

RESEARCH AND DEVELOPMENT OF A SUICIDE ASSESSMENT SCALE IN SINGLE-SESSION SUICIDE CRISIS INTERVENTION

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Abstract

The incidence of suicide, particularly among youth, is on the rise. Research has shown that single-session suicide interventions can effectively reduce suicide risk. The objective of this study was to develop a concise suicide assessment scale that incorporates both risk and protective factors, designed specifically for use in single-session interventions. A combination of item analysis, factor analysis, and characteristic curve analysis was employed to select 83 items from existing literature. These items were then subjected to a two-stage scale development process, including a pre-test and a formal test. The finalized scale, derived from a sample of 798 college students, consists of 30 items across four factors: suicidal behavior, depression, hopelessness, and reasons for living. The Cronbach's α for these factors ranged from 0.85 to 0.95. The criterion validity was found to be 0.77 ($p < 0.01$). ROC curve analysis determined the critical value of the scale to be 120 points, with scores of 120 or lower indicating a suicide risk, which can be further classified as mild, moderate, or severe. This suicide assessment scale is reliable, valid, easy to use, and has the ability to identify suicide risk.

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Keywords: single-session suicide intervention; suicide assessment scale; warning sign; suicide risk factor; protective factor; college students.

Suicide is a serious public health problem and can negatively affect individuals, families, and society. According to the World Health Organization (WHO) (2021), 703,000 people die by suicide worldwide every year, and the WHO estimates about 25 cases of suicide attempts occur for each suicide death. A modest estimate of the suicide death data is that about 20 million people attempt suicide each year (Lew, et al., 2021); however, due to the imperfect registration system, the suicide phenomenon and the number of suicide patients are far more than reported.

China's suicide rate has dropped sharply in recent years, but the number of suicide deaths remains alarming. According to the China Health Statistical Yearbook 2022, the number of suicide deaths per 100,000 among urban and rural residents was 4.31 and 7.09, respectively in 2021 (The Central People's Government of the People's Republic of China, 2023). Lew et al. (2021) found that for each suicide death, about 135 people experienced a substantial negative impact, suggesting that about 10.18 million people in China were negatively affected by suicide in 2021. To reduce the impact of suicide events, it is crucial to develop effective suicide intervention strategies.

Suicide occurs at all stages of the life cycle, and the suicide of young people should be given increased attention. According to the Status of Global Suicide 2019 published by the WHO, suicide remains one of the leading causes of death worldwide, and suicide is the fourth leading cause of death in the global age group of 15-29 years (WHO, 2021). A meta-analysis of suicide attempts among Chinese adolescents pooled 43 previous studies involving 200,124 participants and found that the overall prevalence of suicide attempts among Chinese adolescents was 2.94%, ranking among the median global prevalence of adolescent suicide attempts (Hu, et al., 2015). The suicide phenomenon is particularly serious among college students, especially in the high incidence of suicide attempts among young people. The suicide situation of college students is particularly prominent, with a suicide rate that is two to four times that of their peers and that continues the rise (Hu, et al., 2016). In summary, as a high-risk group for suicide, adolescent suicide assessments have high research value and practical significance. Therefore, this article based its research on the adolescent and young adult population (14-15 years old).

The purpose of suicide assessment and intervention is to reduce the risk of suicide, increase the positive feelings of individuals at risk, and improve the chances of individuals at risk to receive services and thus save their lives. Compared with ordinary cases, suicide risk cases can be given fewer opportunities and time for

intervention, yet the treatment of suicide problems is more urgent than ordinary problems. Therefore, interventions for at-risk individuals should consider achieving effects in a limited number of times or even a single opportunity within a short period (minutes, hours, or days). The single-session intervention model belongs to the short-term working model; that is, within the opportunity of only one or a limited number of interventions, the model can meet the need for emergency treatment for individuals who are at risk for suicide. Previous studies have confirmed the applicability of the single-session suicide crisis intervention model to suicide issues. Lin et al. (2022) found that the Single-Session Suicide Crisis Intervention can effectively reduce suicide risk (an average reduction rate of suicide risk of 21.35%) and produce sustained positive effects covering the individual, relationships, and spirituality, but that the single-session suicide crisis intervention model using four independent scales in the suicide risk evaluation is not suitable for suicide cases with only one intervention opportunity in a short time. A simplified suicide assessment scale covering suicide risk factors and protective factors will be developed and applied to the single-session suicide intervention to effectively reduce suicide risk. Integrating the advantages of assessment and intervention will greatly increase the possibility of saving lives and achieve the goals of rapid clinical assessment and effective intervention. Therefore, based on the study of Lin et al. (2022), this research developed a single-session suicide assessment scale that could be applied to a single-session suicide crisis intervention covering suicidal behavior, cognition, and emotional orientation, and then verified the effectiveness of this scale.

Literature Review

Factors associated with suicide

The factors associated with suicide can be categorized into risk factors, protective factors, and warning signs. While many articles have extensively covered suicide risk factors, this paper will focus on the less-explored areas of suicide protective factors and warning signs. It's important to note that suicide risk factors might not always indicate an immediate crisis (for example, a history of suicide attempts does not necessarily reflect the urgency of the current situation). Therefore, risk factors are generally used as reference points for assessing potential crises. However, to better identify imminent risks and save lives, this study emphasizes suicide warning signs, which can urgently signal the presence of risk, and protective

factors, which serve as crucial buffers during intervention. While all three categories are included in this scale, each has a distinct focus, which is a key feature of this assessment tool.

From a temporal perspective, there is an imbalance in the research on these different factors. Previous suicide research has primarily concentrated on passive (risk) factors that may increase the likelihood of suicide, with relatively little attention given to active (protective) factors that could reduce this risk (Deng, et al., 2012). Rudd (2008) also highlighted the abundance of studies on suicide risk factors compared to the scarcity of research on suicide warning signs. Consequently, this paper aims to develop a scale that encompasses all three factors related to suicide.

Protective factors of suicide

Protective factors can serve as seeds of hope for patients at suicide risk, reducing their short- or long-term suicide risk. The role of protective factors in suicide prevention and interventions is increasingly being recognized (Wang & Wu, 2013). Therefore, in addition to assessing risk factors, suicide risk assessment should also include protective factors, reasons for living, and other factors that can reduce suicide risk. This is consistent with the idea proposed by O’Keefe et al. (2019) that incorporating risk factors and protective factors into assessments and combining them with suicide interventions can improve the psychological resilience of individuals at risk of suicide.

Suicide warning signals

Risk factors can predict danger but not emergencies, which is not conducive to capturing the urgency of suicide risk, so this study investigated suicide warning signals. Suicide warning signals (warning signs for suicide) refer to short-term indications (a few minutes, hours, or days) from high-risk individuals and can be detected by processing the earliest signals closely related to suicidal behavior, such as mood, thoughts, or behavior (Rudd, 2008). In the case of suicide, suicide warning signals present a simple and direct goal: to increase the chance of suicidal individuals to receive services and save their lives (Rudd, 2008).

The suicide warning signal is different from the concept of the suicide risk factor, which applies to different clinical situations. Rudd et al. (2006) stated that most studies of suicide risk factors are clinically relevant, with predictions of suicidal behavior ranging from one year to as long as 20 years, such as past suicide history. Most individuals who reported a past history suicide do not complete suicide, whereas many individuals who do complete suicide have no history of suicide attempts. Rudd et al. (1994) showed that most risk factors are predictive or

informative about suicide, but it was difficult to identify immediate substantial risk at the first point in time. Suicide warning signals are critical and identifiable in the short term, which is conducive to identifying the urgency of suicide risk. Suicide crises are essentially acute and time-limited, so suicide intervention requires assessing critical and identifiable suicide warning signals and taking immediate suicide interventions, which is different from suicide risk discrimination, as suicide warning signs are more closely related to clinical intervention. Rudd et al. (2006) called for the inclusion of suicide warning signs in various theories of suicide.

According to Rudd et al. (2006), the commonly recognized suicide warning signals that require immediate intervention are as follows: the oral or written expressions of suicidal intent (such as the threat of self harm), looking for fatal suicide means (such as weapons, drugs, poison, etc.), preparing for suicide (such as creating a suicide plan, making arrangements for after the related plan, etc.). Other widely recognized warning signs include despair, rage, resentment, reckless or dangerous behavior, feeling helpless, increased alcohol use, interpersonal withdrawal, anxiety, difficulty falling asleep or drowsiness, dramatic shifts in mood, and failure to find a reason to survive (Rudd, 2008).

The scale of this paper was compiled based on previous research covering suicide risk factors, protection factors, and suicide warning factors, and the suicide risk scale was compiled using the content of the suicide warning signal as the risk detection signal.

A theoretical model of suicide

With the deepening of the field of suicide research, researchers have begun to transition from the influencing factors of suicide to a systematic and deep theoretical model to interpret suicide. This paper developed the suicide risk scale according to the following two theories.

Hypothetical theory of suicidal behavior history

Bonner and Rich (1987) put forward the course of suicidal behavior, which states that suicidal behavior is caused by multiple elements (that is, the generation of suicidal behavior is a process of the interaction of environment, cognition, society, emotion, and other variables), and put forward the corresponding concept to form a pattern of the suicide process, as shown in Figure 1.

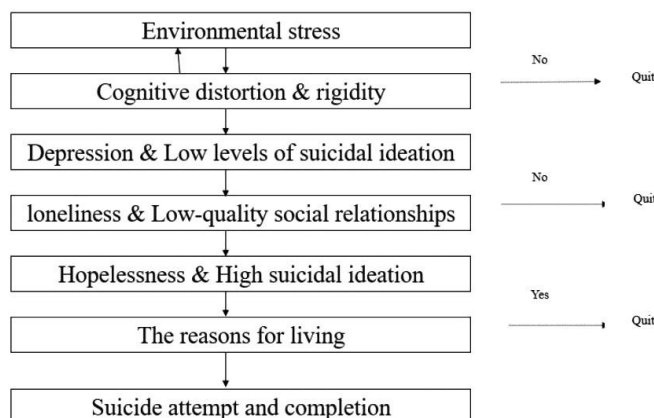


Figure 1. Suicidal behavior course hypothesis

First, the model suggests that the interaction between environmental stress and cognitive distortion/rigidity leads to depression. Schotte and Clum (1982) showed that depression is the most predictive of low levels of suicidal ideation. When falling into depression, individual loneliness and social support variables become crucial. Depressed individuals with high-quality social relationships can overcome depression and loneliness more effectively, while lonely or isolated people are more likely to feel hopeless. Hopelessness predicts higher levels of suicidal ideation and behavior. However, not everyone who experiences hopelessness and intense suicidal ideation attempts suicide. Reasons for living play a key factor in whether crisis cases will lead to suicidal behavior. Based on previous research, Linehan combined cognitive behavioral theory and her own experience to first propose the concept of “reason to living” (Liu & Zhao, 2017). This concept has been widely used as a protective factor of suicide and in the preparation of the reasons for living scale. It is believed that people who commit suicide generally lack important beliefs and values and are more likely to turn suicidal ideation into suicidal behavior, or even complete suicide. The model takes environmental stress, cognition, negative emotions, social support, and reasons for living as the predictive variables of suicide. Suicide involved the interaction of many variables and must go through a series of development processes to finally completed suicide. Therefore, we can think backwards about how to eliminate the development of suicide. Starting from the different variables of the model, especially the protective factors (the buffering role of the reasons for living), changing any one of the variables can fulfill the purpose of intervening in suicide and save lives. The hypothetical model of the suicidal behavior course provides new perspectives on understanding the development of suicide.

Multiple interaction modes of suicidal behavior

Rickelman and Houfek (1995) proposed the multiple interaction model of suicidal behavior, based on the hypothesis of suicidal behavior history. This model includes the environmental, personal, and epidemiological effects on suicidal behavior, as shown in Figure 2.

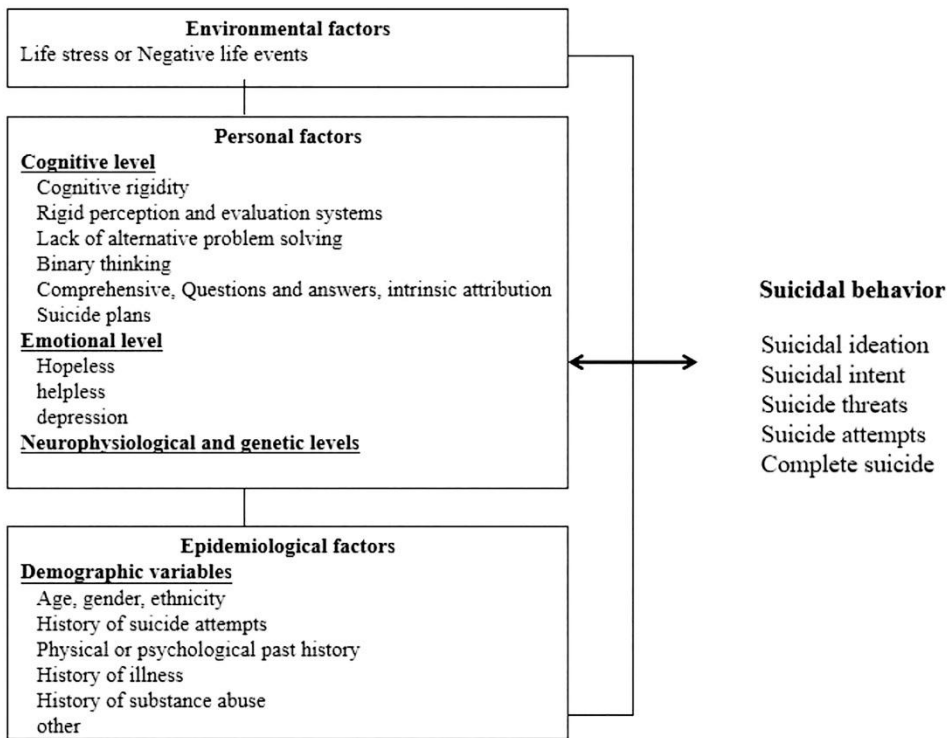


Figure 2. Multiple interaction modes of suicidal behavior

When these aspects are combined, suicidal behavior can be predicted. Neurobiological and genetic factors are involved in suicide. Because the multiple interaction model is based on the assumption of suicidal behavior, it also emphasizes the interaction of multiple variables (namely, environmental life stress or negative life events), which can lead to individual cognition, emotion, neurophysiological and genetic influences. The degree of adverse effect is closely related to demographic variables and epidemiological factors, and variables in the epidemiological factors will in turn affect an individual's environmental life pressure or negative life events.

These factors all form an interaction that jointly promotes the generation of suicidal behavior.

Although the multiple interaction model is built on the pattern of suicidal behavior, the two have some differences. Suicidal behavior course does not mention the neurophysiological and genetic levels or demographic variables; rather, it puts more emphasis on positive interpersonal relationships as survival reasons and other adaptive beliefs, and tries to use adaptive survival reasons as a buffer for suicide to carry out prevention. In addition, the two models construct the suicide course from different levels, and the multiple interaction modes mainly construct the suicide course from the risk factor theory of suicide, while the hypothesis model of suicidal behavior course is explained by the protective factor with deterrent effect, while avoiding the state variables that are difficult or cannot be corrected.

This study adopted the hypothetical model of suicidal behavior and the multiple interaction theory of suicide, combined with risk factors and protective factors. While measuring individual suicide risks, it also simultaneously explored and developed available resources as buffers, thereby developing a suicide scale for use in a single-session suicide crisis intervention. Suicide crisis interventions are different from the practice of suicide risk identification, due to the criticality and urgency of the situation. Suicide risk identification must involve evaluating key and identifiable suicide warning signals. Therefore, the scale covered suicide risk factors, protective factors, and suicide warning factors. Particular emphasis was placed on using suicide warning signals as risk detection signals to compile a one-time unit intervention suicide risk scale.

Development connotation of the suicide risk scale

The general development of suicide risk assessment scales

Building on previous research in the development of suicide risk scales, this paper aims to create a comprehensive scale that integrates both risk factors and protective factors, aligning with the dual objectives of risk assessment and protective intervention. Below is an overview of the research conducted in the development of this Suicide Scale:

The development of suicide risk assessment tools, from a single suicide risk scale to evaluate suicide to a relatively comprehensive and systematic suicide assessment theory, has resulted in a relatively complete evaluation system (Xu, et al., 2019). The single suicide risk scale can be classified into suicidal ideation, suicidal mood, suicidal behavior, and other suicide-related scales according to the measurement dimensions. Relatively comprehensive and systematic suicide assessments were used to assess suicide risk in groups. Suicide risk assessment tools are constantly being developed and improved. They are not only available for different ages, objects, and application places but also combine suicide risk screening

and assessment to form a mature and complete suicide assessment process, which greatly improves the success rate of suicide prevention.

The development of suicide assessment in China is still in its early stage. Single-dimensional scales are being used to evaluate suicide, with some self-compiled scales still in use and being improved, but complete assessment processes and targeted intervention measures are still in the exploratory period (Xu, et al., 2019). The commonly used scales can be divided into two categories. The first category includes scales that are clinically and directly translated but not strictly revised, such as Hamilton Depression Rating Scale (HAM-D; Hamilton, 1967) and the Beck Hopelessness Scale (BHS; Beck, et al., 1974). Their applicability in the Chinese population has not been rigorously or extensively studied. The second category includes suicide risk assessment scales of different dimensions compiled by scholars, such as the suicide attitude questionnaire of Xiao et al. (1999) covering four dimensions: attitudes toward suicidal behavior, attitudes toward suicide victims, attitudes toward suicide victims' families, and attitudes toward euthanasia. Liu et al. (2010) created the college student suicidal tendency scale, which involved the five dimensions of suicide attempts, despair, mental disorders, negative responses, and stress events. Yang and Tong (2008) compiled the preliminary preparation of suicide risk scale for college students, including factors such as suicide ideation, suicide preparation, despair, suicide identity, and life identity. Li et al. (2012) created the Suicide Risk Rating Scale (SRRS) suitable for the Chinese population that included four dimensions: negative mood, cognitive rigidity, suicide attitude, and suicide motivation. Nie et al. (2013) created a questionnaire that measured four dimensions: enjoy the moment, social pressure, family responsibility, and fear of death.

From the above materials, it could be found that most of the compiled scales in China tend to focus on the risk factors of suicide (suicide ideation, suicide attempts, suicide preparation, etc.); however, scales of positive dimensions such as protection factors and reasons for living have begun to increase, indicating that attention to the positive dimensions is also increasing. Based on previous studies, this study developed a risk scale covering suicide risk factors and protection factors to synchronize risk assessment and protection factors intervention.

Preparation structure of the suicide risk scale

Content architecture of the suicide risk scale

Both Bonner and Rich (1987) and Rickelman and Houfek (1995) divided suicidal behavior into different continuous courses. This paper defined a series of suicide-related behaviors such as suicide ideation, suicide attempts, and incomplete suicide as suicide risk behaviors. Suicide risk behavior is a continuous process, and the severity of the suicide risk can be distinguished. Suicide can be divided into different levels based on cognitive, emotional, and behavioral components, and past

scholars have developed different test tools to evaluate different suicide components (Range & Antonelli, 1990).

Suicide cognition is related what an individual thinks about the future. Beck et al. (1979) constructed the argument for the correlation between suicide and hopelessness. Studies of psychiatric inpatients have found that factors such as hopelessness and pessimism about the future effectively predict suicidal behavior (Beck, et al., 1985), and the study of Schotte and Clum (1982) found that despair is a better predictor of a higher level of suicidal ideation. Another study found a high correlation between feelings of despair, suicidal ideation, and suicidal behavior (Rudd, et al., 1994). Some scholars have found that hopelessness is a better predictor of suicidal ideation in adolescents than depression (Kovacs & Beck, 1977), and the Beck Hopelessness Scale was developed to assess hopelessness. Another component of suicidal cognition is “reasons for living” which serves as a buffering factor for suicidal cognition and was developed by Linehan et al. (1983) and developed the Reasons for Living Inventory to measure suicidal cognition.

The emotional component associated with suicide is depression (Zung, 1965). In the past, most studies noted that the more severe the depressive symptoms in adolescents, the higher the rate of suicidal risk behaviors (Liu, et al., 2005; O'Donnell, et al., 2004). A cross-sectional study among Hong Kong adolescents found that depressive symptoms are highly correlated with adolescent suicidal ideation, and pattern tests found a direct effect of depressive symptoms on adolescent suicidal ideation (Lee, et al., 2006). Kim and Kim (2008) studied the risk of suicide attempts in Korean adolescents and found that depressive symptoms can predict suicide attempts in adolescents; therefore, they recommended that suicide risk be assessed by measuring suicidal behavior.

At the level of suicidal behavior, including individual suicidal ideation and suicide attempts, Beck (1979) found that suicidal ideation can be an indicator of suicide risk. He developed a suicidal ideation scale using 50 psychiatric inpatients and 55 outpatients with mood disorder, and identified active suicidal desire, specific plans for Suicide, and passive suicidal desire as factors. The scale also specifically included suicide plans. Harris and Barraclough (1997) and others stated that suicide attempts are the most powerful predictor of suicide, and used this to develop the Suicide Behaviors Questionnaire (SBQ). Thompson and Eggert's (1999) suicide risk screening scale collected 581 high school dropouts aged 14-20 as subjects, from which five dimensions were found: suicidal ideation, suicide attempts, incomplete suicide, depression, and drug abuse.

Combing through the data found that substance abuse is associated with suicide (Marcenko, et al., 1999). Substance abuse refers to the uncontrolled repeated and extensive use of synthetic or semi-synthetic substances with dependent properties to experience pleasure, which can cause great harm to the body and mind (Yang, et al., 2017). Studies have found that substance abuse in adolescents and early adults is associated with suicide (Levy & Deykin, 1989; Vega, et al., 1993). When

adolescents engage in alcohol and drug abuse, the rate of suicidal risk behavior becomes high (Bae, et al., 2005; Borowsky, et al., 2001). Thompson and Eggert (1999) developed a suicide risk screening scale that includes five dimensions: suicidal ideation, suicide attempts, incomplete suicide, depression, and substance abuse. Therefore, in this study, substance abuse was also included in the assessment of the suicide risk scale.

To sum up, suicide contains different aspects, including suicidal behavior (such as suicidal ideation, suicide attempts, suicide plans, feasibility of the suicide method, etc.), suicide cognition (hopelessness and reasons for living), suicide mood (depression), as well as the high-risk factor of substance abuse. A review of the existing scales found that most of them involve only one or two of the three components, and that no scale covers all three. Therefore, this paper proposed a suicide risk scale that could comprehensively cover suicide cognition, suicide emotions, suicidal behavior dimensions, substance abuse, suicide warning signals, and reasons for living, to achieve the dual purposes of covering suicide risk factors and protective factors, to realize the risk assessment and protection factor intervention, and to verify the rationality and feasibility of the structure hypothesis. The suicide risk scale construction pattern is shown in Figure 3 below. At the end of the scale, the background information of the subjects was collected (such as stress events, residence conditions, substance abuse, medical history, family history, etc.), to more comprehensively assess the risk and improve the suicide risk screening rate. This study expected to establish an assessment tool suitable for young people (14-35 years old) with good reliability and effective assessment of suicide high-risk groups, which could be provided as a reference for clinical suicide risk assessment tools.

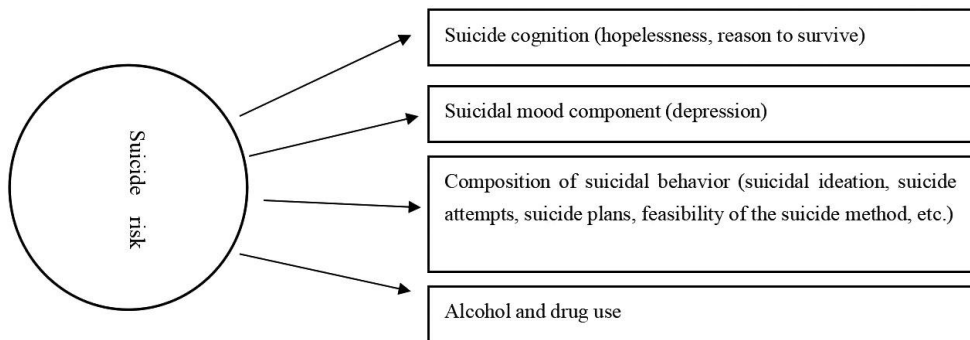


Figure 3. Construction pattern of the suicide risk scale

Questionnaire item structure

The selection of the question bank mainly refers to the content of suicide warning signs by Rudd (2008), in which suicidal behavior is mainly collected from

the suicide-related scale (see Appendix 1 for details); the hopelessness scale adopts the Chinese translation of the Taiwan version of the Beck Hopelessness Scale by Chen (2000); depression is designed with items based on The Diagnostic and Statistical Manual of Mental Disorders-5 diagnostic criteria; substance use is designed with items based on DSM-5 diagnostic criteria; reasons for living refer to Linehan et al. (1983) Reasons for Living Scale Item design. Before determining the question bank, three experts were invited to revise the face validity and expert validity, and then a pre-test study was conducted to test the appropriateness of the model, and items were deleted based on this.

Research Methods

The two-stage scale preparation method was used for pre-testing and formal testing, as shown in Figure 4. Considering the convenience of data collection, the two stages of the study involved university students, and data were collected by offline participants and online questionnaires.

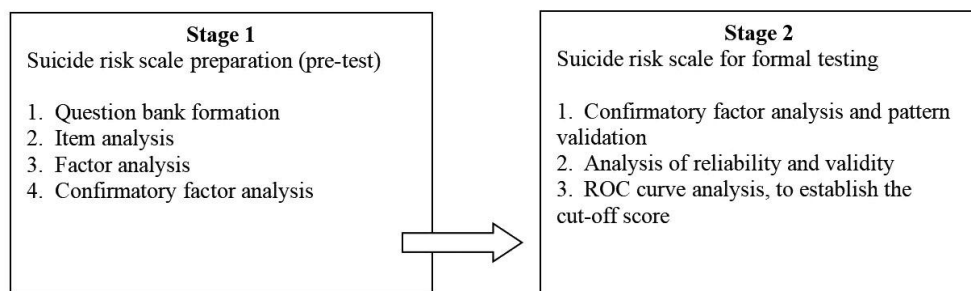


Figure 4. The study process

Preparation suicide scale: pretest

Study procedures

After inviting students to cooperate, with their consent, the participants were informed of the test items and standards, and the group test was carried out. During the collection process, the research member invited students offline to fill in the online scale and informed them of the test content prepared, such as the purpose and confidentiality of the testing, etc. The test place was a university classroom or other place of activity. The final item of the questionnaire encouraged the participants to leave their contact information if they had the above-mentioned suicide problems and wanted help. We also included free help resources and mental health information at the end. For students in need of assistance, help-seeking resources and self-help

messages were provided immediately after data collection, and the students also become potential service subjects for subsequent single-session suicide interventions.

Research tools

The study used Chen's (2000) Taiwan version of the Beck Hopelessness Scale as criterion validity. The scale is composed of 20 "yes-no statements" and is used to assess the subjects' negative expectations for the present and long-term future. The scale is suitable for adolescents over 17 years old, and is especially suitable for measuring subjects who are depressed or have attempted suicide as a predictor of suicide risk. Previous studies demonstrated an internal consistency of 0.82 to 0.93 and a retest reliability (interval) of 0.66 to 0.69, and the correlation with the Beck Depression Inventory (BDI) was 0.46 to 0.76. In the pretest, the internal consistency coefficient of the Beck Hopelessness Scale in this article was 0.96.

Statistical methods

The pretest aimed to streamline the question bank. First, the content validity, surface validity, and expert validity were evaluated for the original question bank, which was revised according to the suggestions. A second round of expert validity evaluation was then carried out to improve the question items again. The following were the statistical methods used in this study:

(1) Descriptive statistics: SPSS23 statistical software was used to test missing values, item distributions, mean and standard deviation analysis, etc.

(2) Exploratory factor analysis: Principal component analysis was used to extract the factors with a characteristic value greater than 1, and a rotation factor matrix was used to find out the appropriate component factors. Questions with a factor load of more than 0.4 under a single factor were retained.

(3) Reliability: Cronbach's α .

(4) Validity: Beck's Hopelessness Scale was the criterion validity of this study

(5) The Confirmatory Factor Analysis: AMOS 23 was used for construct validation. This analysis is mostly used after the development of a scale, to test whether the special indicators (topics) are under the category of each dimension of the theory.

Preparation of the suicide risk scale: formal test

Study procedures

In the formal test data collection process, graduate students with professionally trained psychology backgrounds served as data collectors while visiting university classes or group activity sites for data collection. The data collector participated in the data collection and answered questions on-site until the collection was completed.

Statistical methods

The purpose of the formal test was to calculate the Receiver Operating Characteristic Curve (ROC) and determine the optimal critical value to complete the formal scale. First, confirmatory analysis and an independent sample t-test were used for the overall model fit test, after which the reliability of the internal consistency (Cronbach's α coefficient) was evaluated. The Taiwan version of the Beck hopelessness scale was used to evaluate the association validity of the suicide risk scale. Finally, the ROC is calculated to determine the optimal critical value, cut-off point, sensitivity, specificity, positive predictive value and negative predictive value to establish the discrimination effect of the evaluation scale.

Results

Preparation of the suicide risk scale: pretest

Sample characteristics

A total of 385 participants were involved in the pre-test. After excluding 74 invalid questionnaires, the final sample consisted of 311 participants, resulting in a response rate of 80.8%.

The mean age of the subjects was 21 and there were more females than males (66.9% and 33.1%, respectively). 0.6% of the cases have a history of psychiatric treatment in their families; 1% of the cases themselves have a history of psychiatric treatment; Finally, 2.9% reported recent heavy alcohol consumption. In conclusion, the majority of subjects were women in early adulthood, had no religious beliefs, did not live alone, did not drink a large amount of alcohol, and did not have a family or personal psychiatric medical history.

Analysis results

The original question bank totaled 83 questions, including question 79 (I live on Earth), which tested whether the subjects answered the questions carefully. The analysis of the recovered data was performed as follows.

(1) Item analysis

The purpose of the analysis was to simplify the question bank by analyzing the questions in consideration of deleting items. The items selection standard was: (1) Cronbach's α after deleting the items; (2) internal consistency, set $\alpha < 0.01$; (3) total correlation analysis of project items = $r > 0.3$; (4) factor load > 0.4 ; (5) standard deviation > 0.67 ; and (6) two-tailed significance test < 0.05 . After questions that did not meet the evaluation criteria were cut, 56 items were finally selected.

(2) Factor analysis

Exploratory factor analysis was conducted for the reserved 56 questions. Using the factors extracted from the principal component analysis, four factors were

set up according to the steep slope map, and oblique rotation (Oblimin rotation) was used to simplify the factor structure. The load of the set factor was > 0.4 , and the explanatory variables of the four factors reached 62.313%, indicating that the 56 questions had good explanatory power for the suicide risk variables. The extracted factors were suicidal behavior (29 items), hopelessness (10 items), depression (12 items), and hope and Reasons for living (five items).

Considering the items of the suicidal behavior factor, as many factors had similar meanings or overlapping concepts, this study compared the items and considered their factor loads. Questions with similar items and relatively low factor loads were deleted, and only one similar question was retained. The final scale consisted of suicidal behavior (18 items), hopelessness (10 items), depression (12 items), and hope and the reasons for living (5 items), with 45 questions in total. According to the number of factors (four), the number of steep slope maps was set, and oblique rotation (Oblimin rotation) was used to simplify the factor structure. The loading of factors was > 0.4 . The explanatory variables of the four factors reached 62.385%, higher than the original 56 (62.313%), indicating that the 45 questions had a better interpretation of the suicide risk variables. Among them, there are only two questions left in the substance use dimension, the 2 questions are classified under suicidal behavior factors, respectively, “I have recently drank and had trouble for myself (such as car accidents, injuries, conflicts, etc.)”, and “I have recently used drugs and gotten into trouble (such as car accidents, injuries, conflicts, etc.)”. The final question bank is a total of 45 items for four factors, including suicidal behavior 18, hopelessness 10, depression 12, and hope and the reasons for living 5. See Appendix 2.

Analysis of confirmatory factors

During the confirmatory factor analysis, if the overall fit indices of each factor do not fall within the standard range ($RMSEA < 0.08$; $1 < \text{Chi-square/degrees of freedom} < 3$; $GFI > 0.8$; $AGFI > 0.8$), the items need to be revised. This revision process is conducted in two steps.

In the first step, the standardized estimated value for each item is determined. This value reflects the degree of alignment between the item and its corresponding factor, with 0.5 set as the threshold. Items with a standardized estimated value lower than 0.5 are considered to be below the standard and are candidates for deletion. This step involves model verification, and if the model fit indices are within the acceptable range, the model is deemed successfully constructed.

If the revision is not successful in the first step, the process moves to the second step, which involves adjusting the model based on the modification index of covariance. In this step, items that can most significantly reduce the chi-square value are identified and deleted, with model verification conducted after each deletion. This process continues until the model fit indices meet the acceptable standards, resulting in the deletion of 16 items.

After the model revision, 16 questions were deleted, and the total number of questions was reduced to 29. (see Table 1, Figure5), the analysis results of the adaptation index were known and confirmed that the construction validity of the model was reasonable and acceptable.

Table 1. Model diagram of the confirmatory factor analysis

Fitting the index	df	χ^2	χ^2/df	CFI	NFI	RMSEA
Critical value	—	—	< 3	> 0.90	> 0.80	< 0.10
First order model	371	797.84	2.15	0.93	0.88	0.06

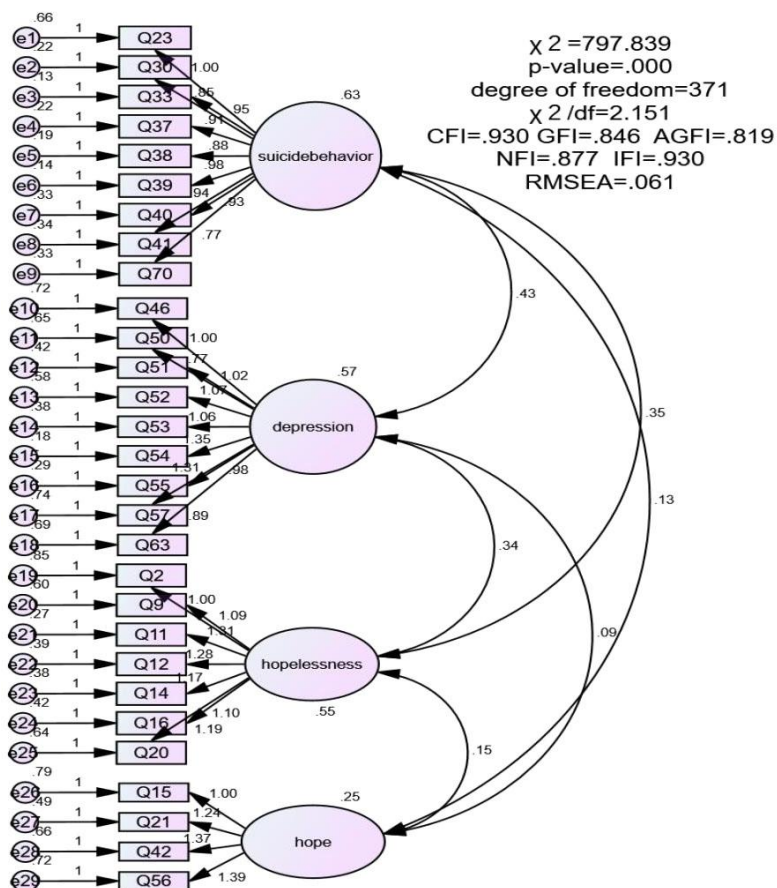


Figure 5. Confirmatory factor analysis model

Intervention strategies for groups at high risk of suicide need to develop shorter and more effective scales, with no more than 30 assessment items or less, and the goal of achieving good reliability and validity in a streamlined scale. In order to meet the needs of this purpose, questions are gradually eliminated in a layer-by-layer manner and achieve better explanatory power.

(4) Reliability analysis

The last retained suicide risk scale included 29 questions, with the Cronbach's α of the hopelessness scale= 0.912, the Cronbach's α of the suicidal behavior subscale= 0.941, the Cronbach's α of the hope and reasons for living subscale= 0.694, and the Cronbach's α of the depression subscale= 0.914. The total Cronbach's α was 0.946, indicating the above content showed good internal consistency.

(5) Expert validity analysis

After confirming that the construction validity of the model, the scale was subject to a second expert validity analysis for the formal test. Three psychology professors were involved in clinical psychology, counseling, and crisis intervention, etc. All rated their opinions on 29 items respectively. The scale has been revised through six versions, involving the grammatical expression of the items, the determination of the duration of the suicidal problem, and the modification of expert opinions. Considering the different subtypes of depression in young people, the question "In recent weeks, I have been depressed, frustrated, or irritable" was modified into two questions: "My mood is depressed" and "I tend to feel irritable." Finally, Determine a 30-item suicide assessment scale (see Appendix 3 for details). The factor structure of the formal scale is detailed in Table 2.

Table 2. Factor structure of the formal scale

items	Factor components			
	1	2	3	4
1. Everything I see is unpleasant and no fun	0.17	-0.03	0.70	-0.04
2. I'm not expecting to get what I want.	-0.13	0.02	0.78	-0.02
3. Things never go my way	0.20	-0.06	0.72	-0.03
4. I never get what I want (including people and things), so it's stupid to want to have anything.	-0.12	0.11	0.84	-0.05
5. I want to give up because I can't make myself better.	0.17	-0.10	0.65	0.11
6. Because I may not get what I want (including people and things), it's no use trying to pursue it.	-0.05	-0.01	0.81	0.05
7. I just can't get good luck, and I don't think I can get good luck in the future.	-0.00	-0.03	0.74	0.10
8. I want to die.	0.15	0.39	0.20	0.21
9. I've already written a suicide note.	-0.14	0.82	0.12	-0.04
10. The tools I plan to use to commit suicide are ready and readily available.	-0.10	0.92	0.01	-0.03
11. I will punish others with my death.	-0.03	0.83	0.04	-0.02

items	Factor components			
	1	2	3	4
12. I will use suicide to lighten the burden on my family.	0.06	0.80	-0.09	0.08
13. Death is the best solution for me.	0.12	0.72	-0.01	0.14
14. I understand that the suicide method I choose has a very high death rate.	0.11	0.80	-0.13	0.05
15. I have the ability and the courage to commit suicide by myself.	0.18	0.74	-0.18	0.02
16. I recently drank alcohol and caused trouble for myself (car accidents, injuries, conflicts, etc.).	-0.05	0.75	0.14	-0.16
17. My mood is depressed.	0.65	0.05	0.15	0.04
18. I tend to feel irritable.	0.67	-0.00	0.13	0.07
19. My weight has increased or decreased significantly (without intentional weight gain or weight loss).	0.51	0.10	0.19	-0.19
20. In recent weeks, I have had insomnia almost every day.	0.58	0.16	0.11	-0.15
21. In recent weeks I have been sleeping almost every day.	0.72	-0.07	-0.04	-0.01
22. I am restless almost every day and need to move or do things constantly	0.69	0.21	-0.000	-0.06
23. I am sluggish almost every day.	0.83	-0.01	-0.06	0.03
24. I am almost tired or inactive every day.	0.88	-0.05	-0.05	0.07
25. I will feel guilty about my mistakes in the past.	0.79	-0.03	-0.13	-0.00
26. There has been a significant decline in the quality of my performance in school or at work.	0.83	-0.08	-0.04	-0.00
27. I am willing to survive.	-0.25	0.26	0.02	0.65
28. I have great confidence in the future.	0.12	-0.15	0.01	0.9
29. I consider myself very valuable.	0.08	-0.13	0.01	0.90
30. I have the reason/belief to live.	-0.11	0.18	0.03	0.80

Preparation of the suicide risk scale: formal test

Sample characteristics

To facilitate the test, the Beck hopelessness scale was included in the suicide risk scale. The number of questions in the combined scale was 43, among which the 39th question “I walk on both feet every day” was used to test whether the subjects were answering carefully. There were 839 data in formal test, 798 data were valid, the response rate was 95.11%.

The mean age of the subjects was 20.5 years, with more female subjects than males, at 61.5% and 38.15%, respectively. There were more undergraduates than graduate students, with 84.5% and 15.5%, respectively. Of the subjects, 2.9% had a history of psychiatric treatment, 3.5% had a family history of psychiatric treatment, and 3% had recently engaged in heavy alcohol consumption. In conclusion, the majority of subjects were women in early adulthood, had no religious beliefs, did not live alone, did not drink a large amount of alcohol, and did not have a personal or family history of psychiatric treatment.

Study results

(1) Validation analysis

The overall fit test of the second-order model was performed using Amos 23.0 software, and the data results were as shown in Table 3 and Figure 6.

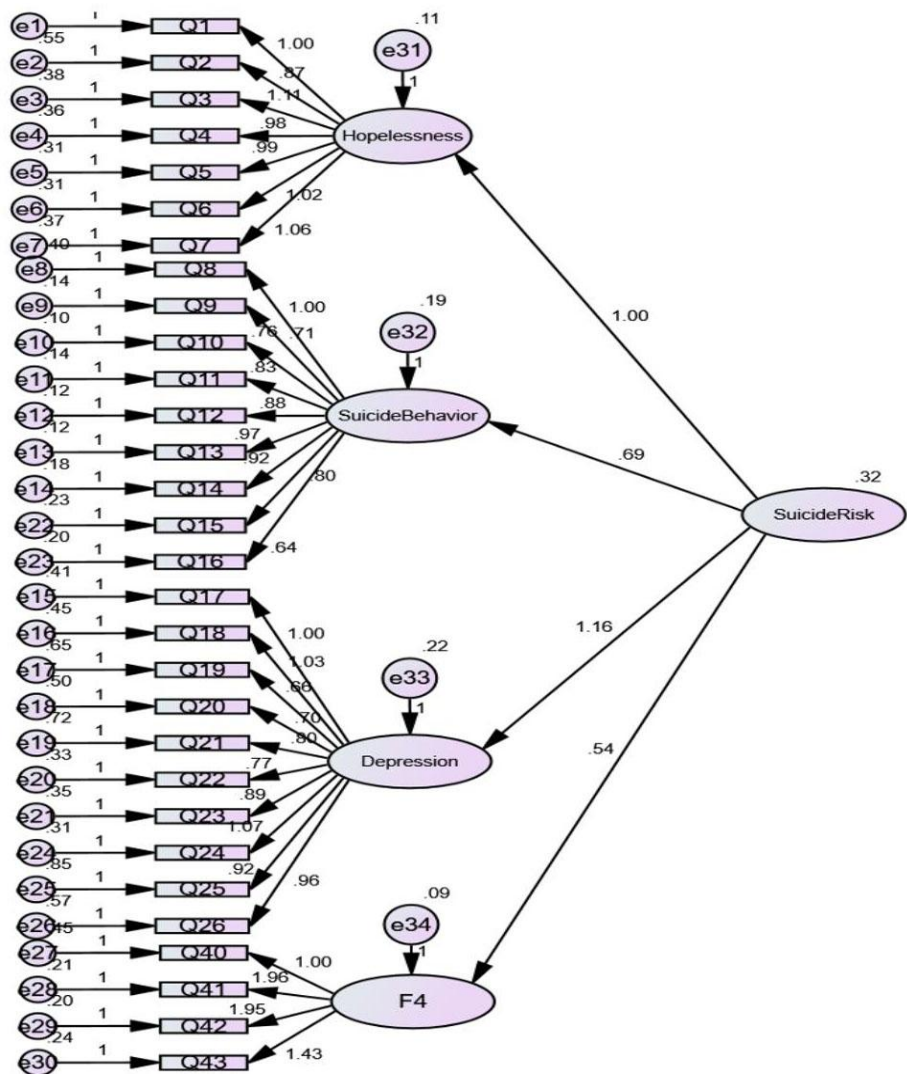


Figure 6. Overall fit of the second-order confirmatory analysis model

Table 3. Second-order model fit indicators

Fitting the index	<i>df</i>	χ^2	χ^2/df	<i>CFI</i>	<i>NFI</i>	<i>RMSEA</i>	<i>RMR</i>
Critical value	—	—	< 3	> 0.90	> 0.90	< 0.10	< 0.10
Second order model	401	2198.75	5.48	0.88	0.86	0.08	0.05

The data indicated that the values of χ^2 and χ^2/df were too large, and the χ^2 fit index is poor. To confirm whether the poor fit of the model is due to the large number of samples or problems with the model itself, we used the bootstrap (Bollen-Stinebootstrap) proposed by Efron and Tibshirani (1994) to verify the cause of poor fit. The Bollen-Stine bootstrap *p* value was calculated as 0.000 by the bootstrap method, meaning that the chance of the next occurrence was 0.0% below the Maximum Likelihood method (ML) method. This inferred that the chi-square value and value (*p*-value) estimated by the most approximate likelihood estimation method were less than 0.05, indicating the poor fit of the model was caused by the large sample number, rather than the model definition.

The result of the bootstrap distributions (default model) was $N = 2000$, *Mean* = 624.766, *Standard Error* = 1.875. The chi-square value of the model was replaced by the modified chi-square value (642.766). As the calculation formulas of each moderate index value were all related to the chi-square value, the model fit indexes all needed to be recalculated. The corresponding updated data are presented in Table 4.

Table 4. Model fit index corrected after bootstrap method

Metric	Numeric value	Metric	Numeric value
Bollen-Stine chi-square	642.77	Degree of freedom estimation	401
Independence model chi-square	15602.09	Parameter estimation	64
Goodness of fit (<i>GFI</i>)	0.96	Independent model degree of freedom	435
Adjust goodness of fit (<i>AGFI</i>)	0.95	Sample number	798
Normed fit index (<i>NFI</i>)	0.96	Normed chi-square (χ^2/DF)	1.60
Non-normed fit index (<i>NNFI</i>)	0.98	Akaike information criterion (<i>AIC</i>)	770.77
Tucker-Lewis index (<i>TLI</i>)			
Incremental fit index (<i>IFI</i>)	0.98	Bayes information criterion (<i>BIC</i>)	1070.42
Related fit index (<i>RFI</i>)	0.96	Expected cross-validation index (<i>ECVI</i>)	0.97
Comparative fit index (<i>CFI</i>)	0.98	Gamma hat	0.99
<i>RMSEA</i>	0.03	McDonald's <i>NCI</i>	0.86
Hoelter's critical <i>N</i>	498.40	<i>PGFI</i>	0.88
<i>p-ratio</i>	0.92		0.88
<i>PCFI</i>	0.91		

From the above data, the high values of χ^2 and χ^2/df were due to the large sample size. The Bollen-Stine bootstrap correction results significantly improved the SEM overall model allocation moderation index. Regarding the fit index of this model, except for χ^2 , all other indicators showed that the model fit well. According to the results of the overall adaptation index, this study confirmed that the matching model was acceptable.

(2) Independent sample t-test

To further confirmed the rigor of the scale design, the 25% extreme scores at both ends of the Beck hopelessness score were divided into two groups, and *t*-tests were conducted on the total score and the four dimensions of the scale respectively, and the results were found to be significantly different, as listed in Table 5: For the total score of the suicide risk scale, $t = -23.264$, $p < 0.01$; for hopelessness dimension, $t = -24.472$, $p < 0.01$; For suicidal behavior dimension, $t = -12.275$, $p < 0.01$; for depression dimension, $t = -15.468$, $p < 0.01$; For reasons for living dimension, $t = -19.729$, $p < 0.01$.

Table 5. T-test on extreme value groups at both ends of Beck Hopelessness score 25%

	Mean (standard deviation)		<i>df</i>	<i>t value</i>	<i>p</i>	effect size <i>d</i>
	Upper 25% (<i>N</i> = 207)	Under 25% (<i>N</i> = 221)				
The total score of the suicide scale	108.91(16.99)	139.10(7.98)	426	- 23.26	0.00	2.27
Hopelessness	22.49(5.03)	32.05(2.57)	426	- 24.47	0.00	2.39
Suicidal behavior dimension	38.72(6.28)	44.28(1.73)	426	- 12.28	0.00	1.20
Depression dimension	33.81(7.96)	44.02(5.33)	426	- 15.47	0.00	1.51
Reasons for living dimension	13.87(3.23)	18.75(1.52)	426	- 19.73	0.00	1.93

(3) Reliability analysis

The overall Cronbach's α coefficient of the suicide risk scale was 0.945, and the Cronbach's α coefficients for hopelessness, suicidal behavior, depression, and reasons for living were 0.889, 0.920, 0.905, and 0.853, respectively. The above data showed that the internal consistency of the suicide risk scale was good.

(4) Calibration and correlation validity

In this study, the Taiwanese version of the Beck hopelessness scale was used to determine the association validity of the suicide risk scale. The correlation coefficient between the Beck hopelessness scale and the total score of the suicide risk scale was 0.771 ($p < 0.01$), which showed that the Beck hopelessness scale had

a significant positive association with the suicide risk scale. The suicide risk scale had good standard validity.

(5) Predictive validity

The study used the ROC curve to verify the predictive validity, and the scale was scored in a 5-point Likert format. The higher the total score, the lower the risk of suicide, and vice versa. The Beck hopelessness scale was scored using the suicide risk scale, so a higher total score on the Beck hopelessness scale indicated the subject was more hopeful, while a lower score indicated the subject was more hopeless. A total score of the suicide risk scale greater than 120 indicated no suicide risk, while a score of 120 indicated a suicide risk and required attention. AMOS23 statistical software was used to draw the ROC curve. The ROC area (AUC) of the suicide risk scale was 0.905, the standard error was 0.014, and the 95% confidence interval was 0.877 to 0.932 ($p < 0.001$), as shown in Figure 7.

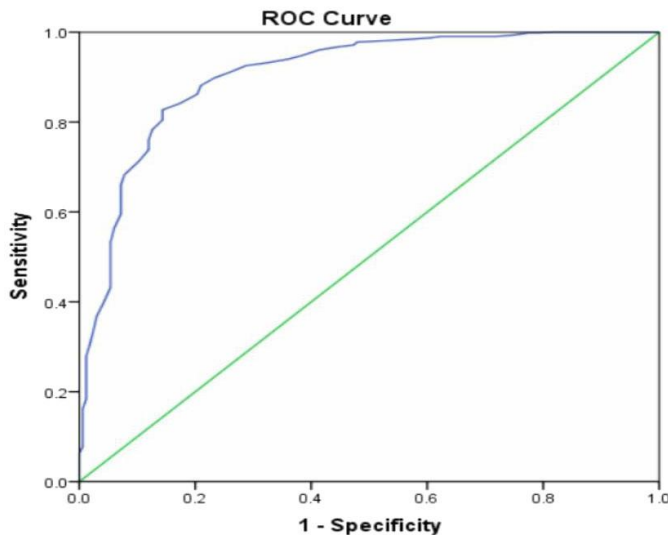


Figure 7. The ROCK curve of the suicide risk scale

(6) Optimal cut-off value

The suicide risk scale calculated the best cut-off values of the scale as the ROC curve as 20%, 15%, and 10%. When the suicide risk scale totaled 119.5, the sensitivity was 0.827, the specificity was 0.856, the area under the curve was 0.905, and the corresponding number of people was 32%. When the suicide risk scale totaled 114.5, the sensitivity was 0.89, the specificity was 0.832, the area under the curve was 0.922, and the corresponding number of people was 23%. When the suicide risk scale totaled 109.5, the sensitivity was 0.922, the specificity was 0.798, the area under the curve was 0.921, and the corresponding number of people was

16%. Therefore, the cut-off value of the suicide risk scale was set at 120. When the total score was greater than 120, no suicide risk was indicated, and the positive predictive value (predicting a healthy population) of the scale was 82.7%. When the score was 120 or less, the subject would require attention and intervention if necessary to reduce the suicide risk value. The suicide risk value could be further divided into low, medium, and high suicide risk. A low suicide risk was indicated when the total score was between 116 and 120, a medium suicide risk was indicated when the total score was 111-115, and a high suicide risk was indicated when the total score was 110.

Discussion and Conclusion

Preparation of the suicide risk scale: pretest discussion

In the pretest compiled by the scale, the dimension of substance abuse was not included in the modeling, and only one question was retained. The content of the substance use question reflected the behavioral level and had a high load of suicidal behavior factors (0.69), so it was included in the dimension of suicidal behavior. The factors are named suicidal behavior, depression, hopelessness, reasons to living, and the scale includes suicidal cognition (hopelessness, reasons to living), suicidal mood (depression), suicidal behavior (suicidal ideation, attempts, plans, accessibility, etc.) as a whole, which also involved the concept of early warning signals. This will reduce the time and effort for suicide clients to fill in multiple scales with different dimensions, and can also achieve the purpose of assessment and intervention in one single-session crisis intervention. This study complements the shortcomings of Lin et al. 's (2022) study of using four independent scales to assess suicide risk, and has a more integrated effect on the Single-Session Suicide Crisis Intervention with time urgency.

Compared with the general suicide scale, the Suicide Assessment Scale developed in this study emphasized the role of protective factors in addition to the common exploration of risk factors. O'Keefe et al. (2019) proved that including both risk and protective factors in the assessment and combining the two when introducing suicide interventions is effective in suicide prevention and improving the resilience of individuals at risk of committing suicide. Therefore, the fusion of risk factors and protection factors could play a direct role in reducing suicide risk, and could support the participants in receiving a positive intervention when first filling in the scale, to achieve the purpose of initially buffering the suicide risk.

Suicide risk scale preparation: formal test discussion

In the second stage of scale compilation, the concept of scale model construction was reasonable and acceptable, the excellent internal consistency of the suicide risk scale, the scale had good validity.

The suicide risk scale consisted of 30 questions that were clearly stated and easy to fill in, and that required about 15 minutes to complete. The simplicity and less time consuming were consistent with the clinical preference for the risk assessment scale (Wang, et al., 2022). The main purpose of the suicide risk was is to efficiently evaluate the population at risk of suicide, so the false negative rate was minimized when choosing reference values. When the score of the suicide risk scale was greater than 120, it was judged to be positive (no suicide risk). The positive predictive value (predicting a healthy population) was 82.7%, indicating that the probability of assessing a healthy population using the scale was high and was not easy to misjudge, while the negative predictive value was 14.4%, which was not easy to miss. When the suicide risk table was 120, there was a risk of suicide, and attention and intervention were needed. When the total scores were 116-120, 111-115, and 110 or lower, the risk level could be divided into low, middle, and high suicide risk.

This scale can not only effectively assess risk and take immediate intervention, but also understand the degree of suicide risk for the first time, and its results can provide reference for subsequent intervention plans. Wang (2023) research shows that when suicide risk assessment and intervention are integrated, the purpose of risk assessment and life-saving can be effectively achieved. Yang and Tong (2008) proposed that suicide risk assessment needed to integrate multiple factors to be more comprehensive, which can reduce the error of false positives or false negatives. The suicide assessment scale developed in this study covered suicidal behavior, depression, and hopelessness, reasons for living, also included the concept of warning signs, plus the suicide risk background information at the end of the scale. Overall, a relatively comprehensive consideration of the multiple dimensions of suicide will improve the accuracy of suicide assessment.

In conclusion, the structural assumptions of the suicide risk scale were reasonable and feasible. The suicide risk scale had good reliability, validity, and applicability, had a short test time and easy operation, and could be used as a suicide risk assessment tool for young people (14-35 years old).

The suicide risk scale: individuals with high suicide risk

The risk status of the college students who completed the questionnaire was analyzed. Out of the 798 participants, 33.3% (266 students) were identified as being at risk of suicide. Among these, 73 participants (9.2%) scored between 116-120, 57 participants (7.1%) scored between 111-115, and 136 participants (17%) scored below 111. These results indicate that one-third of the respondents were at risk, with

a significant portion (17%) classified as high-risk. This underscores the seriousness of the suicide situation among college students, particularly those at high risk, highlighting the need for urgent attention and timely intervention.

These findings align with the study by Hu et al. (2016), which also identified college students as a particularly high-risk group for suicide. The pressing need to develop effective suicide assessment and intervention programs for this population is a key motivation behind this study.

The upper 25% of the scores and the under 25% of the scores on the Beck Hopelessness Scale as groups 1 and 2 and the two groups as independent variables, the t-tests of the total scores of the suicide risk scale and the four dimensions of the scale were found to be respectively significant. The formal ROC cut-off scores and the T Test of significance of the Beck hopelessness scale both proved that high-risk cases are different from low-risk or no-risk cases. It is obvious that the analysis of the cut-off score results of this study is feasible for identifying high-risk suicide groups.

Research limitations and outlook

This study utilizes a sample of Chinese college students, who, compared to their counterparts in other countries, exhibit distinctive suicide-related characteristics: they are predominantly early adult women, typically have no religious beliefs, do not live alone, do not consume alcohol, and have no personal or family history of mental illness. Given that Chinese college students primarily reside on campus and often adhere to atheistic beliefs, the characteristics of this suicide group differ from those identified in international research. Since suicide is influenced by a complex interaction of sociocultural, developmental, spiritual, psychological, and family environmental factors (Bridge, et al., 2006), it is recommended that the findings of this study be extended to other cultural groups to further validate its generalizability.

This study aims to offer a reference point for suicide intervention. It is recommended that the scale developed here be applied to future suicide crisis cases, such as those in suicide prevention and treatment centers, emergency departments, and psychiatric departments dealing with high-risk cases, including borderline personality disorder, to verify its discriminative effectiveness. Additionally, the scale could be integrated into the Single-Session Suicide Crisis Intervention developed by Lin et al. (2022) to assess the efficacy of combining suicide assessment and intervention within a single session, thus contributing to improved suicide prevention and treatment efforts.

Authors' Notes

Acknowledgments. This study sincerely thanks all students and their guardians for agreeing to participate, especially the school, for supporting the research and providing all resources.

Conflict of interest statement. I hereby declare that there are no potential conflicts of interest associated with this publication, and that any financial support has been noted in the Acknowledgment section.

Data availability statement. The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Ethics Statement. The authors confirm that the study submitted was conducted according to the WMA Declaration of Helsinki - Ethical Principles for Medical Research Involving Human Subjects. The paper collects data in the form of questionnaires.

Anonymous coding is used, and the subjects' consent is obtained. The full text is analyzed with all data, and no individual data is reported. Cases can withdraw from the group voluntarily throughout the process.

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