Classification Decision Tree Analysis on Influencing Factors of Suicidal Behavior in College Students

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Abstract   To identify the risk and protective factors of suicide behavior in college students, the gratitude questionnaire, Dual-Mode of Self-Control Scale, suicide questionnaire, and demographic information survey were conducted among college students, and 11,288 valid data were obtained for classification decision tree analysis. The results showed that: (1) The incidence of suicidal ideation was 17.1% within one year, and the incidence of suicidal behavior was 3.8% within six months; (2) The results of classification decision tree analysis showed that suicide ideation was the root node, and gratitude, impulsivity, control, family class, and only-child or not were all important leaf nodes (AUC = 0.959). The main conclusions are as follows: (1) Suicidal ideation is the most important proximal risk factor of suicide behavior in college students, impulsivity is the medium risk factor, gratitude, and moderate control are the distal protective factors; (2) The risk of transitioning from suicidal ideation to suicidal behavior is higher among college students from low social classes, and among non-only-child college students from families of middle and high social classes..

Keywords   college students, suicide behavior, gratitude, self-control, classification decision tree

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1   Introduction

Suicide among college students worldwide has long been a significant public health concern. Among them, Asian college students exhibit more severe behavioral issues and suicidal thoughts (Mortier et al., 2018). 14.5–26.4% of college students report having suicidal ideation, and 5.0–14.0% report having attempted suicide. Suicide has become an important cause of abnormal death among college students (Shen et al., 2020; Shim & Jeong, 2018). In addition to marking the end of a person's life, suicide causes relatives and loved ones to suffer irreversible psychological damage. It also has a severe detrimental effect on schools and society. Therefore, preventing college students from committing suicide has been a hot issue in academic circles and society for many years.

Based on how it develops and occurs, suicide can be classified into three categories: suicidal ideation, suicide attempts, and completed suicide. The majority of academics believe that suicidal ideation is an important risk factor for suicide attempts, and suicide attempts are an important predictor of completed suicide. Studies revealed that the probability of attempted suicide in people with suicidal ideation is more than 4.4 times higher than that of those without such thoughts (Park et al., 2017). Suicide attempters are about ten times more likely to attempt suicide again than the general population, for they encounter more suicide risk factors and have fewer suicide protective factors in life due to various reasons (Lew et al., 2021; Liu et al., 2017). Therefore, reducing the formation of suicidal ideation and preventing the transformation of suicidal ideation into suicidal behavior are two important ways to prevent suicide among college students. Due to the convenience of studying suicidal ideation and the practical difficulty of investigating suicidal behavior, more studies on suicide among college students in recent years have focused on suicidal ideation, with substantial results achieved in terms of theoretical construction, influencing factors, and practical intervention (Lew et al., 2021). However, there are only limited studies on the factors affecting college students' suicidal behavior and even less research into the risk factors that turn suicidal ideation into suicidal behavior.

The dual systems model of self-control believes that self-control includes two neurocognitive processes: the impulse system and the control system. Risky behaviors such as suicide and self-injury in adolescents are usually related to the imbalance of these two major nervous system functions (Wang et al., 2014). Previous studies have found that suicidal thoughts and behaviors are much more common in high-impulsive individuals than in low-impulsive individuals. This is because people with high impulsivity tend to perceive problems in absolute terms and would easily feel extremely frustrated and depressed in response to even the smallest negative stimulus (Lew et al., 2021; Wang et al., 2014). Although impulsivity has been confirmed to be a predictor of suicide, the role of impulsivity and control in the transition from suicidal ideation to suicidal behavior remains unclear. According to the integrated motivational-volitional (IMV) model of suicidal behavior, suicidal ideation, and suicidal behavior belong to two different cognitive processes. The formation of suicidal ideation is more likely to be influenced by the bottom-up system of impulsivity, while suicide behavior is more likely to be affected by the top-down system of control (Rory, 2011). Individuals with high self-control have more resources for cognitive processing, stronger executive function, and are more rational in their decision-making. On these grounds, this study proposes Hypothesis 1: Impulsivity may play a certain regulatory role in the transition from suicidal ideation to suicidal behavior among college students, which means high-impulsive individuals may accelerate such a transition; and Hypothesis 2: Control may have a certain moderating effect on the relationship between suicidal ideation and suicidal behavior among college students. That is, good control ability may slow down the transition from suicidal ideation to suicidal behavior.

Early studies focused on the risk factors for suicide in college students and found that anxiety, depression, pain, loneliness, despair, negative life experiences, impulsivity, upset, and self-control were important suicide predictors (Chang et al., 2019; Matsubara et al., 2021). Researchers' interest in the protective factors for suicide has gradually increased in recent years due to the rise of positive psychology. It has been established that self-esteem, optimism, goal-setting, hope, mental elasticity,

self-compassion, and social support are important protective factors for suicide (Kelliher et al., 2018; Shahram et al., 2021). The protective factors listed above are all psychological in nature, and personality traits at the moral level are rarely touched upon. As a traditional virtue in Chinese culture, gratitude is considered not only a positive moral and emotional experience but also a valuable individual resource and personality trait (Yu et al., 2010). The model of "positive life orientation" proposed by Wood et al. believes that people who are grateful tend to notice and appreciate all the good and positive aspects of life and have higher psychological well-being (Alex et al., 2010). The broaden-and-build theory of gratitude holds that gratitude, as a positive emotional trait, has a distinct contagious and divergent effect. It can stimulate an individual's cognitive flexibility, broaden their schema for behavioral strategies, and help them construct positive and effective coping resources for stressful situations (Alex et al., 2010). Therefore, people with high gratitude are more socially adaptable, while those with low gratitude are more likely to have suicidal thoughts when they feel pessimistic and hopeless in adversity (Sánchez-Álvarez et al., 2020; Lin et al., 2018). As a protective factor for suicidal ideation, does gratitude have the same protective effect on suicide attempts? Is it able to prevent or weaken the transition from suicidal ideation to suicidal behavior? Based on the coping theory of gratitude and the broaden-and-build model, this study proposes Hypothesis 3: Gratitude may act as a buffer between suicidal ideation and suicidal behavior.

The method typically used to investigate the risk factors for suicidal behavior is logistic regression analysis, since suicide is a low-probability event in the general population. This approach has the benefit of revealing the independent influences of multiple factors; that is, it can show the specific contribution of each factor but is unable to rank the factors in order of importance. As a non-parametric test method, classification tree analysis (CTA) helps explore the interaction between several factors simultaneously and provides higher statistical power. In addition, the decision tree analysis method takes into account the complex relationships between each variable and the other variables in the model, as well as the outcome variables. The optimal partition point for each variable and the

best combination of various factors are thus determined, and layer by layer, the optimal branch nodes to predict the target variable based on the importance order of the influencing factors are constructed. As a result, in recent years, researchers have increasingly become interested in the adoption of the classification decision tree model in the field of suicide research (Kim et al., 2021; Kirtley et al., 2022). Furthermore, due to the sensitivity and stigma associated with suicidal behavior problems, it is challenging to conduct prospective studies in large groups, and there are many interference variables. The majority of earlier research has been conducted using cross-sectional studies, which makes it difficult to determine causality. The retrospective cohort study, which makes a causal correlation analysis of the current risk behavior by tracing back to the exposure of influencing factors in a specific period in the past, can overcome the difficulty of longitudinal tracking and save a significant amount of labor, material, and financial resources.

Therefore, with college students as the research subjects, this study employed the classification decision tree model to predict suicidal behavior in the past half year by collecting data on suicidal ideation and other influencing factors in the past year using the retrospective cohort study approach. This study further explored the risk factors and protective factors for suicidal behavior, as well as the influence path and importance order of the factors, in an attempt to provide more science-based theoretical guidance and countermeasure suggestions for suicide early warning management and health education in colleges and universities.

2　Research Methods

2.1　Participant and procedures

With the method of cluster random sampling, a total of 11788 students from two universities in Shanxi Province were selected as the research subjects. The members of the research group had trained teachers in charge of mental health education and class teachers in advance about the test instruction remarks before a questionnaire survey was conducted in each class. The survey was conducted in May of the spring semester for about 20 minutes (including content that was not analyzed in this study).

The questionnaire was collected on the spot, and the survey was completed in two batches. 472 invalid questionnaires that were either not seriously answered or with missing data were eliminated, and a total of 11316 valid questionnaires were recovered, with a recovery rate of 96.00%. Among them, 11,288 are from Han ethnic group, and 28 are from ethnic minority groups. Ethnic minorities are removed from this study because their composition ratio is too small for them to be categorized and compared. Ultimately, 11288 subjects in all took part in the statistical analysis. Of them, 6990 (61.90%) were girls and 4298 (38.10%) were boys; 5267 (46.70%) were the only child in the family, and 6021 (53.30%) were not; 5133 were from rural areas (45.50%) and 6155 were from urban areas (54.50%); 5650 were freshmen (50.10%), 3306 were sophomores (29.30%), and 2332 were juniors and above (20.70%). The age range was 18 to 26, with an average age of 19.96 ± 1.38 years. The ethics committees of the universities approved this study.

2.2   Instruments

Gratitude Questionnaire: The Gratitude Questionnaire (GQ) adopted in this study was developed by McCullough et al. (2002) and revised by Wei et al. (2011). The questionnaire consists of six items on a scale from 1 to 7, with higher scores correlated with a higher gratitude disposition. The internal consistency coefficient of GQ in this study was 0.86. The scores of the subjects were ranked from low to high in this study, and with the dividing lines set at 33% from the bottom and 33% from the top, the participants were split into three groups: low gratitude (≤ 27 points), medium gratitude (28–36 points), and high gratitude (≥ 37 points). The fitting results of the confirmatory factor analysis are as follows: χ^2/df = 5.96, RMSEA = 0.11, NFI = 0.98, CFI = 0.98, and IFI = 0.98.

Dual-Mode of Self-Control Scale: This study employed the Dual-Mode of Self-Control Scale (DMSC-S), revised by Xie et al. (2014) from the Chinese Academy of Sciences. The DMSC-S consists of two subscales of the control system and impulse system, and all the items in it are scored on a 5-point scale. Twelve items make up the impulse system scale, which covers three dimensions: impulsivity, easy distraction, and low delay of gratification. Higher scores indicate higher levels of impulse. The control

system scale has a total of nine items, involving two dimensions of problem-solving and future time view. The higher the score, the stronger the control ability. In this study, the internal consistency coefficients of the subscales of impulse and control were 0.90 and 0.91, respectively, and that of the scale as a whole was 0.82. The fitting results of confirmatory factor analysis are as follows: χ^2/df = 4.23, RMSEA = 0.04, NFI = 0.96, NNFI = 0.96, CFI = 0.97, IFI = 0.97, and GFI = 0.96. The subjects' scores for the impulse system and self-control system were ranked from low to high. Based on these scores, with the dividing lines set at 33% from the bottom and the top, respectively, the participants were categorized into the following groups: low impulse (≤ 23 points), medium impulse (24–29 points), high impulse (≥ 30 points), low control (≤ 30 points), medium control (31–35 points), and high control (≥ 36 points).

Suicidal ideation: Based on the questions about suicidal ideation in SCL-90 and the Beck Scale for Suicide Ideation, along with the concepts of active suicidal ideation, passive suicidal ideation, and death thoughts, this study included three self-compiled questions: (1) How many times in the past year have you had suicidal ideation? (2) How many times in the past year have you hoped that some external force would take your life (like hoping to pass away in your sleep or by accident)? (3) How many times in the past year have you thought, "I don't want to live anymore" or that you wanted to die? Response choices are all graded from 0 to 4, with 0 = never, 1 = once in a while, 2 = twice, 3 = three to five times, and 4 = more than five times. Suicidal thoughts are considered to have never occurred when the total score of these three types of suicidal ideation is 0, regarded as a single occurrence when the highest score is 1, and categorized as multiple occurrences when the highest score is greater than or equal to 2. There are more questions on the questionnaire interspersed with the three mentioned above.

Suicide behavior: A self-compiled question: Have you had any suicide attempts or suicide behavior in the past six months? Like with the suicidal ideation mentioned earlier, the response choices are rated on a scale from 0 to 4. A score of 0 indicates having no suicidal behavior, and other scores are interpreted as having suicidal behavior.

MacArthur Scale of Subjective Social Status: This study adopted the single-item scale created by Adler et al. (2000). A drawing of a ladder with ten rungs indicating levels one to ten was shown to the participants. They were asked to choose the appropriate level according to the actual socioeconomic status of their families, with a higher number denoting a better family status. The scale has been proven to have good reliability and validity by Chinese scholars like Yang Shenlong and Guo Yongyu (Yang et al., 2016). In this study, levels 1–3 were classified as low-class families (25.20%), levels 4–6 as middle-class families (62.10%), and levels 7–10 as high-class families (12.70%).

In addition to the aforementioned content, the survey also includes basic demographic variables such as age, gender, being an only child or not, the year of study, and coming from urban or rural areas.

2.3   Statistical methods

EpiData software was used to input data and establish a database, and SPSS 26.0 was used for statistical analysis. To compare the incidence of suicide attempts among different suicidal ideation groups, the chi-square test was employed. The classification decision tree was adopted to analyze the importance of each influencing factor.

Building a classification decision tree model: the decision tree model is constructed using the Chi-squared automatic interaction detector (CHAID) method, and the significance is adjusted by the Bonferroni method. α is set to be 0.05 for both the separate and total significance test levels, and the maximum depth of the tree is set to three layers. Additionally, the minimum number of samples of parent nodes and child nodes is set to 100 and 50, respectively.

3   Results

3.1   The present status and characteristics of suicidal ideation and suicidal behavior among college students

With regard to the occurrence of suicidal ideation in the past year, among the 11288 college students, 17.1% (1932/11288) had suicidal ideation, 8.7% of them (980/11288) had single suicidal ideation, and 8.4% (952/11288) had multiple suicidal ideation. The percentage of male college students

who experienced suicidal thoughts was 18.5% (794/4298), while the percentage of female students was 16.3% (1138/6900). The incidence of suicidal ideation was 16.6% (1019/6155) in urban college students and 17.8% (913/5133) in rural college students. Suicidal ideation occurred in 19.1% (1081/5650) of freshmen, 14.8% (489/3306) of sophomores, and 15.5% (362/2332) of juniors. Suicidal ideation was found in 19.5% (1028/5267) of the only child and 15.0% (904/6021) of the non-only child. The incidence of single and multiple suicidal ideation in different groups and the group differences are shown in Table 1.

Table 1 Incidence of suicidal ideation among college students grouped by different demographic variables in the past year

Suicidal ideation	Gender		Year of study			Family		Only child	
	Male	Female	Freshman	Sophomore	Junior	Urban area	Rural area	Yes	No
Never	3504 (81.5%)	5852 (83.7%)	4569 (80.9%)	2817 (85.2%)	1970 (84.5%)	5136 (83.4%)	4220 (82.2%)	4239 (80.5%)	5117 (85.0%)
Single occurrence	306 (7.1%)	674 (9.6%)	573 (10.1%)	232 (7.0%)	175 (7.5%)	536 (8.7%)	444 (8.6%)	474 (9.0%)	506 (8.4%)
Multiple occurrences	488 (11.4%)	464 (6.6%)	508 (9.0%)	257 (7.8%)	187 (8.0%)	483 (7.8%)	469 (9.1%)	554 (10.5%)	398 (6.6%)
	$\chi^2 = 91.24$ **		$\chi^2 = 38.05$ **			$\chi^2 = 6.04$ *		$\chi^2 = 58.90$ **	

Note: *$p < 0.05$, **$p < 0.01$, the same below.

As for suicidal behavior that occurred in the past six months, the overall incidence of suicidal behavior among 11288 college students was 3.8% (429/11288). Among them, the incidence of suicidal behavior in males (4.4%) was significantly higher than that in females (3.4%), and the chi-square test revealed statistical significance ($\chi^2 = 7.30$, $p < 0.01$). The incidence of suicidal behavior in sophomores was 2.9%, which was significantly lower than that in freshmen (4.4%) and juniors (3.7%), and the chi-square test results showed statistical significance ($\chi^2 = 11.60$, $p < 0.01$). The incidence of suicidal behavior did not differ statistically between participants from urban and rural areas or between the only-child group and the non-only-child group. Table 2 presents the details.

For 1932 students who had suicidal ideation, the incidence of suicidal behavior in the past six months was 22.2% (429/1932). There was no difference between males (23.9%, 190/794) and females (21.0%, 239/1138) ($\chi^2 = 2.32$, $p > 0.05$). There was also no difference between participants from urban areas (23.4%, 238/1019) and rural areas (20.9%, 191/913) ($\chi^2 =

1.65, $p > 0.05$). Compared to the incidence of the only child (19.0%, 195/1028), the non-only child's incidence was distinctly higher at 25.9% (234/904), and the chi-square test showed a significant difference ($\chi^2 = 13.32$, $p < 0.01$). The incidences for freshmen, sophomores, and juniors are 22.8% (246/1081), 19.8% (97/489), and 23.8% (86/362), respectively. No statistically significant difference was found across participants in different years of study ($\chi^2 = 2.28$, $p > 0.05$).

Table 2 Incidence of suicidal behavior among college students grouped by different demographic variables in the past six months

Suicidal behavior	Gender		Year of study			Family		Only child	
	Male	Female	Freshman	Sophomore	Junior	Urban area	Rural area	Yes	No
None	4108 (95.6%)	6751 (96.6%)	5404 (95.6%)	3209 (97.1%)	2246 (96.3%)	5917 (96.1%)	4942 (96.3%)	5072 (96.3%)	5787 (96.1%)
Exist	190 (4.4%)	239 (3.4%)	246 (4.4%)	97 (2.9%)	86 (3.7%)	238 (3.9%)	191 (3.7%)	195 (3.7%)	234 (3.9%)
	$\chi^2 = 7.30^{**}$		$\chi^2 = 11.60^{**}$			$\chi^2 = 0.16$		$\chi^2 = 0.26$	

3.2 Classification decision tree analysis of influencing factors of college students' suicidal behavior

The decision tree model has three layers, including 20 end nodes, with a classification error rate of 3.8%. The root node of the model is the total number of suicidal ideation in the past year, indicating that suicidal ideation is still the most important factor that affects suicidal behavior. The decision tree model mainly consists of two branch paths, which are the single suicidal ideation group and the multiple suicidal ideation group. The incidence of suicidal behavior in the multiple suicidal ideation group was 30.6%, 2.17 times that of the single suicidal ideation group, which was 14.1%, as shown in Figure 1.

For the first branch of the multiple suicidal ideation group, the level of impulsivity is one of the most important influencing factors of suicidal behavior. The incidence of suicidal behavior in the high-impulsive group (40.2%) was significantly higher than that in the other groups (17.8%). The rates of suicidal behavior in the high, medium, and low impulsivity groups were 40.2% (218/542), 19.6% (46/235), and 15.4% (27/175), respectively. For college students with low-to-medium impulsivity in the multiple suicidal ideation group, the gratitude trait is one of the most important protective factors for suicidal behavior. Suicidal behavior was far more

frequent in the low gratitude group (27.7%) than in the medium and high gratitude groups (9.7%). For high-impulsive college students who had multiple suicidal thoughts in the past year, the incidence of suicidal behavior in the moderate control group (27.2%) was lower than the incidence of suicidal behavior in the lack of control or excessive control group (44.6%). Suicidal behavior was reported in 44.8% (143/319) of the low control group and 43.7% (38/87) of the high control group, respectively.
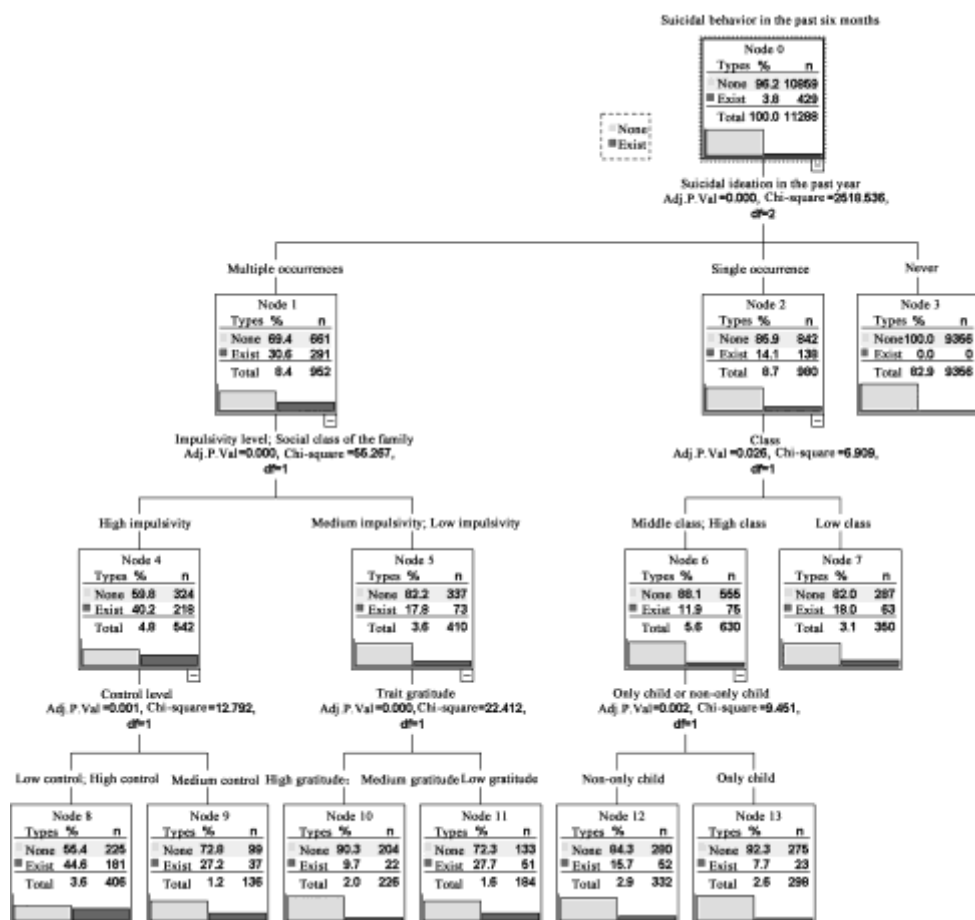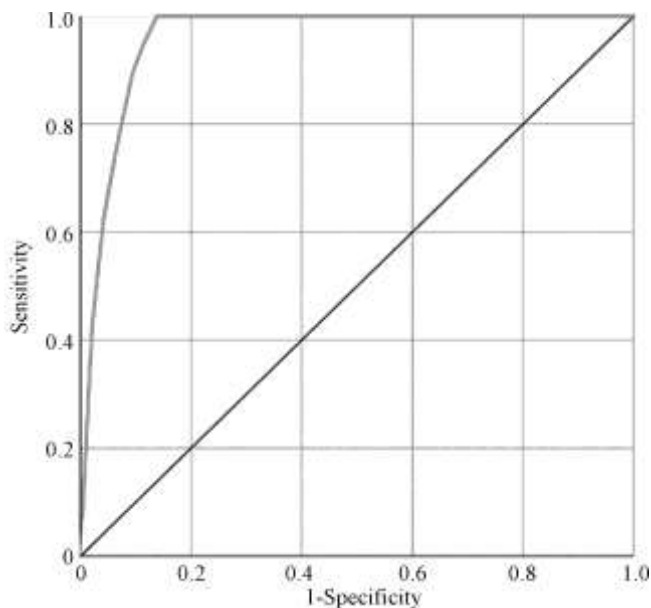

Fig. 1 Classification decision tree model of influencing factors of college students' suicidal behavior

For college students in the second branch path, or single suicidal ideation group, the social class of the family is one of the most important

influencing factors of suicidal behavior. College students from low-class families had a significantly greater rate of suicide behavior (18.0%) compared to the middle-class and high-class family groups (11.9%). Additionally, in middle-class and high-class family groups, non-only-child college students had a considerably higher incidence of suicide behavior (15.7%) than only-child ones (7.7%). Among them, the suicide rates for non-only child and only child students in high-class families were 15.4% (6/39) and 10.9% (5/46), respectively. The suicide rates for non-only child and only child college students in middle-class families were 15.7% (46/293) and 7.1% (18/252), respectively.

According to the prediction probability of the classification decision tree model, the ROC curve was drawn, and the area under the curve (AUC) was 0.959 (95% CI [0.956,0.963], $p < 0.01$). By calculating the Youden index, the optimal sensitivity (0.946), specificity (0.887), and accuracy (0.962) of the model were determined. The three indicators were all above 0.80, indicating that the classification decision tree model constructed in this study is fairly effective in predicting the risk of suicidal behavior among college students, as shown in Figure 2.

Fig. 2 ROC curve of classification decision tree model of college students' suicidal behavior

4   Discussions

4.1   Suicidal ideation and suicidal behavior of college students

The results of this study showed that 17.1% of college students had suicidal ideation and 3.8% of college students had suicidal behavior, which closely aligns with the incidence of suicidal ideation (19.2%) (Lee et al., 2020) and suicidal behavior (4.5%) (Lew et al., 2020) reported by researchers from China and other countries. The rates are significantly lower than those of suicidal ideation (26.4%) and suicidal behavior (14.0%) reported by Shen et al. (2020). However, they are greatly higher than the incidence of suicidal ideation (12.4%) and suicidal behavior (1.1%) of college students found by Oh et al. (2022). These differences may be related to the samples' different cultural regions and academic backgrounds. Studies have confirmed that the suicidal ideation and behaviors of science students are generally higher than those of liberal arts students, and the suicide incidence of medical students is the most prominent among science students (Khan et al., 2021). This study found that the incidence of suicidal behavior among college students showed a typical inverted U-shaped distribution over the years of study. The incidence of suicidal behavior among sophomores (2.9 %) was the lowest, followed by juniors (3.7%) and freshmen (4.4 %). This pattern may be attributed to the fact that freshmen experience adjustment challenges related to learning methods, interpersonal contact, extracurricular activities, eating habits, and independent learning, and juniors are stressed due to internships, postgraduate entrance examinations, and job hunting. Yet the sophomore year is relatively easy and has more stable interpersonal relationships.

In this study, the suicidal ideation and suicidal behavior of males were slightly higher than those of females. This may be because, in the face of stressful situations or negative emotions, women are more likely to open up to others and ask for professional mental health help. Males with machismo to the bones believe that it is embarrassing and hurts their pride to confide in others or ask for help when going through unpleasant and stressful events. They are more negative and passive than females in seeking help (Mackenzie et al., 2006). The results of this study showed no

significant difference in the incidence of suicidal behavior between urban and rural college students. However, there are differences in the rates of suicidal ideation. Compared to their urban counterparts, college students from rural areas have a much higher incidence of suicidal thoughts. This may be because urban college students have a wider range of experiences and are hence more flexible and confident, while rural college students tend to be more rigid and self-abasing. When confronted with life events, rural students exhibit a stronger emotional stress response (Zhang et al., 2014), and they are more likely to feel lonely and helpless, which can lead to suicidal ideation (Fang et al., 2016).

The comparison between the only-child and non-only-child college student groups in this study produced interesting results. On the one hand, for college students in general, the suicidal ideation of non-only-child college students is significantly lower than that of only-child college students, which is consistent with relevant research results in China (Li et al., 2007). On the other hand, for the particular group with suicidal ideation, non-only-child college students have a much greater rate of suicidal behavior compared to only-child college students. The seemingly paradoxical results may be attributed to differences in family environments, growth experiences, and family support. Only-child college students have been spoiled since they were young, but they are lonely at heart and lack emotional stability and resilience to setbacks (Yu et al., 2018). When faced with challenges in life, they are more likely to show symptoms of anxiety and depression (Cheng et al., 2019), which have important predictive power over suicidal ideation. Psychological stress theory holds that suicidal ideation is a strong manifestation of the emotional stress response, a sign that an individual's life events are too much for them to handle on their own. According to the social support buffering hypothesis, timely and effective support from family and friends is similar to firewood being delivered in the winter, and it can to some degree help people get back on their feet and embrace the future, reducing the occurrence of suicidal behavior (He et al., 2019). Parental support from the family is one of the most critical forms of social support for preserving students' mental health. Because there are more children in the family,

non-only-child college students perceive more negative information, such as emotional neglect and criticism from their parents (Zhang et al., 2017), and are more likely to understand, accept, and recognize suicidal behavior (Li et al., 2008). Therefore, when experiencing life stress, non-only-child students have a lower perception of the emotional support they receive from the family, and feelings of insecurity, powerlessness, and loss of control arise in their hearts, raising the risk of suicidal behavior. Only-child college students tend to experience greater support and care from their families when they face challenges, which can greatly improve their ability to cope, enhance their sense of life control, and help them resolve the crises of life, thus reducing the risk of suicidal behavior.

4.2 Results of the classification decision tree analysis of influencing factors of suicidal behavior among college students

The results of the classification decision tree of this study showed that suicidal ideation was the root node, indicating that suicidal ideation was the most important risk factor for suicidal behavior among college students. Compared to adolescents with suicidal ideation (17.3%) in the research by Hill et al. (2020), students with suicidal ideation in this study had a greater rate of suicidal behavior (21.8%). The variation in interval time and research design may be the cause of the discrepancy between the two results. This study is retrospective, whereas the other one is longitudinal. Furthermore, the intervals between suicidal ideation and behavior were also different. The duration of this study was half a year, while that of Hill et al. (2020) was one year. Studies have confirmed that the longer the interval between risk factors and suicidal behavior, the lower the predictive effect on suicidal behavior (Probert et al., 2020). This study also discovered that the rate of suicidal behavior increases with the frequency of suicidal ideation. The incidence of suicidal behavior among students with multiple suicidal thoughts in the past year (30.6%) was 2.2 times higher than that among students with single suicidal ideation (14.1%). A higher rate of suicidal ideation is associated with a higher frequency of stressful life events and a stronger motivation for suicide.

Psychological Development and Education   2024: 40(3)

Thus, people who experience it should be prioritized for suicide prevention.

For college students who had multiple suicidal thoughts in the previous year, impulsivity was the most important proximal risk factor for suicidal behavior. The risk of suicidal behavior in high-impulsive students was 2.26 times (40.2%/17.8%) higher than in low-impulsive students, and the predicted theoretical hypothesis 1 was verified. It shows that "impulsivity is the devil." Especially for students who experience multiple suicidal thoughts, suicide can be triggered by anything, much like an arrow on the bowstring. The higher the level of impulsivity, the greater the risk of triggering suicidal behavior. For high-impulsive college students with multiple suicidal thoughts, moderate control is helpful in inhibiting suicidal behavior and is a powerful protective factor for suicidal behavior. The probability of suicidal behavior increased by 1.65 times (44.8%/27.2%) for excessive control and 1.61 times (43.7%/27.2%) for lack of control. The expected theoretical hypothesis 2 was successfully verified. It is worth noting that the moderating effect of control on suicidal behavior is not a simple linear relationship but presents an inverted U-shaped curve. This may be because high-impulse college students with multiple suicidal thoughts are already under a great deal of stress, and their hearts are full of negative energy like a balloon that could burst at any time. Moderate control may help to remove some of the negative energy, while lack of control will lead to the burst of the balloon or self-destruction. Excessive control will result in a strong conflict between extreme depression at the rational level and impulsive outbreak at the emotional level, causing extreme self-frustration and despair in a short period of time, which can easily lead to suicidal behavior. For low-to-medium-impulsive college students with multiple suicidal thoughts, gratitude is the most powerful protective factor for suicidal behavior. The risk of suicidal behavior of low-gratitude college students was 2.86 times (27.7%/9.7%) that of high-gratitude college students, which confirms the anticipated theoretical hypothesis 3. The moderating effect of gratitude between suicidal ideation and suicidal behavior was mainly restricted to individuals with low and medium impulsivity who experienced multiple suicidal thoughts, which is

consistent with the research results of Rey et al. (2019). When individuals encounter challenges in life, gratitude, as a positive personality trait, can help them expand interpersonal connections, optimize cognitive schema, improve coping efficacy, and promote social adaptation, all of which reduce their risk of suicidal behavior.

For college students who had a single suicidal ideation in the previous year, family socioeconomic status had a significant impact on suicidal behavior. College students from low-class families were 1.51 times (18.0%/11.9%) more likely to have suicidal behavior than those from middle-class and high-class families, which is consistent with relevant studies from China and other countries. The lower the family income, the higher the children's risk of suicide during adolescence and college years (Liu et al., 2018). The suicide risk effect on low-class families may derive from the following three factors: First, students from poor families are more sensitive, have low self-esteem, lack external emotional connection and social support, have poor emotional regulation ability, and are prone to anxiety and depression when they encounter problems (Biswas et al., 2020). Second, poor college students, as a vulnerable group, are prone to a negative attribution style when they come across problems. They experience more discrimination, loneliness, and hostility in life and have a lower sense of self-esteem (Xie et al., 2016). Third, Chinese college students remain heavily dependent on their families in many aspects of life since they have not yet fully integrated into society. Their families and parents are still the first people they look to for assistance when they run into problems. Low-class parents typically lack the financial means and social resources to offer more insightful guidance and advice when their children are confronted with pressures and challenges in life (Lawrence et al., 2021). Social support is a dual protective factor for suicidal ideation and suicidal behavior (Veale et al., 2017), in which parental support has a stronger protective effect than other types of support (Rey et al., 2019). Parents' timely and effective care and support can bail an individual out and resolve the crisis, while students who are neglected by their parents cannot see any hope or future when facing challenges, which leads to the risk of suicide (Yu & Liu, 2020). Comparing middle- and high-class

families, it was found that the suicide rate of non-only child from high-class families was 1.41 times that of students from only-child families (15.4%/10.9%), and the suicide rate of non-only children in middle-class families was 2.35 times that of only-child families (15.7%/7.1%). This may be because parents of only-child families devote all their emotional care and education investment to one child, while parents of non-only-child families bear the greater burden of raising their children. Children in these families receive less emotional support from their parents or are even neglected when faced with stressful circumstances since parents have to divide their limited emotional attention and educational resources among multiple children (Jiang & Li, 2020). Recent studies have also confirmed that the self-esteem and resilience of only-child college students are significantly higher than those of non-only-child college students, and their coping styles are more positive (Liu & Liang, 2019). These positive psychological capitals are important protective factors for suicide (Shahram et al., 2021).In real life, middle-class families clearly have fewer social resources than high-class families. Therefore, the suicide risk gap between the non-only child and the only child in middle-class families (2.35 times) differs greatly from that in high-class families (1.41 times). This disparity suggests that while society is currently actively responding to the call for two-child and three-child policies advocated by the government, it is necessary to regulate health education for parents and guide parents to raise their children with as much consideration for their inner needs as possible. One significant strategy to lower the likelihood of suicide behavior among college students is for parents to identify their children's psychological problems early and provide prompt assistance.

4.3 The enrichment and expansion of existing theoretical models of suicide

Currently, the most influential theoretical models for the development of suicidal behavior are the three-step theory (3ST) of suicide (Klonsky et al., 2021) and the integrated motivational-volitional (IMV) model of suicidal behavior (O'Connor et al., 2018). The former believes that there are three steps in the suicide process: the formation of suicidal ideation, the escalation of suicidal ideation, and the occurrence of suicidal behavior.

Suicidal capability, such as genetic factors and personality traits, determines the third step (Klonsky et al., 2021). The latter theory also divides the process of suicidal behavior into three phases: the feeling of defeat; the emergence of suicidal ideation; and suicidal attempt or suicide. Volition is involved in regulating the third phase (O'Connor et al., 2018). The results of this study support the mechanism hypothesis of the third stage of the two theoretical models mentioned above and show that impulsive personality traits are an important risk factor in the process of an individual's transition from strong suicidal ideation to suicidal behavior.

Although the three-step theory of suicide holds that strong suicidal ideation is a prerequisite for suicidal behavior, the original theoretical model does not clearly define the different intensities of suicidal ideation. In other words, there is a lack of workable concepts to distinguish between strong ideation and moderate ideation. This study clearly defines single and multiple suicidal ideation as moderate and strong suicidal ideation, respectively, which is a refinement and improvement of Klonsky's three-step theory of suicide. Furthermore, the three-step theory of suicide model ignores the occurrence of suicidal behavior in those with moderate suicidal ideation and only concentrates on the factors that influence suicidal behavior in people with strong suicidal ideation. In fact, people with moderate suicidal ideation may also commit suicide, and they represent a special group that should not be disregarded in suicide prevention efforts. This study found that for moderate suicidal ideation groups, external family socioeconomic status, rather than internal impulsive traits, is an important regulatory factor for the transition from suicidal ideation to behavior. The support from low-class families is limited, and the risk of suicide is the highest, followed by the high-class family, with the risk of suicidal behavior slightly lower. Middle-class families offer the greatest support and have the lowest risk of suicidal behavior. These findings are in line with research conducted in China and other countries (Lawrence et al., 2021; Xie et al., 2020). Therefore, the results of this empirical study are a great enrichment and expansion of the 3ST suicide model and the IMV model.

4.4   The contribution and limitations of this study

The greatest contribution of this study is to verify and enrich the IMV model and the 3ST model of suicide, as well as to provide the following suggestions for college suicide prevention initiatives: First, the main characteristics of the group of college students who have never had suicidal ideation in the previous year are the large population base and the lowest risk of suicidal behavior. The most effective way to prevent suicide for this set of college students is to offer mental health education courses that emphasize emotional control and the development of the trait of gratitude. By improving personal quality, the risk of suicide can be nipped in the bud and prevented from the distal end. Second, the group of college students who have had a single suicidal ideation in the past year is characterized by a relatively low risk of suicidal behavior (14.1%), and they are greatly affected by their family environment. For this group of college students, the best way to prevent suicide is to establish a platform for home-school contact so that the channel of communication between home, school, and students is kept open. Make sure that students are able to receive parental support immediately after they encounter problems, and ease their stress response to curb the risk of suicide from the medium end before it escalates. Third, a high incidence of suicidal behavior (30.6%) and an imminent suicide risk characterize the group of college students who have experienced multiple suicidal thoughts in the preceding year. In view of this group, suicide prevention work should be mainly based on small-group psychological counseling, supplemented by individual psychotherapy. The counseling for high-impulsive students concentrates on emotional regulation, and the counseling for low-impulsive students emphasizes gratitude and integration. By reducing negative emotions, the will to commit suicide is extinguished from the proximal end.

This study has some limitations and drawbacks as well. First, the participants of this study are mainly students of the Han ethnic group at inland provincial colleges, and the proportion of junior students is relatively small. Further research using larger and more representative samples in the future is still necessary to see whether the findings can be applied to students from ethnic minorities or other local colleges and

universities. Second, because suicidal behavior is a low-probability event, this study may still have outcome bias due to the insufficient sample size. Hence, larger sample tests are required in the future. Third, since the results of this study are based on a limited set of predetermined factors, whether there are other risks or protective factors with a greater capacity to predict college students' suicide attempts <mark>needs to be further explored</mark> by more scholars in the future.

5   Conclusion

(1) 17.1% of college students had suicidal ideation in the past year, of which 8.7% had suicidal ideation once and 8.4% had multiple times; 3.8% of college students had suicidal behavior in the past six months.

(2) Suicidal ideation is the most important proximal risk factor for suicidal behavior among college students. The incidence of suicidal behavior among college students with single suicidal ideation and multiple suicidal ideation in the past year was 14.1% and 30.6%, respectively.

(3) For college students who had suicidal ideation multiple times in the previous year, impulsivity was the proximal risk factor for suicidal behavior, and gratitude and moderate control were the distal protective factors. Low family socioeconomic status is a proximal risk factor for suicidal behavior in college students with single suicidal ideation in the past year; the incidence of suicidal behavior in non-only-child college students from higher-class families was 15.7%, which was significantly higher than that of only-child college students (7.7%).

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