The factor structure and psychometric properties of the Chinese version of the Positive and Negative Suicide Ideation Inventory (PANSI-C) in a non-clinical sample of Chinese adolescents

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Abstract

Backgrounds: The Positive and Negative Suicide Ideation (PANSI) Inventory is a widely used self-report questionnaire which is designed to comprehensively evaluate the protective factors and negative risk factors associated with suicidal behaviors among adolescents. The present study aimed to evaluate the psychometric properties and measurement invariance of the Chinese version of the PANSI in a non-clinical sample of Chinese adolescents.

Methods: Participants (N = 1198) were Chinese middle school students aged 11–17 years (44.8% boys and 51.9% girls, 3.3% missing values) in Guizhou Province. All participants completed the Chinese version of the Positive and Negative Suicide Ideation Inventory (PANSI-C), the Rosenberg self-esteem scale (RSE), and the suicide probability scale (SPS). Cronbach’s alpha coefficients, confirmatory factor analysis, Pearson’s correlations, and multigroup confirmatory factor analysis tests were conducted thereafter.

Results: The results showed that the Cronbach’s alpha coefficients for the two subscales of the PANSI-positive suicide ideation and the PANSI-negative suicide ideation were .696 and .915, respectively. The confirmatory factor analysis supported the fit of the two-factor model as the best fitting model [Chi-square goodness of fit = 703.859, \( p < .001 \), degrees of freedom = 76, comparative fit index = .919, Tucker–Lewis index = .903, standardized root mean square residual = .047, root mean square error of approximation (90% CI) = .083 (.077, .089)]. Positive suicide ideation had negative correlations with the SPS and positive correlations with the RSE, whereas the negative suicide ideation had positive correlations with the SPS and negative correlations with the RSE. All correlations were statistically significant (\( p < .001 \)), demonstrating the criterion validity of the PANSI-C. Moreover, the strict measurement invariance of the PANSI-C was supported across gender, single-parent and non-single-parent households groups, and the strong measurement invariance was supported across age.

Limitations: The feasibility of this study is limited to Chinese normal adolescents and lack of clinical samples.

Conclusion: Empirical support for the reliability and validity of the PANSI-C was found. The PANSI-C instrument is found to be useful in assessing positive and negative suicide ideation in Chinese normal adolescents.

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Introduction
Suicide is a widespread issue of concern worldwide. According to the World Health Organization [54], suicide was the 18th leading factor of death in the world in 2016, and the second leading factor of death among people aged 15–29. A number of studies have shown, the incidence of suicide ideation among adolescents was 10.72–12.1% [24], with suicidal intention and planning at 8.1% [32]. In China, more than 10,000 teenagers died by suicide each year [36]. As such, there have been numerous efforts made to improve abilities to identify adolescents at elevated risk of suicide, so as to prevent and effectively reduce the youth suicide rate [15, 37].

Suicidal behavior is a series of complex processes, from suicidal ideation, suicide plan, suicidal attempt, and suicide death [19]. Suicidal ideation is the main risk factor for suicidal behavior, refers to the idea that the individual wants to end life [4]. Although individuals with suicidal ideation do not necessarily die by suicide [31], suicidal ideation is indeed an important predictor of suicide risk [18, 22]. Studies have shown that the peak of suicidal ideation occurs in adolescence, with the incidence rising from less than 1% at the age of 10 to 17% at the age of 18 [32]. In adolescence, adolescents have the cognitive ability to think and evaluate death, but they are in an immature state in terms of cognitive control and emotional response. This imbalance can easily lead to suicidal ideation [28]. Therefore, paying attention to the related factors of suicidal ideation among adolescents will not only help screen out high-risk groups, but also help maintain the mental health of adolescents [26].

The development of effective measurement instruments can be an important means for identifying and studying suicidal ideation. A number of instruments have been developed to assess adolescents’ suicidal ideation. The Beck scale for suicide ideation (BSI) [3], which is used to evaluate the status of one’s suicidal ideation over the past week, has 19 items and results in scores in two dimensions, one is suicide ideation and the other is suicidal tendency. The higher the score, the higher one’s risk of suicidal ideation and suicide is. The suicidal ideation questionnaire (SIQ) [40], consists of 30 items that evaluate specific thoughts and cognitions about suicide and death over the past month. The higher the SIQ score, the more serious one’s suicidal ideation is. The modified scale for suicide ideation (MSSI) [29] includes 18 items; the higher the score, the more serious one’s suicidal ideation is. Another scale, such as the suicidal ideation scale (SIS) [42], has been designed for college students, and uses 10 items to measure suicidal ideation over the past year. Although each of these measurements has merits, their limitations cannot be ignored. Most people believe that suicidal behavior is closely related to risk factors, such as psychological distress or psychiatric disorders [17], and research on suicidal behavior has also focused on the risk factors of suicidal ideation, and rarely considers the protective factors.

It has been noticed, however, the factors affecting suicidal ideation or behavior may be multidimensional [39]. For example, individuals with suicidal thoughts may also express their desire to survive [48]. The Positive and Negative Suicide Ideation (PANSI) Inventory combined with risk and protective factors (i.e., positive ideation and negative suicide ideation) to evaluate individual suicidal ideation [35]. In the original study, the PANSI showed good reliability and a two-factor structure among college students [35]. The study tested the reliability and validity of the PANSI with diverse samples of young adults, high school students, and psychiatric inpatients, and the results showed good reliability and a stable two-factor structure [30, 33, 34]. A large number of studies have verified the measurement performance of the scale. For instance, the PANSI has been shown to be an effective and reliable instrument to measure the severity of suicidal ideation among clinical outpatients in Malaysia [43]. The PANSI has also shown good psychometric properties among Korean middle school students [23], as well as good reliability and validity among Nigerian college students and Colombian students [1, 49]. In China, research involving a sample of middle school students and senior high school students in Taiwan found that Cronbach’s alpha coefficients of the PANSI-negative suicide ideation (PANSI-NSI) was .94, and that the PANSI-positive ideation (PANSI-PI) was .86. The two-factor model has also

Keywords: Suicide ideation, Positive and Negative Suicide Ideation (PANSI), Psychometric properties, Measurement invariance
been replicated. However, participants in this study were limited to urban areas [6]. Another study also found that the PANSI had good reliability and validity among high school students in Henan, China [50].

Measurement invariance means that, given a latent factor, the conditional distribution of the observed variables is invariant across groups, namely there is no measurement bias associated with a specific group in different conditions [7]. Studies have shown that when the same measurement scale is applied in different situations, the measurement characteristics are likely to change [10]. Different groups (e.g., country, gender, and age) may have different understandings of the items in a particular scale [14, 44, 46]. Although some studies have compared the differences in PANSI scores between genders, the conclusions have been inconsistent. In the PANSI-NSI subscale, males have generally scored significantly higher than females, but there has been no significant difference between the genders in the PANSI-PI subscale [1]. Some studies have shown that girls’ scores in the PANSI-NSI are significantly higher than those of boys [6], while others have shown that there is no significant difference between in PANSI scores between males and females [30, 33, 35]. Single-parent family children refer to children under the age of 18 who are raised by their father or mother alone due to the divorce of their parents or the death of one party, or other reasons, and who do not have the ability to live independently [5]. Defects in family structure and absence of parent education make children from single-parent families face huge challenges in psychological development and social adaptation [16, 51], specifically showing more problems in self-esteem, social anxiety, anti-social behavior [8, 38, 47]. If researchers want to use the PANSI scale to explore the actual differences in suicidal ideation between different groups, it is necessary to ensure that the scale has the invariance of cross-group measurement [13]. Furthermore, we tested whether the PANSI remained unchanged in the youth age category. In the World Health Organization [53] age classification, the age of adolescents is 10–19 years. In addition, adolescents are divided into younger adolescents (10–14 years) and older adolescents (15–19 years). Therefore, we divided the age group into 11–14 years and 15–17 years to measure the invariance in the current study. In summary, this study examined the measurement invariance of gender, single-parent and non-single-parent households and age of the PANSI.

Based on the above review of existing literature, this study aimed to evaluate the reliability and validity of the PANSI and its measurement invariance on variables such as gender, single-parent and non-single-parent household and age so as to provide scientific basis for further research in related fields.

### Methods

#### Translation procedure

We first used the method of “translation and back-translation”; with separate translations performed by three graduate students in psychology which were then compared and used to form the first draft of the measurement. Next, a group consisting of a psychology professor and eight postgraduates discussed and revised the first draft to form the second draft of the PANSI. After that, a senior professor of psychology was invited to join the discuss and revise the measure so that the language was accurate, fluent, and in line with Chinese expression habits so as to achieve equivalence between the Chinese and English versions, producing a final, formal questionnaire that formed the Chinese version of the PANSI (PANSI-C), see Table 1.

#### Subjects and data collection

In the convenient sampling of the four middle school classes, students read the informed consent form, and those who agree to participate will get small gifts after completing the questionnaire. The committee of the School of Psychology of Guizhou Normal University approved the study. Both the students and their parents had been informed that participation was voluntary, that results would be reported only in aggregate, and that the study responses and data management would be kept confidential. Use the following inclusion criteria: (a) no psychiatric disorders, (b) suicidal ideation occurred in the past 2 weeks, and (c) fully completing the survey. Study participants were comprised of 1198 middle school students with an average age of 13.86 (SD = 1.60), where 44.8% were boys, 51.9% were girls, and 3.3% were missing values.

#### Table 1 The Chinese translation of the PANSI (PANSI-C)

| PANSI-NSI | Chinese Translation |
|-----------|---------------------|
| 1. 我对未来充满了希望。 |
| 2. 我觉得自己能掌控生活中的大多数情况。 |
| 3. 对生活很满意。觉得未来充满了希望。 |
| 4. 学习上很顺利, 我感到很愉快。 |
| 5. 有自信心处理生活中的大部分问题。 |
| 6. 感觉生命是值得活下去的。 |

| PANSI-PI | Chinese Translation |
|----------|---------------------|
| 1. 感到很孤独和悲伤, 为了结束痛苦而想自杀。 |
| 2. 想到自杀，除了自杀别无选择。 |
| 3. 在面对不能解决的问题时，除了自杀别无选择。 |
| 4. 想自杀。 |
| 5. 想结束生命。 |
| 6. 想死。 |
| 7. 未自杀。 |

This text is a translation of the original Chinese text and may contain minor discrepancies due to the nature of translation.
this data. Regarding where they lived, 40.8% lived in rural areas, 53.2% in urban areas, and 6% were missing
this data. Most of the participants had siblings ($n = 914$, 76.3%), and the vast majority of them came from non-
single-parent households ($n = 1021$, 85.2%). See Table 2 for further details.

**Measurements**

**Demographic information**

Demographic information included participants’ gender (i.e., boy or girl), age, home address (i.e., rural or
urban), grade (i.e., first, second, or third grade), whether they were an only child (i.e., yes/no), whether they lived
in a single-parent family (i.e., yes/no), and whether they wanted to have a sibling (i.e., yes/no).

**Positive and Negative Suicide Ideation Inventory (PANSI)**

Suicidal ideation was measured by the Positive and Negative Suicide Ideation (PANSI) Inventory [35]. The PANSI
evaluates both the protective and risk factors associated

**Table 2** Frequency distribution of adolescents’ demographical characteristics ($N = 1198$)

| Variables             | Groups     | $N$ | %  |
|-----------------------|------------|-----|----|
| Gender                | Boy        | 537 | 44.8 |
|                       | Girl       | 621 | 51.9 |
|                       | Missing    | 40  | 3.3 |
| Age                   | 11         | 1   | .1  |
|                       | 12         | 65  | 5.4 |
|                       | 13         | 333 | 27.8|
|                       | 14         | 406 | 33.9|
|                       | 15         | 259 | 21.6|
|                       | 16         | 75  | 6.3 |
|                       | 17         | 7   | .6  |
|                       | Missing    | 52  | 4.4 |
| Address               | Rural      | 489 | 40.8|
|                       | Urban      | 637 | 53.2|
|                       | Missing    | 72  | 6   |
| Grade                 | First grade| 424 | 35.4|
|                       | Second grade| 420 | 35.1|
|                       | Third grade| 315 | 26.3|
|                       | Missing    | 39  | 3.3 |
| Only child            | Yes        | 237 | 19.8|
|                       | No         | 914 | 76.3|
|                       | Missing    | 47  | 3.9 |
| Single-parental family| Yes      | 124 | 10.4|
|                       | No         | 1021| 85.2|
|                       | Missing    | 53  | 4.4 |
| Want a younger sibling| Yes       | 399 | 33.3|
|                       | No         | 705 | 58.8|
|                       | Missing    | 99  | 7.9 |

with suicidal ideation, and comprises two dimensions (14 items total): positive ideation (PANSI-PI, 6 items) and
negative suicide ideation (PANSI-NSI, 8 items). PANSI-
NSI and PANSI-PI examined the frequency of specific
negative thoughts (e.g., failure to accomplish something
important) or positive thoughts (e.g., excited about doing
well at school or work) related to suicidal behavior [35].
Participants used a Likert scale ranging from 1 (i.e.,
“none of the time”) to 5 (i.e., “most of the time”) to assess
the frequency they experience suicidal ideation. Higher
scores indicate more positive or negative suicide ideation,
depending on the item’s particular subscale. The Cron-
bach’s $\alpha$ coefficients of the PANSI-NSI and PANSI-PI in
this study were .915 and .696, respectively.

**Rosenberg self-esteem scale (RSE)**

Based on previous studies on suicidal ideation, the
Rosenberg self-esteem scale (RSE) scale was selected as
criterion instruments [23, 43]. The Rosenberg self-esteem
scale (RSE) is a 10-item self-report questionnaire that
assesses individual self-esteem [41]. The SES we used
is a Chinese version translated by Yang and Wang [55].
Participants use a Likert scale ranging from 1 to 4. The
higher the score, the higher one’s level of self-esteem is.
The Cronbach’s alpha coefficient of the SES in this study
was .826.

**Suicide probability scale (SPS)**

According to the research of Osman et al. [35], the SPS
was selected as the effective standard instrument. The
suicide probability scale (SPS) was developed by Cull and
Gill [11], it includes four subscales: Hopelessness, Negative
Self-Evaluation, Hostility and Suicide Ideation. The
Chinese version of the SPS was translated by Liang and
Yang [25]. This study uses the suicide ideation subscale,
including 8 items, to measure the frequency of suicidal
ideation in the past week. Participants use a Likert scale
ranging from 1 to 4, with higher scores indicate the risk
of suicide. The Cronbach’s alpha coefficient of the SPS in
the present study was .799.

**Statistical analysis**

Statistical Packages for Social Sciences (SPSS) version
25.0 and Mplus version 8.3 were used to perform the sta-
tistical analyses.

SPSS 25.0 was used to make the most basic descrip-
tive statistics. Cronbach’s alpha coefficients were used
to evaluate the reliability of the PANSI-C. A value of
Cronbach’s alpha coefficients < .60 was considered to be
insufficient; .60–.69 was marginal; .70–.79 was considered
acceptable; .80–.89 was considered good; ≥ .90 was
considered excellent [2]. Some researchers have pointed
out, based on experience, that when the coefficients of
skewness and kurtosis (absolute values) are less than 2 and 7, respectively, the Maximum Likelihood (ML) estimation method is acceptable [12, 52]. The absolute value of skewness of the data in the current study ranged from .007 to 1.899, and the absolute value of kurtosis was between .046 and 2.996. It can be seen ML can also be used to obtain reasonable parameter estimation results. We used confirmatory factor analysis to fit the model, and we used the approximate root mean square error of approximation (RMSEA) and its 90% CI, the comparative fit index (CFI), the Tucker–Lewis index (TLI), the standardized root means square residual (SRMR), and other fitting indicators to evaluate the degree of model fit. Past research supports that, if the CFI or TLI are more than .90 and the SRMR is less than .08, then RMSEA rates approximating .06 or lower indicate a good fit, .07–.08 an acceptable fit, .08–.10 a limited fit, and > .10 as unfit [21, 45]. The Pearson correlation coefficient was used to evaluate the correlation between the PANSI-C and each scale. Correlation intensity has been explained by Colton [9] as follows: 0–.25 = irrelevant or very small correlation, .26–.50 = general correlation, .51–.75 = moderate correlation, and .76–1.00 = complete correlation. Correlations were used to analyze the construct validity of the PANSI-C. The test for measurement invariance was a comparison of a series of nested models. Since the Chi-square test is extremely sensitive to the sample size, the larger the sample size, the more significant the result of the Chi-square test. As the sample size continues to increase, even small changes will cause significant differences [20]. Based on the above considerations, this study uses the difference in model fitting index between groups (∆CFI, ∆TLI) and ∆RMSEA as a reference index for measuring invariance. If configural invariance is obtained, then it means that the composition of latent variables is the same among different groups. If weak invariance is established, indicating that the factor loadings between the groups are equal. Strong invariance is used to test whether the intercepts of the observed variables are equal. The strict invariance model is used to test whether the error variances between different groups are equal [27]. Some researchers pointed out that when using the ∆CFI, ∆TLI and ∆RMSEA values to compare nested models, the measurement invariance model is acceptable when ∆CFI(TLI) ≤ .01 and ∆RMSEA ≤ .015 [7].

Results

Reliability

In this study, for the PANSI-C subscales, the Cronbach’s alpha coefficients were .696 and .915, respectively, showing acceptable reliability for both. The Cronbach’s alpha coefficients of the PANSI-C subscales and the other scales are shown in Table 3.

Validity

Construct validity

Since the PANSI scale has shown a stable two-factor structure in previous studies, the current study directly verified the PANSI-C’s two-factor structure. The confirmatory factor analysis results showed acceptable fitting indices of the two-factor model—χ2 = 703.859, p < .001, df = 76, χ2/df = 9.261, CFI = .919, TLI = .903, SRMR = .047, RMSEA (90% CI) = .083 (.077, .089)—and the relative fitting indices of CFI and TLI were all above .90.

Criterion validity

Positive ideation was negatively related to negative suicidal ideation (− .476) and suicide probability (− .409), and positively related to self-esteem (.567). Negative suicidal ideation was negatively related to self-esteem (− .509), and positively related to suicide probability (.707). All correlations were statistically significant (p < .01). The Pearson correlation matrix of variables is shown in Table 3.

Measurement invariance

Testing was conducted based on gender, family structure (i.e., single-parent and non-single-parent households) and age.

Configural invariance

The baseline models of gender, single-parent/non-single-parent household and age samples were combined into

Table 3 Correlations of PANSI-C with other subscales

| Variable    | 1 | 2            | 3            | 4            | MSD(SD)         | Alpha |
|-------------|---|--------------|--------------|--------------|----------------|-------|
| 1. PANSI-PI | 1 | .476***      | .567***      | .409***      | 20.82 (4.45)   | .696  |
| 2. PANSI-NSI| − | 1            | − .509***    | − .532***    | 13.31 (6.89)   | .915  |
| 3. RSE      | .567*** | 1            | .707***      | − .532***    | 28.22 (5.50)   | .826  |
| 4. SPS      | − .409*** | − .509***    | 1            | 13.64 (4.52) | .799  |

PANSI-PI the positive and negative suicide ideation-positive ideation, PANSI-NSI the positive and negative suicide ideation-negative ideation, RSE the Rosenberg self-esteem scale, SPS the suicide probability scale

** p < .01, *** p < .001
multiple sets of confirmatory factor analysis models, and no restrictions were imposed on those groups of parameters. The results showed that the model fit was good (CFI\textsubscript{gender} = .927, TLI\textsubscript{gender} = .913, SRMR\textsubscript{gender} = .051, RMSEA\textsubscript{gender} = .059; CFI\textsubscript{family} = .925, TLI\textsubscript{family} = .910, SRMR\textsubscript{family} = .051, RMSEA\textsubscript{family} = .062; CFI\textsubscript{age} = .919, TLI\textsubscript{age} = .904, SRMR\textsubscript{age} = .053, RMSEA\textsubscript{age} = .061), and the fit indices are presented as Model 1, with configural invariance shown in Table 4. These results show that the PANSI-C is morphologically invariant among these groups, that is, suicidal ideation in these groups can be measured by the 14 items of the PANSI-C and the same factor structure.

**Weak invariance**

Based on Model 1, all factor loadings in each group were set to be equal, or more specifically, each item was affected by the measured latent factors in the same gender, single-parent and non-single-parent household and age groups. The model fit index is presented as Model 2 in Table 4, and the model fits well. Compared to Model 1, with $\Delta$CFI(TLI) $\leq$ .01 and $\Delta$RMSEA $\leq$ .015, the fit between Model 2 and Model 1 can be considered as being good, with the weak invariance of the PANSI-C between the different groups satisfied.

**Strong invariance**

Based on Model 2, all intercepts of each group of models were set to be equal. The model fit index is presented as Model 3 in Table 4, and the model fits well. Compared with Model 2, with $\Delta$CFI(TLI) $\leq$ .01 and $\Delta$RMSEA $\leq$ .015, it can be considered that the strong invariance is satisfied, namely the mean difference of the PANSI-C latent factors between the different groups can be expressed by the mean of the observed variables.

**Strict invariance**

In Model 3, the residual variances in the model were set to be equal. The model fit index is presented as Model 4 in Table 4, and the model fits well. Compared with Model 3, with $\Delta$CFI(TLI) $\leq$ .01 and $\Delta$RMSEA $\leq$ .015 for gender and different family structure, $\Delta$TLI = +.012 $>$ .01, $\Delta$CFI = +.005 $\leq$ .01 and $\Delta$RMSEA = −.004 $\leq$ .015 for age. It can be considered that gender and family structure groups meet strict invariance, namely the differences between the two groups of variation in the PANSI-C observation variable fully reflect the variation of the latent factor.

**Discussion**

The PANSI-C is a self-report instrument used to evaluate both the protective factors and negative risk factors associated with suicidal behaviors among adolescents [35]. The current study examined the psychometric properties of the PANSI-C, especially its measurement invariance, across different samples (i.e., gender, single-parent

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**Table 4** Measurement invariance testing results of the PANSI-C across different groups

| Model   | $\chi^2$ | $df$ | TLI | CFI | SRMR | RMSEA | $\Delta$TLI | $\Delta$CFI | $\Delta$RMSEA |
|---------|---------|-----|-----|-----|------|-------|-------------|-------------|--------------|
| Across gender |         |     |     |     |      |       |             |             |              |
| Model 1 | 823.480 | 152 | .913 | .927 | .051 | .059  | –           | –           | –            |
| Model 2 | 841.111 | 164 | .918 | .926 | .056 | .057  | +.005       | −.001       | −.002        |
| Model 3 | 867.567 | 176 | .919 | .921 | .058 | .057  | +.001       | −.005       | 0            |
| Model 4 | 899.094 | 190 | .929 | .926 | .058 | .053  | +.01        | +.005       | −.004        |
| Across family structure |         |     |     |     |      |       |             |             |              |
| Model 1 | 805.982 | 152 | .910 | .925 | .051 | .062  | –           | –           | –            |
| Model 2 | 828.913 | 164 | .915 | .924 | .057 | .060  | +.005       | −.001       | −.002        |
| Model 3 | 844.225 | 176 | .918 | .921 | .057 | .059  | +.003       | −.003       | −.001        |
| Model 4 | 887.175 | 190 | .926 | .923 | .058 | .056  | +.008       | +.002       | −.003        |
| Across age |         |     |     |     |      |       |             |             |              |
| Model 1 | 875.323 | 152 | .904 | .919 | .053 | .061  | –           | –           | –            |
| Model 2 | 909.603 | 164 | .907 | .916 | .061 | .060  | +.003       | −.003       | −.001        |
| Model 3 | 924.590 | 176 | .910 | .913 | .062 | .059  | +.003       | −.003       | −.001        |
| Model 4 | 947.191 | 190 | .922 | .918 | .062 | .055  | +.012       | +.005       | −.004        |

Model 1, configural invariance; Model 2, weak invariance; Model 3, strong invariance; Model 4, strict invariance; $\chi^2$, Chi-square goodness of fit; $df$, degrees of freedom; TLI, Tucker–Lewis index; CFI, comparative fit index; SRMR, standardized root mean square residual; RMSEA, root mean square error of approximation; $\Delta$TLI, TLI difference; $\Delta$CFI, CFI difference; $\Delta$RMSEA, RMSEA difference.
and non-single-parent households and age). This is the first study to explore the measurement invariance of the PANSI (as the PANSI-C). Our results verify the two-factor structure of the PANSI-C and support the scalar invariance of the PANSI-C in different samples. The results of the current study show that the PANSI-C has good reliability and validity in a sample of Chinese adolescents.

The results of the current study showed that, in terms of reliability, the Cronbach's alpha coefficients for both the PANSI-NSI and PANSI-PI were acceptable, at .915 and .696, respectively, which is consistent with previous research findings [34, 35, 43]. Compared with previous studies, the reliability of the PANSI-PI subscale in this study was lower, which may be due to the fact that the participants were normal middle school students and do not understand the positive items of suicidal ideation.

In terms of validity, confirmatory factor analysis fitting indicators were good, indicating that the PANSI-C has good structural validity, which is the same as the structure obtained from the original scale and previous studies [1, 6, 30, 33–35, 43, 49]. It shows that the two-factor structures of the PANSI were also supported in Chinese adolescents. According to correlation analysis, positive ideation was negatively related to negative suicidal ideation and suicide probability, and positively related to self-esteem. Negative suicidal ideation was negatively related to self-esteem, and positively related to suicide probability, this was consistent with previous studies [23, 35, 43]. This also verified the good construct validity of the PANSI in China.

Although some studies have compared the differences in the PANSI scores between genders, the conclusions have been inconsistent [1, 6]. The measurement invariance of a scale should be checked before any comparison of scale scores for different groups is made [27]. Therefore, we examined the measurement invariance of the PANSI-C between different samples (i.e., gender, single-parent and non-single-parent households and age). We gradually establish four models, namely configural invariance, weak invariance, strong invariance and strict invariance. The results of the configural invariance evaluation show that the number of factors and factor model were equal in gender, single-parent and non-single-parent households samples. The evaluation of weak invariance showed that the scale observation items and potential factors were equivalent in different samples. The evaluation of strong invariance showed cross-group differences in the mean of observed variables reflected the intra-group difference of the mean of potential variables. When strict invariance is obtained, the error variance of each group meets the cross-group equivalent. The results of measurement invariance show that the composition of latent variables, factor loadings, intercept and error variance of the PANSI-C in gender, single-parent and non-single-parent household samples were equal, indicating that the severity of suicidal ideation in different groups can be accurately compared when the PANSI-C is used. In addition, we obtained strong invariance across age groups, indicating that different age groups have the same reference point, so that the latent variable scores estimated by the observed variables are unbiased and the comparison between groups is meaningful. In short, the measurement invariance of the PANSI-C among different samples is obtained. The measurement results of the PANSI-C can be directly compared between different gender, family structure and age groups.

In summary, the PANSI-C consists of two dimensions, positive ideation and negative suicidal ideation, and shows good reliability and validity in the samples used in the current study. It meets the requirements of psychological measurement theory, and is a reliable and effective instrument for detecting the occurrence of suicidal ideation in Chinese adolescents, and can be applied to the psychological assessment of suicidal ideation in Chinese adolescents as well as in other related research fields. Nevertheless, several issues needed to be considered when interpreting these results. First, it lacks popularization to the other samples in China. Future research should be conducted on more representative and larger samples. Second, further studies are needed to explore the measurement invariance of PANSI-C in more groups, for providing evidence for cross-group research.

Conclusion
In conclusion, the current study examined the psychometric properties of the PANSI-C in Chinese adolescents, looking in particular at its measurement invariance across samples determined by gender, single-parent/non-single-parent households and age. This effort broadens the psychometric and measurement properties of the PANSI-C, which could be meaningful for future empirical study into suicidal ideation prevention and treatment. Our results support the measurement invariance of the PANSI-C in the different samples, the findings indicate that the PANSI-C is a valid measure of suicidal ideation.

Abbreviations
PANSI: Positive and Negative Suicide Ideation; PANSI-C: Chinese version of the Positive and Negative Suicide Ideation Inventory; RSE: Rosenberg self-esteem scale; SPS: Suicide probability scale; WHO: World Health Organization; BSI: Beck scale for suicide ideation; SIQ: Suicidal ideation questionnaire; MSSI: Modified scale for suicide ideation; SIS: Suicide ideation scale; PANSI-NSI: PANSI-negative suicide ideation; PANSI-PI: PANSI-positive ideation; SPS: Statistical packages for social sciences; ML: Maximum likelihood; χ²: Chi-square goodness of fit; df: Degrees of freedom; TLI: Tucker–Lewis index; CFI: Comparative fit index; SRMR: Standardized root mean square residual; RMSEA. Root mean square error
of approximation; $\Delta$TLI: TLI difference; $\Delta$CFI: CFI difference; $\Delta$RMSEA: RMSEA difference.

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Authors’ contributions
WC conceptualized the article and provided framework of the manuscript. TY analyzed the data and drafted the manuscript. RG and GZ collected the data and offered suggestions and guidance for revising the data analysis of this manuscript. The final version was approved by WC. All authors read and approved the final manuscript.

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Availability of data and materials
The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the School of Psychology of Guizhou Normal University. Written informed consent was obtained from individual or guardian participants.

Consent for publication
Not applicable.

Competing interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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References
1. Aloba O, Adefemi S, Aloba T. Positive and Negative Suicide Ideation (PANSI) Inventory: initial psychometric properties as a suicide risk screening tool among Nigerian university students. Clin Med Insights Psychiatry. 2018;11:1–9. https://doi.org/10.1177/1796375717715910.
2. Barker C, Pistran N, Elliot R. Research methods in clinical and counselling psychology. Hoboken; Wiley; 1994.
3. Beck AT, Steer RA. Manual for beck scale for suicide ideation. SanAntonio: SanAntonio Psychological Corporation; 1991.
4. Bonner RL, Rich AR. Toward a predictive model of suicidal ideation and behavior: some preliminary data in college students. Suicide Life Threaten Behav. 2011;117(1):50–63. https://doi.org/10.1111/j.1943-278x.1987.tb0061x.
5. Brody GH, Munry VM, Kim S, Brown AC. Longitudinal pathways to competence and psychological adjustment among African American children living in rural single-parent households: Child Dev. 2002;73(5):1505–16. https://doi.org/10.1111/1467-9624.00486.
6. Chang HI, Lin CC, Chou KR, Mia WF, Yang CY. Chinese version of the positive and negative suicide ideation: instrument development. J Adv Nurs. 2009;65(7):1485–96. https://doi.org/10.1111/j.1365-2648.2009.05005.x.
7. Cheung GW, Rensvold RB. Evaluating goodness-of-fit indexes for testing measurement invariance. Struct Equ Model. 2002;9(2):233–55. https://doi.org/10.1207/s15328007sem0902_5.
8. Chinawa JM, Obu HA, Manyike PC, Obi IE, Iresaal OQ, Chinawa AT. Self esteem among adolescents in Nigerian secondary schools: a neglected issue. Br J Med Med Res. 2014;51(1):98–106. https://doi.org/10.9734/BJMMR/2015/12492.
9. Colton T. Statistics in medicine. 1st ed. Boston: Little, Brown, and Company; 1974.
10. Cronbach LJ. Essentials of psychological testing. 4th ed. New York: Harper & Row Publishers; 2012.
11. Cull JL, Gill WS. Suicide probability scale. Los Angeles: Western Psychological Services; 1982.
12. Finney SJ, DiStefano C. Nonnormal and categorical data in structural equation modeling. In: Hancock GR, Mueller R, editors. structural equation modeling. Information Age. Charlotte; 2006. p. 269–314.
13. French BF, Finch WH. Confirmatory factor analytic procedures for the determination of measurement invariance. Struct Equ Model. 2006;13(3):378–402. https://doi.org/10.1207/s15328007sem1303_3.
14. Galambos NL, Leadbeater BJ, Barker ET. Gender differences in and risk factors for depression in adolescence: a 4-year longitudinal study. Int J Behav Dev. 2004;28(1):16–25. https://doi.org/10.1080/10650025034400235.
15. Gibb BE, Alloy LB, Abramson LY, Rose DT, Whitehouse WG, Hogan ME. Childhood maltreatment and college students’ current suicidal ideation: a test of the hopelessness theory: Suicide Life Threatening Behav. 2001;31(4):405–13. https://doi.org/10.1016/s0131-4400(02)40242.
16. Haimi M, Lerner A. The impact of parental separation and divorce on the health status of children, and the ways to improve it. J Clin Med Genom. 2016;4(1):137–47. https://doi.org/10.4172/2472-12-ex.1000137.
17. Hawton K, Heeringen KV. The international handbook of suicide and attempted suicide. Hoboken; Wiley; 2000.
18. Horwitz AG, Czyz EK, King CA. Predicting future suicide attempts among adolescent and emerging adult psychiatric emergency patients. J Clin Child Adolesc Psychol. 2015;44(4):751–61. https://doi.org/10.1080/15374161.2014.910789.
19. Hu J, Dong YH, Chen XD, Liu Y, Ma DY, Liu XY, Zheng RZ, Mao XQ, Chen T, He W. Prevalence of suicide attempts among Chinese adolescents: a meta-analysis of cross-sectional studies. Compr Psychiatry. 2015;61:78–89. https://doi.org/10.1016/j.comppsych.2015.03.001.
20. Hu L, Benlter PM. Evaluating model fit. In: Hoyle RH, editor. Structural equation modeling: concepts, issues, and applications. Newbury Park: Sage; 1993. p. 16–99.
21. Hu L, Bentler PM. Cutoff criteria for fit indices in covariance structure analysis: conventional criteria versus new alternatives. Struct Equ Model. 1999;6(1):1–55. https://doi.org/10.1080/10705519909540118.
22. Klonisky ED, May AM, Saffer BY. Suicide, suicide attempts, and suicidal attempts and suicidal ideation. Annu Rev Clin Psychol. 2016;12(1):307–30. https://doi.org/10.1146/annurev-clinpsy-021815-093204.
23. Lee HM, Kim S, Sook Y. A reliability and validity study of the Korean version of PANSI (Positive and Negative Suicide Ideation) Scale. Korean J Soc Welfare. 2016;68(3):149–80. https://doi.org/10.20970/ksw2016.68.3.007.
24. Li ZZ, Li YM, Lei XJ, Zhang D, Liu L, Tang SY, Chen L. Prevalence of suicidal ideation in Chinese college students: a meta-analysis. PloS ONE. 2014;9(10):e104368. https://doi.org/10.1371/journal.pone.0104368.
25. Liang YN, Yang LZ. Study on reliability and validity of the Suicide Probability Scale. China J Health Psychol. 2010;18(2):225–7. https://doi.org/10.13342/jcnk.cnhp.2010.02.031.
26. Liu Y, Yang Y, Wang CX, Yang YN, Xia JX, B X, B L, L. The effect of school climate and negative emotion on adolescent suicidal ideation: one year follow-up cross-lagged regression analyses. Stud Psychol Behav. 2020;18(6):784–90.
27. Meredith W. Measurement invariance, factor analysis and factorial invariance. Psychometrika. 1993;58(4):525–43. https://doi.org/10.1002/0.3634.6.
28. Miller AL, Rathus JH, Linehan MM. Dialectical behavior therapy with suicidal adolescents. New York: The Guilford Press; 2007.
29. Miller RW, Norman WH, Bishop SB, Dow MG. The modified scale for suicide ideation: reliability and validity. J Consult Clin Psychol. 1986;54(5):724–5. https://doi.org/10.1037/0022-006X.54.5.724.
30. Muehlenkamp JJ, Gutierrez PM, Osman A, Barrios FX. Validation of the Positive and Negative Suicide Ideation (PANSI) Inventory in a diverse sample of young adults. J Clin Psychol. 2005;61(4):431–45. https://doi.org/10.1002/jclp.20051.
31. Nock MK, Borges G, Bromet EJ, Alonso J, Angermeyer M, Beautrais A, Bufflea R, Chiu WT, De Girolamo G, Gluzman S. Cross-national prevalence and risk factors for suicidal ideation, plans and attempts. Br J Psychiatry. 2008;192(2):98–105. https://doi.org/10.1192/bjp.bp.107.040113.

32. Nock MK, Green JG, Huang J, McLaughlin KA, Sampson NA, Zaslavsky AM, Kessler RC. Prevalence, correlates, and treatment of lifetime suicidal behavior among adolescents: results from the National Comorbidity Survey Replication Adolescent Supplement. JAMA Psychiat. 2013;70(3):300–10. https://doi.org/10.1001/jamapsychiatry.55.

33. Osman A, Barrios FX, Gutierrez PM, Jiandani J, Kopper BA, Truelove RS. A preliminary validation of the Positive and Negative Suicide Ideation (PANSI) inventory: psychometric evaluation with adolescent psychiatric inpatient samples. J Pers Assess. 2002;79(3):512–30. https://doi.org/10.1207/S15327752JPA7903_07.

34. Osman A, Gutierrez PM, Jiandani J, Kopper BA, Barrios FX, Linden SC, Truelove RS. A preliminary validation of the Positive and Negative Suicide Ideation (PANSI) inventory with normal adolescent samples. J Clin Psychol. 2003;59(4):493–512. https://doi.org/10.1002/jclp.10154.

35. Osman A, Gutierrez PM, Kopper BA, Barrios FX, Chiros CE. The Positive and Negative Suicide Ideation Inventory: development and validation. Psychol Rep. 1998;82(3):783–93. https://doi.org/10.2466/pq.1998.82.3.783.

36. Parry J. Falling suicide rates in China mask emerging upward trends. BMJ. 2014;349(jul076):g4486. https://doi.org/10.1136/bmj.g4486.

37. Peng SH, Yang YXZ, Rockett IRH. A typology of social capital and its mixed blessing for suicidal ideation: a multilevel study of college students. Soc Sci Med. 2019;243:112640. https://doi.org/10.1016/j.socscimed.2019.112640.

38. Perales F, Johnson SE, Baxter J, Lawrence D, Zubrick SR. Family structure and Negative Suicide Ideation (PANSI) inventory with normal adolescent samples. J Pers Assess. 2002;79(3):512–30. https://doi.org/10.1207/S15327752JPA7903_07.

39. Peng SH, Yang YXZ, Rockett IRH. A typology of social capital and its mixed blessing for suicidal ideation: a multilevel study of college students. Soc Sci Med. 2019;243:112640. https://doi.org/10.1016/j.socscimed.2019.112640.

40. Parry J. Falling suicide rates in China mask emerging upward trends. BMJ. 2014;349(jul076):g4486. https://doi.org/10.1136/bmj.g4486.

41. Reynolds WM. Suicidal Ideation Questionnaire (SIQ): Professional Manual. Odessa, Florida: Psychological Assessment Resources; 1987.

42. Rudd MD. The prevalence of suicidal ideation among college students. Suicide Life-Threatening Behav. 1989;19(2):173–83. https://doi.org/10.1111/j.1532-2788.1989.tb01031.x.

43. Sinnenh A, Cei TP, Chinnia K, Shah SA, Maniam T, Subramaniam P. Psychometric properties and validation of the Positive and Negative Suicide Ideation (PANSI) Inventory in an outpatient clinical population in Malaysia. Front Psychol. 2015;6:1934. https://doi.org/10.3389/fpsyg.2015.01934.

44. Steenkamp JEM, Baumgartner H. Assessing measurement invariance in cross-national consumer research. J Consum Res. 1998;25(1):78–107. https://doi.org/10.1086/209528.

45. Steiger JH. Structural model evaluation and modification: an interval estimation approach. Multivariate Behav Res. 1990;25(2):173–80. https://doi.org/10.1207/s15327906mbr2502_4.

46. Sun YC, Chen CL, Wen SH. Taiwanese depression questionnaire revisited: Factor structure and measurement invariance across genders. J Formos Med Assoc. 2018;117(9):1356–61. https://doi.org/10.1016/j.jfma.2018.12.006.

47. Tebeka S, Hoertel N, Dubertret C, Le Strat Y. Parental divorce or death during childhood and adolescence and its association with mental health. J Nerv Ment Dis. 2016;204(9):678–85. https://doi.org/10.1097/NMD.0000000000000549.

48. Turner RM, Korslund KE, Barnett BE, Josiassen RC. Assessment of suicide in schizophrenia: development of the interview for suicide in schizophrenia. Cogn Behav Pract. 1998;5(2):139–69. https://doi.org/10.1016/S1077-7034(98)80002-3.

49. Villalobos-Galvis FH. Validity and reliability of the Positive and Negative Suicide Ideation Inventory, Colombian students. Universitas Psychol. 2010;9(2):509–20.

50. Wang XZ, Gong HL, Kang XR. Reliability and validity of Chinese revision of Positive and Negative Suicide Ideation Inventory in high school students. China J Health Psychol. 2011;19(8):946–66. https://doi.org/10.13342/j.cnki.chjhp.2011.08.014.

51. Weaver JM, Schofield TJ. Mediation and moderation of divorce effects on children’s behavior problems. J Fam Psychol. 2015;29(1):39–48. https://doi.org/10.1037/fam0000043.

52. West SG, Finch JF, Curran PJ. Structural equation models with nonnormal variables: problems and remedies. In: Hoyle RH, editor. Structural equation modeling: concepts, issues, and applications. Thousand Oaks: Sage; 1995. p. 56–75.

53. World Health Organization. Global accelerated action for the health of adolescents (AA-HA!): guidance to support country implementation: brochure; 2017. https://apps.who.intiris/handle/10665/255416.

54. World Health Organization. Suicide data; 2020. https://www.who.int/mental_health/prevention/suicide/suicideprevent/en/.

55. Yang Y, Wang DF. Retest of the bidimensional model of Rosenberg Self-Esteem Scale. Chin Ment Health J. 2007;21(9):603–605.

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