needs [63]. When the individual basic psychological needs to be frustrated, negative thoughts and behaviors such as

Table 5 Multivariate logistic regression analysis ($n=404$)

Variables		Wald χ^2	B	OR (95%CI)	*p*
Age		5.63	-0.32	0.72 (0.55, 0.95)	0.018*
Orientation					
Heterosexual			1.00		
Others		2.09	0.69	1.99 (0.78, 5.06)	0.148
Drink caffeinated products at 5 PM-11 PM					
No			1.00		
Yes		0.98	0.31	1.37 (0.74, 2.53)	0.323
Smoking at 5 AM-11 AM					
No			1.00		
Yes		0.11	0.42	1.52 (0.13, 17.85)	0.738
Smoking at 11 AM-5 PM					
No			1.00		
Yes		1.86	1.67	5.29 (0.48, 58.11)	0.173
Smoking at 5 PM-11 PM					
No			1.00		
Yes		0.04	0.16	1.17 (0.25, 5.38)	0.841
CESD	Depression mood	12.96	0.15	1.16 (1.07, 1.26)	< 0.001***
	Positive mood	2.22	-0.09	0.91 (0.81, 1.03)	0.136
INQ-15	Perceived Burdensome	10.55	0.10	1.10 (1.04, 1.17)	0.001**
	Thwarted Belongingness	1.45	0.02	1.02 (0.99, 1.05)	0.229
GAD-7 Scores		0.53	0.03	1.03 (0.96, 1.10)	0.467

Note: *$p<.05$, ** $p<.01$, ***$p<.001$

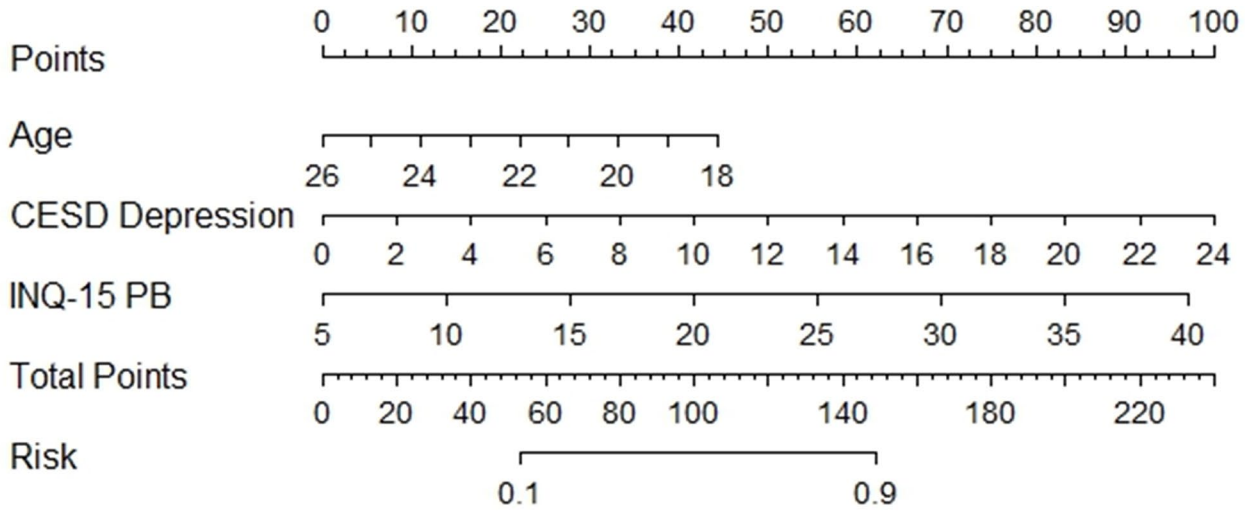

Fig. 3 Nomograms were constructed with multivariate logistic regression

self-injury and SI will appear [64]. In addition, the sense of PB is "empathic concern when a person's needs affect others, leading to the loss of guilt, pain, responsibility and self-awareness" [65], so the perception of burden will produce a certain painful emotional experience. Psychological distress was a significant predictor of reporting SI compared to depression or despair. Seidman believes that psychological pain is the direct cause of suicidal behavior, psychological pain beyond the maximum limit, the individual will be suicide as the only means of terminating pain or psychological pain is the cause of SI, the change of psychological pain is significantly associated with the change of SI. The interpersonal theory of suicide suggests that there are two dimensions of PB: one is the belief that oneself is the burden of others ", and the other is the emotional perception of self-hatred. Among them, individual predictors of self-hatred include low self-esteem status. Studies have shown that self-esteem is closely related to the individual's mental health status. Previous studies have found a close association between self-esteem and SI. According to the view of cognitive theory, the emergence of internalization problems (such as SI, depression,

loneliness) is usually associated with low self-esteem [66], a large number of studies also verified that self-esteem has significant negative predictor of SI. In conclusion, psychological distress and low self-esteem status may play an important role between self-burden feelings and SI.

PB sensation may independently influence mental health or become a stressor contributing to depression [67]. However, in practice, we know very little about the relationship between depressive mood and the SI. Depression is the most common emotional and psychological problem, which is a continuous comprehensive emotional state primarily manifested as low mood, anxiety, lack of security, and low self-evaluation [68]. Young adults are at the border of adolescence and adulthood, and their physical, psychological and social development is unique. In the process of adapting to oneself, the society and the environment, various cognitive conflicts and psychological disorders will appear. Specifically, in the process of adapting to themselves, society and the environment, young people not only need to deal with their own physiological and psychological changes, but also need to balance the different influences from school, family and society. More importantly, they need to deal with the academic pressure and interpersonal relationship problems in school, which is a major challenge to their emotional regulation. Young adults are at the junction of adolescence and adulthood, and their physical, psychological, and social development are unique. Various cognitive conflicts and psychological disorders will arise during the process of adapting to oneself, society, and the environment [69, 70]. Therefore, young adults are the population with a high incidence of depression, and the detection rate of depression is higher worldwide, at 13–15% [71]. Numerous studies have demonstrated that depression is closely related to SI [72–74]. Depression was considered a direct predictor of SI [75], and the detection rate of those with depressive disorder was 47–69% [76, 77]. The effect of depression on SI is multifaceted, multi-pathway. The Differential Activation Theory of Suicidality states that depression and individual SI are significantly associated [78, 79]. The theory suggests that the activation of SI is related to the individual's extremely negative self-experience, self-perception, and extremely unbalanced self-perception. Depression mediates or regulates SI through negative self-evaluation. Depression individual evaluation of self is low, easy to produce negative cognition, often produce guilt, inferiority, and this kind of negative emotions rise is one of the main reasons of SI, the implementation of SI in a short period of time to get rid of remorse, despair, sadness, such as negative emotions, restore calm state of mind. The associations do not fade over time but grow closer, allowing depression to trigger individual SI easily [64]. The run-away theory of suicides also holds that individuals may have the idea that 'suicide can solve all problems' because they cannot bear a lot of negative emotions. The most representative of negative emotions is depression, which is longer lasting and stronger than any other negative emotions, so it is a fact that there is a close connection between depression and SI. Furthermore, neuroimaging studies link brain circuits and emotion regulation to the SI. The occurrence of depressive mood is closely related to the dysregulation of reward response [80], and the reward response occurs in the brain. The current study agree that depressed patients have reduced sensitivity of reward response loop [81], lead to their own reward learning impaired, not objective comparison of the value of various choices, destroy the ability to find alternative solutions, more prone to SI [82]. Depression patients experience deficits in emotional conflict processing, and the associated neural mechanisms involve neurophysiological abnormalities such as amygdala-orbital frontal lobe, Para hippocampal gyrus-temporal pole, and Para hippocampal gyrus-fusiform gyrus. The amygdala-orbitofrontal functional connectivity was diminished in depressed patients, while enhanced Para hippocampal-temporal pole and Para hippocampal gyrus-fusiform functional connectivity fully mediated the effects on SI.

Second, this study also found that age may be an independent protective factor in the young population, with SI decreasing gradually with increasing age. The adolescent risk behavior trajectory suggests that dopaminergic activation in the nucleus accumbens leads to a rise in emotional pursuit, with impulse-risk behavior peaking at this stage [83, 84]. Young adults are in a seminaive and semimature development period and cannot deal with life stress. Acute or chronic stress leads to reduced cerebral serotonin levels, associated with increased impulsive-aggressive behavior [84, 85]. This impulsive-aggressive behavior contributes significantly to suicide in children and adolescents, but it diminishes with age in adulthood [21].

In addition to the above three independent factors, the EN model retained eight potential factors: sexual orientation, caffeine product use, smoking, CESD positive mood scores, INQ-15 TB scores, and GAD-7 scores. Although these variables did not show statistical significance in the multivariate logistic regression analysis, previous studies reported these variables, so we must also consider the effects of these potential influencing factors. A recent meta-analysis of mental health studies found a higher incidence of SI or suicide attempts in heterosexual youth, which is consistent with our findings [86]. This may be due to the stigma and discrimination experienced by specifically oriented youth groups, creating a hostile social environment leading to mental health problems such as chronic stress and depression [87]. This study revealed

that caffeine product use and smoking were potential risk factors for SI. Excess caffeine affects an individual's perception of stress through cortisol responses, increasing the rates of anxiety and suicide [88]. Smoking decreases serotonin and monoamine oxidase A levels and reduces levels of these neurotransmitters, which are associated with depressive episodes and SI production [89, 90]. Furthermore, negative mood swings, such as depression, anxiety, and a frustrated sense of belonging, are often painful [40]. When the level of pain is too high and beyond the reach of the individual, SI develops, and people resort to suicidal behavior to alleviate it.

This research has some limitations. First, the outcome variable tested in this study was SI, which may not be representative of populations dying by suicide or suicide attempts. In future studies, people focusing on attempted suicide may need to provide a more comprehensive and accurate analysis of factors and outcomes related to suicide. Second, prior studies demonstrated that racial and cultural issues can influence SI and behavioral risk among emerging adults and college students; however, we did not control for ethnicity in the included groups, and future studies should consider including variables such as race and culture to get a more comprehensive understanding of the influencing factors of SI. Third, our data were collected during the global outbreak of COVID-19 waves. This viral pandemic may have affected the findings. In the future, we will avoid data collection during large public health time outbreaks and use data from young people in other time periods to validate our study again.

Conclusion

This is the first study to use an Elastic Network logistic regression model in analyzing the factors influencing suicidal ideation in young adults. We found that Perceived Burdensome, depression, and age can together significantly affect suicidal ideation in this population. Thus, the focus should be shifted to the synergistic effect of Perceived Burdensome and depression in young adults, and timely intervention may be an important step toward effectively preventing suicidal behavior.

Abbreviations

SI	Suicidal ideation
NSRR	National sleep research resource
ANSWERS	Assessing nocturnal sleep/wake effects on risk of suicide
CESD	Center for epidemiologic studies depression
S-UPPS-P: Short Urgency	Premeditation, perseverance, sensation seeking, positive urgency, impulsive behavior scale
PSQI	Pittsburgh sleep quality index
INQ-15	Interpersonal needs questionnaire-15
C-SSRS	Columbia-suicide severity rating scale
ISI	Insomnia severity index
GAD-7	Generalized anxiety disorder-7 questionnaire
DDNSI	Disturbing dream and nightmare severity index
BRISC	BRief index of sleep control
EN	Elastic network
PB	Perceived burdensome
TB	Thwarted belongingness
IPTS	Interpersonal-psychological theory of suicide
Q1	Lower quartile
Q3	Upper quartile
NHST	Null hypothesis significance test
BF	Bayes factors
H_0	Null hypothesis
H_1	Alternative hypothesis
AUC	Area under curve
OR	Odds ratio
CI	Confidence interval

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12888-024-06415-6.

Supplementary Material 1

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Author contributions

FW, YK and YL designed the study. ZG, XH, and TK finished the manuscript. ZG led the statistical analyses. YW input the data. FW and YW secured funding for the study. All authors approved the final manuscript for submission.

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Data availability

The relevant information about the ANSWERS can be accessed at: https://doi.org/10.25822/0vvb-6t89. The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (University of Arizona) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all patients for being included in the study. The study was approved by the University of Arizona IRB (protocol # 2005675654).

Informed consent

Data is gathered through participation in undergraduate psychology courses as well as the distribution of flyers and emails. Prior to completing the survey, participants were required to provide informed consent through an electronic consent framework.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. BROADBEAR JH, DWYER J. Coroners' investigations of suicide in Australia: the hidden toll of borderline personality disorder [J]. J Psychiatr Res. 2020;129:241–9.
2. ILICETO P, D'ANTUONO L FINOE, et al. Psychometric properties of the Italian version of the interpersonal needs Questionnaire-15 (INQ-15-I) [J]. J Clin Psychol. 2021;77(1):268–85.
3. KLONSKY E D, MAY A M, SAFFER BY, Suicide. Suicide attempts, and suicidal ideation [J]. Annu Rev Clin Psychol. 2016;12:307–30.
4. ROSSOM RC, COLEMAN K J, AHMEDANI B K, et al. Suicidal ideation reported on the PHQ9 and risk of suicidal behavior across age groups [J]. J Affect Disord. 2017;215:77–84.
5. SIMON G E, SHORTREED S M JOHNSONE, et al. Between-visit changes in suicidal ideation and risk of subsequent suicide attempt [J]. Depress Anxiety. 2017;34(9):794–800.
6. NOCK M K, BORGES G, BROMET E J, et al. Suicide and suicidal behavior [J]. Epidemiol Rev. 2008;30(1):133–54.
7. NOCK M K, GREEN JG, HWANG I, et al. Prevalence, correlates, and treatment of lifetime suicidal behavior among adolescents: results from the National Comorbidity Survey Replication Adolescent supplement [J]. JAMA Psychiatry. 2013;70(3):300–10.
8. BILSEN J. Suicide and youth: risk factors [J]. Front Psychiatry, 2018, 9: 540.
9. O'CONNOR R C, NOCK M K. The psychology of suicidal behaviour [J]. Lancet Psychiatry. 2014;1(1):73–85.
10. KPOSOWA AJ. Unemployment and suicide: a cohort analysis of social factors predicting suicide in the US National Longitudinal Mortality Study [J]. Psychol Med. 2001;31(1):127–38.
11. QIN P, AGERBO E, MORTENSEN PB. Suicide risk in relation to socioeconomic, demographic, psychiatric, and familial factors: a national register-based study of all suicides in Denmark, 1981–1997 [J]. Am J Psychiatry. 2003;160(4):765–72.
12. LEE J I, LEE M B LIAOSC, et al. Prevalence of suicidal ideation and associated risk factors in the general population [J]. J Formos Med Assoc. 2010;109(2):138–47.
13. CASH S J, BRIDGE JA. Epidemiology of youth suicide and suicidal behavior [J]. Curr Opin Pediatr. 2009;21(5):613–9.
14. ARAIN M, HAQUE M. Maturation of the adolescent brain [J]. Neuropsychiatr Dis Treat. 2013;9:449–61.
15. HAWTON K. Sex and suicide. Gender differences in suicidal behaviour [J]. Br J Psychiatry. 2000;177:484–5.
16. RUSSELL S T JOYNERK. Adolescent sexual orientation and suicide risk: evidence from a national study [J]. Am J Public Health. 2001;91(8):1276–81.
17. DELFABBRO PH, WINEFIELD H R, WINEFIELD AH. Life-time and current suicide-ideation in Australian secondary school students: Socio-demographic, health and psychological predictors [J]. J Affect Disord. 2013;151(2):514–24.
18. USALL J, PINTO-MEZA A, FERNáNDEZ A, et al. Suicide ideation across reproductive life cycle of women. Results from a European epidemiological study [J]. J Affect Disord. 2009;116(1–2):144–7.
19. AGERBO E, NORDENTOFT M, MORTENSEN PB. Familial, psychiatric, and socioeconomic risk factors for suicide in young people: nested case-control study [J]. BMJ. 2002;325(7355):74.
20. BOTEGA NJ, DE AZEVEDO R C, MAURO ML, et al. Factors associated with suicide ideation among medically and surgically hospitalized patients [J]. Gen Hosp Psychiatry. 2010;32(4):396–400.
21. HAWTON K, VAN HEERINGEN K. Suicide [J] Lancet. 2009;373(9672):1372–81.
22. CHU C, BUCHMAN-SCHMITT J M, STANLEY I H, et al. The interpersonal theory of suicide: a systematic review and meta-analysis of a decade of cross-national research [J]. Psychol Bull. 2017;143(12):1313–45.
23. WILSON K G CURRAND, MCPHERSON C J. A burden to others: a common source of distress for the terminally ill [J]. Cogn Behav Ther. 2005;34(2):115–23.
24. BANTJES JR, KAGEE A, MCGOWAN T, et al. Symptoms of posttraumatic stress, depression, and anxiety as predictors of suicidal ideation among South African university students [J]. J Am Coll Health. 2016;64(6):429–37.
25. MIRANDA R, VALDERRAMA J, TSYPES A, et al. Cognitive inflexibility and suicidal ideation: mediating role of brooding and hopelessness [J]. Psychiatry Res. 2013;210(1):174–81.
26. PARKER G, BROTCHIE H. Gender differences in depression [J]. Int Rev Psychiatry. 2010;22(5):429–36.
27. QUAN D, REN J, REN H, et al. Exploring influencing factors of chronic obstructive pulmonary disease based on elastic net and bayesian network [J]. Sci Rep. 2022;12(1):7563.
28. TUBBS A S, HENDERSHOT S, GHANI S B, et al. Social Jetlag and other aspects of Sleep are linked to Non-suicidal Self-Injury among College students [J]. Arch Suicide Res. 2023;27(2):686–703.
29. VERBEEK M J A, HOMMES M A, STUTTERHEIM S E, et al. Experiences with stigmatization among transgender individuals after transition: a qualitative study in the Netherlands [J]. Int J Transgend Health. 2020;21(2):220–33.
30. JIANG L, WANG Y, ZHANG Y, et al. The reliability and validity of the Center for epidemiologic studies Depression Scale (CES-D) for Chinese University students [J]. Front Psychiatry. 2019;10:315.
31. ZHANG B, FOKKEMA M, CUIJPERS P, et al. Measurement invariance of the Center for Epidemiological Studies Depression Scale (CES-D) among Chinese and Dutch elderly [J]. BMC Med Res Methodol. 2011;11:74.
32. LI Z, HICKS MH. The CES-D in Chinese American women: construct validity, diagnostic validity for major depression, and cultural response bias [J]. Psychiatry Res. 2010;175(3):227–32.
33. NADORFF M R, NAZEM S. Insomnia symptoms, nightmares, and suicide risk: duration of sleep disturbance matters [J]. Suicide Life Threat Behav. 2013;43(2):139–49.
34. CYDERS M A, LITTLEFIELD A K, COFFEY S, et al. Examination of a short English version of the UPPS-P Impulsive Behavior scale [J]. Addict Behav. 2014;39(9):1372–6.
35. BILLIEUX J, ROCHAT L, CESCHI G, et al. Validation of a short French version of the UPPS-P Impulsive Behavior scale [J]. Compr Psychiatry. 2012;53(5):609–15.
36. DUGRé JR, GIGUéRE C, PERCIE DU SERT O, et al. The Psychometric properties of a short UPPS-P impulsive behavior Scale among Psychiatric patients evaluated in an emergency setting [J]. Front Psychiatry. 2019;10:139.
37. BUYSSE D J, REYNOLDS C F TH 3RD, et al. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research [J]. Psychiatry Res. 1989;28(2):193–213.
38. VAN ORDEN K A, WITTE T K JAMESLM, et al. Suicidal ideation in college students varies across semesters: the mediating role of belongingness [J]. Suicide Life Threat Behav. 2008;38(4):427–35.
39. BRYAN C J. The clinical utility of a brief measure of perceived burdensomeness and thwarted belongingness for the detection of suicidal military personnel [J]. J Clin Psychol. 2011;67(10):981–92.
40. VAN ORDEN K A, CUKROWICZ K C, WITTE T K, et al. Thwarted belongingness and perceived burdensomeness: construct validity and psychometric properties of the interpersonal needs questionnaire [J]. Psychol Assess. 2012;24(1):197–215.
41. PéREZ RODRíGUEZ S, GARCíA-ALANDETE J, GALLEGO HERNáNDEZ DE TEJADA B, et al. Psychometric properties of the interpersonal needs Questionnaire-15 in Spanish adolescents [J]. Front Psychiatry. 2022;13:833400.
42. POSNER K, BROWN G K, STANLEY B, et al. The Columbia-suicide severity rating scale: initial validity and internal consistency findings from three multisite studies with adolescents and adults [J]. Am J Psychiatry. 2011;168(12):1266–77.
43. SALVI J. Calculated decisions: Columbia-suicide severity rating scale (C-SSRS) [J]. Emerg Med Pract, 2019, 21(5): Cd3–4.
44. CROSBY A E, HAN B, ORTEGA L A, et al. Suicidal thoughts and behaviors among adults aged ≥ 18 years–United States, 2008–2009 [J]. MMWR Surveill Summ. 2011;60(13):1–22.
45. MORIN C M, BELLEVILLE G, BéLANGER L, et al. The Insomnia Severity Index: psychometric indicators to detect insomnia cases and evaluate treatment response [J]. Sleep. 2011;34(5):601–8.
46. CHU C, HOM M A, ROGERS M L, et al. Insomnia and suicide-related behaviors: a multi-study investigation of thwarted belongingness as a distinct explanatory factor [J]. J Affect Disord. 2017;208:153–62.
47. JOHNSON S U, ULVENES P G, ØKTEDALEN T, et al. Psychometric properties of the General anxiety disorder 7-Item (GAD-7) scale in a Heterogeneous Psychiatric sample [J]. Front Psychol. 2019;10:1713.
48. TOUSSAINT A, HüSING P, GUMZ A, et al. Sensitivity to change and minimal clinically important difference of the 7-item generalized anxiety disorder questionnaire (GAD-7) [J]. J Affect Disord. 2020;265:395–401.
49. KRAKOW B J, MELENDREZ D C, JOHNSTON L G, et al. Sleep dynamic therapy for Cerro Grande Fire evacuees with posttraumatic stress symptoms: a preliminary report [J]. J Clin Psychiatry. 2002;63(8):673–84.

50. LEE R, KRAKOW B. Psychometric properties of the Disturbing dream and nightmare severity index-korean version [J]. J Clin Sleep Med. 2021;17(3):471–7.
51. MCCALL W V, BATSON N, WEBSTER M, et al. Nightmares and dysfunctional beliefs about sleep mediate the effect of insomnia symptoms on suicidal ideation [J]. J Clin Sleep Med. 2013;9(2):135–40.
52. GRANDNER MA, OLIVIER K, GALLAGHER R, et al. Quantifying impact of real-world barriers to sleep: the brief index of Sleep Control (BRISC) [J]. Sleep Health. 2020;6(5):587–93.
53. HOIJTINK H, MULDER J, VAN LISSA C, et al. A tutorial on testing hypotheses using the Bayes factor [J]. Psychol Methods. 2019;24(5):539–56.
54. WAGENMAKERS E J, MARSMAN M, JAMIL T, et al. Bayesian inference for psychology. Part I: theoretical advantages and practical ramifications [J]. Psychon Bull Rev. 2018;25(1):35–57.
55. GOODMAN S N. Toward evidence-based medical statistics. 1: the *P* value fallacy [J]. Ann Intern Med. 1999;130(12):995–1004.
56. DIENES Z. Bayesian Versus Orthodox statistics: which side are you on? [J]. Perspect Psychol Sci. 2011;6(3):274–90.
57. MALONE HE. COYNE I. Complementing the *P*-value from null-hypothesis significance testing with a Bayes factor from null-hypothesis bayesian testing [J]. Nurse Res, 2020, [Epub ahead of print].
58. WAGENMAKERS E J, LOVE J, MARSMAN M, et al. Bayesian inference for psychology. Part II: example applications with JASP [J]. Psychon Bull Rev. 2018;25(1):58–76.
59. DIENES Z, MCLATCHIE N. Four reasons to prefer bayesian analyses over significance testing [J]. Psychon Bull Rev. 2018;25(1):207–18.
60. JAHN D R, CUKROWICZ K C. The impact of the nature of relationships on perceived burdensomeness and suicide ideation in a community sample of older adults [J]. Suicide Life Threat Behav. 2011;41(6):635–49.
61. WILSON K G, KOWAL J. Self-perceived burden, perceived burdensomeness, and suicidal ideation in patients with chronic pain [J]. Can J Pain. 2017;1(1):127–36.
62. MARCUS M A, WESTRA H A, EASTWOOD JD, et al. What are young adults saying about mental health? An analysis of internet blogs [J]. J Med Internet Res. 2012;14(1):e17.
63. HILL R M, PETTIT JW. The role of autonomy needs in suicidal ideation: integrating the interpersonal-psychological theory of suicide and self-determination theory [J]. Arch Suicide Res. 2013;17(3):288–301.
64. BRITTON P C, VAN ORDEN K A, HIRSCH J K, et al. Basic psychological needs, suicidal ideation, and risk for suicidal behavior in young adults [J]. Suicide Life Threat Behav. 2014;44(4):362–71.
65. MCPHERSON CJ, WILSON K G. MURRAY M A. feeling like a burden: exploring the perspectives of patients at the end of life [J]. Soc Sci Med. 2007;64(2):417–27.
66. CREEMERS D H, SCHOLTE R H, ENGELS RC, et al. Damaged self-esteem is Associated with internalizing problems [J]. Front Psychol. 2013;4:152.
67. GARBER J. Depression in children and adolescents: linking risk research and prevention [J]. Am J Prev Med. 2006;31(6 Suppl 1):S104–25.
68. DAVEY C G, HARRISON B J. The self on its axis: a framework for understanding depression [J]. Transl Psychiatry. 2022;12(1):23.
69. CASEY B, J, JONES R M. HARE T A. The adolescent brain [J]. Ann N Y Acad Sci. 2008;1124:111–26.
70. STEINBERG L. Cognitive and affective development in adolescence [J]. Trends Cogn Sci, 2005, 9(2): 69–74.
71. KORCZAK D J, WESTWELL-ROPER C SASSIR. Diagnosis and management of depression in adolescents [J]. CMAJ. 2023;195(21):E739–46.
72. BRåDVIK L. Suicide risk and Mental disorders [J]. Int J Environ Res Public Health, 2018, 15(9).
73. FIEDOROWICZ J G, PERSONS J E, ASSARI S, et al. Depressive symptoms carry an increased risk for suicidal ideation and behavior in bipolar disorder without any additional contribution of mixed symptoms [J]. J Affect Disord. 2019;246:775–82.
74. KEILP J G, GRUNEBAUM M F, GORLYN M, et al. Suicidal ideation and the subjective aspects of depression [J]. J Affect Disord. 2012;140(1):75–81.
75. KIM S. LEE K. The effectiveness of Predicting suicidal ideation through depressive symptoms and social isolation using machine learning techniques [J]. J Pers Med, 2022, 12(4).
76. ASNIS G M, FRIEDMAN T A, SANDERSON W C, et al. Suicidal behaviors in adult psychiatric outpatients, I: description and prevalence [J]. Am J Psychiatry. 1993;150(1):108–12.
77. SOKERO T P, MELARTIN T K, RYTSäLä HJ, et al. Suicidal ideation and attempts among psychiatric patients with major depressive disorder [J]. J Clin Psychiatry. 2003;64(9):1094–100.
78. CHA CB, O'CONNOR R C, KIRTLEY O, et al. Testing mood-activated psychological markers for suicidal ideation [J]. J Abnorm Psychol. 2018;127(5):448–57.
79. PACHKOWSKI MC, HEWITT P L, KLONSKY ED. Examining suicidal desire through the lens of the three-step theory: a cross-sectional and longitudinal investigation in a community sample [J]. J Consult Clin Psychol. 2021;89(1):1–10.
80. PROUDFIT G H, BRESS J N, FOTI D, et al. Depression and Event-related potentials: emotional disengagement and reward insensitivity [J]. Curr Opin Psychol. 2015;4:110–3.
81. TURNER B D, ROOK J M, LINDSLEY C W, et al. mGlu(1) and mGlu(5) modulate distinct excitatory inputs to the nucleus accumbens shell [J]. Neuropsychopharmacology. 2018;43(10):2075–82.
82. ROTHKIRCH M, TONN J, KöHLER S, et al. Neural mechanisms of reinforcement learning in unmedicated patients with major depressive disorder [J]. Brain. 2017;140(4):1147–57.
83. CHAMBERS R A, TAYLOR J R, POTENZA M N. Developmental neurocircuitry of motivation in adolescence: a critical period of addiction vulnerability [J]. Am J Psychiatry. 2003;160(6):1041–52.
84. ROMER D. Adolescent risk taking, impulsivity, and brain development: implications for prevention [J]. Dev Psychobiol. 2010;52(3):263–76.
85. ROSIEK A, ROSIEK-KRYSZEWSKA A, LEKSOWSKI Ł, et al. Chronic stress and suicidal thinking among Medical students [J]. Int J Environ Res Public Health. 2016;13(2):212.
86. MARSHAL M P, DIETZ L J, FRIEDMAN M S, et al. Suicidality and depression disparities between sexual minority and heterosexual youth: a meta-analytic review [J]. J Adolesc Health. 2011;49(2):115–23.
87. BURTON C M, MARSHAL M P, CHISOLM D J, et al. Sexual minority-related victimization as a mediator of mental health disparities in sexual minority youth: a longitudinal analysis [J]. J Youth Adolesc. 2013;42(3):394–402.
88. KIM H, PARK J, LEE S, et al. Association between energy drink consumption, depression and suicide ideation in Korean adolescents [J]. Int J Soc Psychiatry. 2020;66(4):335–43.
89. EVINS A E, KORHONEN T, KINNUNEN T H, et al. Prospective association between tobacco smoking and death by suicide: a competing risks hazard analysis in a large twin cohort with 35-year follow-up [J]. Psychol Med. 2017;47(12):2143–54.
90. MALONE K M WATERNAUXC, HAAS G L, et al. Cigarette smoking, suicidal behavior, and serotonin function in major psychiatric disorders [J]. Am J Psychiatry. 2003;160(4):773–9.

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