

# Development and validation of inferiority-compensation scale among high school students

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## Research Article

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## Abstract

An increasing numbers of high school students are inflicted by different degrees of mental disorders in learning, such as moodiness, learning difficulties, test anxiety, difficult to cope with frustration, etc., which are one of the factors leading to inferiority of students. In this study, the initial questionnaire of inferiority compensation for high school students was formed through literature searching, expert evaluation, interviews and open questionnaires. 1187 high school students were tested in different periods, including 461 copies of valid questionnaires of exploratory factor analysis in the first stage and 643 copies of valid questionnaires of confirmatory factor analysis in the second stage. The results showed that the inferiority compensation questionnaire for high school students consisted of two sub-questionnaires: self-compensation and others-compensation, and which two were both composed of five dimensions including academic performance, physical fitness, social communication, appearance and self-esteem. Confirmatory factor analysis showed that the total questionnaire and the two sub-questionnaires all had good structural validity, and the combined reliability and values (such as the correlation coefficient of each dimension) of the two sub-questionnaires were within the ideal range. With good reliability and validity, and meeting the requirements of psychometrics, the questionnaire can be used in the relevant research and practice of inferiority compensation for high school students.

## Introduction

### **All but Death, can be Adjusted. – Emily Dickinson**

As Adler described in his book “What life should mean to you” (Adler, 1917), each of us in life has varying degrees of inferiority and since self-inferiority can make us nervous, depressed, and anxious, we will strive to obtain a sense of superiority in action to compensate for our inferiority and change its situation. In other words, everyone always believes that the situation where they are needs to be improved at all times.

The concept of compensation originally referred to the phenomenon of an individual causing a defective organ of the body to perform better than a perfectly normal organ (Huang et al., 2019; Stallen et al., 2018). Now it gradually develops into a phenomenon where individuals experience frustration in the pursuit of a goal, or due to a physical deficiency and try to compensate with their strengths. Adler first extended the word compensation from physiology to psychology. Previous studies believed that everyone would make up for the self-inferiority caused by the insufficiency in reality or imagination to overcome this inferiority and become a superior person to others (Hoorens & Damme, 2012; Leach & Spears, 2008). Thus, the current interpretation of inferiority compensation refers to a series of phenomena that which behavioral and cognitive efforts made by individuals enable the individual abilities to be improved in some aspects and function reflected overcome inferiority to regain self-confidence. The method of compensation is to make up for their shortcomings and inferiority through efforts and achievements in some aspects, to give full play to the individual subjective initiative (Akdoğan & Çimşir, 2019), and to use and transform the objective environment to adapt to their problems in society (Tümlü & Şimşek, 2021).

From the perspective of the executors of compensation behavior, Adler believes that the perpetrator of compensatory behavior is only the self and no others, i.e., there is only self-compensation (Vaughan, 1927). Some scholars who support Adler's view also believe that inferiority is unique to individuals, independent of others, and others do not replace it (Friehe et al., 2021; Toma, 2022; Watermann et al., 2021). Thus, from this point of view, these scholars believe that compensation can only be completed by individuals with inferiority, that is, there is only self-compensation without compensation for others.

However, due to the diverse self-concepts between the eastern and western cultural backgrounds (Dhawan et al., 1995), the ego from oriental collectivism includes the perception of others, while western individualism, where members advocate personal values and are used to distinguishing themselves from the outside, does not include anyone else (Hong et al., 2001). Hence, some scholars put forward different opinions that the individual's sense of insecurity, and feelings of powerlessness and disappointment due to the inability to achieve the goal, can be regarded as inferiority complex (David & Trandafira, 2012). In real life, this inferiority complex whether from physical, psychological or social obstacles, can all be compensated. In addition, the compensation behavior does not necessarily have to be completed by the inferiority of self, it can also be completed by others or groups, even by the whole country or nation (Proulx et al., 2012; Ritchie & Long, 2021). Friehe et al indicates that if a person incorporates the object of comparison into his system, the threat of others' success will be significantly reduced (Friehe et al., 2021). According to a study by Booyesen et al indicates that there are more possibility to occur others-compensation in individuals under a collectivism culture than under a individualism culture (Booyesen et al., 2021). In additions, some scholars proposed compensation for others from the perspective of compensation behavior executor, and further explained that compensation for others is an objective completing method different from self-compensation (Hirao, 2014; Hoorens & Damme, 2012). Since Adler considers that the individual obtains superiority in the form of social identity, it is undeniable that there are other forms of identity to gain excellency, which can be seen as a substitute compensation obtained through the identity of others.

In the development of his compensation theory, Adler insisted that is not a symbol of deformity, but a normal phenomenon in the personal pursuit of excellence (Adler, 1917). And inferiority has a positive or negative effect on individual development depends on the compensation attitude to the individual (Friehe et al., 2021; Rode & Sáenz de Viteri, 2018). If an individual manages to make up for the defects of his own organs or abilities, he will improve the environment around him by direct and practical means, and change the strength of his internal beliefs, and consequently transform the inferiority at this time into the internal motivation for progress. Then that compensation is effective, and inferiority plays a positive role.

If a person simply pursues the sense of superiority but does not attempt to change the surrounding environment, then compensation will point to the useless side of life, make himself intoxicated or numb in fantasy, and obtain the emotional experience of self-confidence in the way of self-paralysis. In this case, the inner self-abasement will not disappear (Fan et al., 2011). Adler believes that such compensation will only become a tumor of their psychological growth, and eventually form inferiority complex (Adler, 1917). But inferiority complex will make people drift apart from society, discouraged, lack

of self-confidence, and people with inferiority complex do not believe that they will make any progress in life (Yu et al., 2020; Zhang et al., 2021).

The psychological problems prevail among high school students (Shen et al., 2020). If they can actively make up for the negative factors, they will gain confidence, have higher level of self-evaluation, and their inferiority will be improved to some extent (Greenaway et al., 2015). However, if students do not actively make up for their own shortcomings, while choose to escape, the inferiority complex gradually forms, resulting in psychological abnormalities. For that reason, for high school students, inferiority compensation is one of the vital approaches to get rid of inferiority, gain self-confidence and develop mental health.

Yet, based on cultural background differences, the inferiority compensation questionnaire has not been systematically compiled by scholars. As mentioned above, mental problems are prevalent issues among high school students. It remains unclear that how they view their inferiority, why avoid talking the topic of inferiority and how enhance their social adaptability and self-confidence? Here, we hope to answer the questions above through investigating the patterns of inferiority compensation of high school students.

## **Materials And Methods**

There were 2 main phases to the study. In the first development phase, potential question items were generated and tested in face-to-face interviews and 2 pilot rounds. In the second validation phase (the main study), we confirmed the internal reliability of the scale and examined construct validity and test-retest reliability

## **Participants**

### **Predictive samples**

Convenience sampling was applied to obtain representative samples of school students from high schools in Chongqing, China. Students filled out questionnaires on the spot-on laptops or online in first round of the questionnaires. Altogether 500 questionnaires were distributed. After screening according to the inclusion and exclusion criteria and eliminating the ineligible questionnaires, a total of 461 predictive questionnaires were collected and questionnaires return rate was 92.2%. The survey time was from January 2020 to March 2020. Informed consent was signed by all participants before the formal study in accordance with the Declaration of Helsinki, and all procedures were approved by the Chongqing Normal University research ethics committee. The procedures were performed in accordance with ethical guidelines and regulations.

Random sampling was applied to obtain samples of school students. School students from high schools in Chongqing, China were recruited in the second-round study to fill out the questionnaire on the spot (these students did not participate in the first round of the questionnaires). Altogether 687 questionnaires were distributed. After screening according to the inclusion and exclusion criteria and eliminating the

ineligible questionnaires, a total of 643 predictive questionnaires were collected and questionnaires return rate was 93.59%. The second survey time was from October 2020 to March 2021

## **Scale development**

Literature retrieval (Cai et al., 2017; Kim et al., 2013). We retrieved the relevant literature at home and abroad, where we selected, analyzed and collated the phrases and sentences that can reflect the self-inferiority compensation of high school students.

We firstly identified relevant conceptual dimensions about inferiority-compensation and developed a pool of 25 items based on a review of the literature and consultation with experts, and in-country stakeholders.

## **Candidate Question Items and Face-to-Face Interviews**

Using a structured interview, investigators identified 4 open-ended sthemes and concepts regarding the participants which the methods that can be used to overcome inferiority and how the honors of others have an impact on overcoming inferiority.

We also distributed 156 copies of questionnaires, and, as a result, 105 of them were collected effectively, and the recovery rate was 67.3% (for some students were sensitive to the word inferiority, so they did not fill out the scale). The investigation time was November 2019.

After eliminating the equivocal, irrelevant and unmanageable answers, the obtained content sorted out with the relevant literature, then discussing with the professors of psychology in related fields. At last, we divided inferiority compensation scale into two sub-scales: self-compensation sub-scale and others-compensation sub-scale. The dimensions of the sub-scales are obtained through the open scale results of interviews and the five dimensions of the inferiority scale revised by Chavez and Fritz (Chavez & Heatherton, 2017; Fritz et al., 2020). And Final dimensions identified included: academic performance, physical fitness, social communication, appearance, and self-esteem. We drafted about 4–6 items for each of these conceptual domains. Part items were adapted from Hirao’s job inferiority scale (Hirao, 2014) as shown in Table 1.

The set of items was introduced by “Because one subject is poor, I will make up for it by taking advantage of other subjects?”. Following items were the statements like “Because of the weak reading ability, I will make up by reading extracurricular books”, “Because of the weak sports scores, I make up for the promotion by attending sports meetings” and “I praise myself in front of the opposite sex to be looked up to.” Response options included completely inconsistent, basically inconsistent, uncertain basically consistent, completely consistent. The detailed items are shown in Appendix 1.

Table 1  
List of open-ended scale results

	Frequency	Operational Definition	Dimensions	Explanation
self-compensation	76	Some behavioral phenomena in which individuals take the initiative to overcome their shortcomings and exploit their strengths in order to improve their abilities in a certain area	academic performance	Proactively compensate for for academic shortcomings
	25		physical-fitness	Proactively compensate for physical deficiencies
	53		social communication	Proactively compensate for social deficiencies
	14		appearance	Proactively compensate for lack of appearance
	43		self-esteem	Proactively compensate for self-esteem deficiencies
others-compensation	45	Individuals feel a series of self-confidence boosting phenomena indirectly brought about by the success or honor of their team, collective and relational others	academic performance	Glory of others boosts individual academic confidence
	20		physical-fitness	Glory of others enhances individual physical self-confidence
	39		social communication	"Glory to others increases social confidence
	9		appearance	"Glory to others increases one's self-confidence in appearance

Frequency	Operational Definition	Dimensions	Explanation
17		self-esteem	"Glory to others increases self-esteem and self-confidence

## Assessment of validity and reliability

To assess the concurrent validity of the inferiority-compensation scale (ICS), the compensation scale (Schmitter-Edgecombe et al., 2014) was used as a criterion measure. There are 13 items in the scale. The Cronbach  $\alpha$  coefficient of the internal consistency of the scale was 0.833, and the split-half reliability was 0.734. In current study, the Cronbach  $\alpha$  coefficient of the scale is 0.809, and the test-retest reliability after one month is 0.793.

## Data management and statistical analysis

Data were double-entered and crosschecked using the statistical software Epita3.1. An exploratory factor analysis was conducted on the data collected in Phase 1 using SPSS22.0. Validation factor analysis was conducted on the data collected in Phase 2 using Amos 23.0.

## Results

### Item analysis

We calculated the critical value (around 27%). According to independent samples t-tests, items with nonsignificant difference was removed. The statistical analysis results showed the self-compensation sub-scale of inferiority compensation scale finally includes 33 items; and the others-compensation of sub-scale inferiority compensation scale finally includes 28 items.

The correlation between the total scores and items scores: In order to investigate the correlation between the total scores and the scores of 33 items in the self-compensation sub-scale and 28 items in the others-compensation sub-scale, Pearson test was used to analyze the correlation between each item score and the total scores in present study, and the items were deleted according to the correlation coefficient of 0.4. The results showed that the self-compensation prediction scale left 31 items in the end; and the others-compensation prediction scale finally left 27 items.

### Construct validity

The KMOs for the self-compensation and other-compensation subscales in this study were 0.92 and 0.91 respectively, with p less than 0.001, which supported that the data were appropriate for exploratory factor analysis.

Using the principal component dimension extraction analysis method, and the promax oblique rotation method, additionally combining with the scree test with eigenvalues greater than 1, the two sub-scales finally extracted five factors, which were consistent with the inferiority compensation theory. As a result, we deleted 10 items in the self-compensation sub-scale, retained 21 items, and the total variance of explanation was 58.97%. On the other hand, we deleted 6 items in the others-compensation and retained 20 items., and the total variance of explanation was 57.85%.

## Confirmatory Factor Analysis

In order to ensure that the structure of total high school students' inferiority compensation scale conforms to the measurement standard, confirmatory factor analysis is used to fit the structure of exploratory factor analysis. According to the exploratory factor analysis of fitting degree test, we analyzed the correctness of its results and the reliability of the theoretical model. Amos 23.0 was used for confirmatory factor analysis of 643 copies of scales. According to the model fitting index, the structure models of the two sub-questionnaires and the total self-inferiority compensation questionnaire are verified. The model under the first-order dimension represents the goodness-of-fit related indicators between the items (test questions) and the five objects, namely, self-esteem, social interaction, academic performance, physical fitness and appearance. Here, M1 and N1 were used to separately represent the models of the sub-scales of self-compensation and others-compensation. The model under the second dimension represents the fitting degree parameters between self-compensation and others-compensation and those five dimensions and items, respectively. Here, M2 and N2 were used to represent the models of self-compensation and others-compensation. In addition, by fitting all the question models of the total scale, the RMSEA was greater than 0.1, but by calculating the average value of each dimension and then fitting again (Xiong et al., 2018), the RMSEA is 0.8 to reach the ideal range, therefore, here is the average value of each dimension. In this study, m1, m2, m3, m4, m5; n1, n2, n3, n4 and n5 represent the mean values of academic performance under the sub-scales of self-compensation and others-compensation, respectively. According to Table 2, the construct validity of the general questionnaire and the two sub-scales is good.

Table 2  
Indicators of validation factor model fit

	$\chi^2$	<i>df</i>	$\chi^2/df$	<i>CFI</i>	<i>IFI</i>	<i>RMSEA</i>
<i>M1</i> (self-compensation first-order model)	623.96	179	3.48	0.90	0.90	0.06
<i>M2</i> (self-compensation second-order model)	637.43	184	3.46	0.90	0.90	0.06
<i>N1</i> (others-compensation first-order model)	526.28	160	3.28	0.92	0.92	0.05
<i>N2</i> (others-compensation second-order model)	569.67	165	3.45	0.91	0.91	0.06
Total scale	168.37	34	5.48	0.93	0.93	0.08

## Reliability

In this study, Cronbach's coefficient was used to measure the reliability of the scale. As shown in Table 3, in terms of internal consistency reliability, Cronbach's  $\alpha$  for the reliability analysis of the self-compensation subscale was good, at  $\alpha = 0.90$ . In terms of the five factors, Cronbach's  $\alpha$  was 0.80 for academic performance, 0.74 for physical fitness, 0.76 for social communication, 0.68 for appearance and 0.77 for self-esteem. These results demonstrated that the items were internally consistent.

Table 3  
Reliability analysis of the self-compensation subscale

Dimensions	Academic performance	Physical-fitness	Social communication	Appearance	Self-esteem	Total
Cronbach $\alpha$	0.80	0.74	0.76	0.68	0.77	0.90
Split-half reliability	0.73	0.70	0.71	0.67	0.72	0.83

As shown in Table 4, in terms of internal consistency reliability, Cronbach's  $\alpha$  for the reliability analysis of the others-compensation subscale was good, at  $\alpha = 0.90$ . In terms of the five factors, Cronbach's  $\alpha$  was 0.79 for academic performance, 0.77 for physical fitness, 0.81 for social communication, 0.66 for appearance and 0.77 for self-esteem. These results demonstrated that the items were internally consistent.

Table 4  
Reliability analysis of the others-compensation subscale

Dimensions	Academic performance	Physical-fitness	Social communication	Appearance	Self-esteem	Total
Cronbach $\alpha$	0.79	0.77	0.81	0.66	0.77	0.90
Split-half reliability	0.76	0.72	0.74	0.66	0.76	0.83

## Concurrent validity

In this study, the high school students' inferiority compensation scale has two composite scales, so we can test its combination reliability. The combined reliability was calculated by formula (Žvelc et al., 2020). The combination reliability of self-compensation and others-compensation sub-scales was 0.67 ~ 0.80 and 0.70 ~ 0.80, respectively, which were both greater than 0.6 suggesting that the internal consistency of questions in each dimension was good in this study. The results of item reliability are within the acceptable range of indicators, indicating that each item has a good interpretation of the dimensions.

## Construct validity

Construct validity can indicate the degree to which a test can detect a theoretical construct. In present study, Pearson product-moment correlation was used to test the correlation between the total score of the formal scale and the scores of each dimension and to investigate the construct validity of the scale.

According to Table 5, Table 6 and Table 7, the correlation coefficients between the total scores of the two subscales and the scores of each dimension were 0.68 ~ 0.84 and 0.69 ~ 0.83, and the correlation coefficients between the scores of each dimension were 0.42 ~ 0.56 and 0.41 ~ 0.62, indicating that the dimensions were highly correlated with the scale, while the two dimensions were moderately low correlated. Furthermore, those results indicated that the two dimensions were independent and interrelated.

Table 5  
Pearson's correlation analysis of the dimensions of self-compensation with the total score of the subscales

Dimensions	Total	Academic performance	Physical-fitness	Social communication	Appearance	Self-esteem
Total	1					
Academic performance	0.77	1				
Physical-fitness	0.73	0.51	1			
Social communication	0.84	0.53	0.55	1		
Appearance	0.68	0.47	0.45	0.51	1	
Self-esteem	0.74	0.48	0.42	0.56	0.43	1

Table 6  
Pearson correlation analysis of the dimensions of others-compensation with the total score of the subscales

Dimensions	Total	Academic performance	Physical-fitness	Social communication	Appearance	Self-esteem
Total	1					
Academic performance	0.74	1				
Physical-fitness	0.76	0.51	1			
Social communication	0.83	0.47	0.62	1		
Appearance	0.69	0.49	0.41	0.46	1	
Self-esteem	0.70	0.44	0.41	0.51	0.44	1

Table 7  
Pearson correlation analysis of the total scale

Dimensions	Total scale	Others-compensation	Self-compensation
Total scale	1		
Self-compensation	0.94	1	0
Others-compensation	0.92	0.74	1

## Discussion

In this study, we developed and validated the ICS for measuring the way to compensate for self-inferiority among middle and high school students. contained two sub-scales and ten dimensions. The final version of the 41-item ICS contains two subscales – self-compensation, and others-compensation. Our results indicate that the ICS has acceptable validity and reliability for tracking and evaluating ways to compensate for self-inferiority.

## CMS Reliability and Validity

First of all, in order to clarify the specific elements of inferiority compensation among middle and high school students, this study carried out an open scale survey, combed and analyzed the existing relevant studies, and constructed the theoretical structure of inferiority compensation by integrating the discussions on Adler’s inferiority and transcendence theory in previous literature.

At the same time, after repeated discussions with experts, professors and graduate students of psychology in relevant research fields, the initial scale items were repeatedly screened by eliminating those questions of ambiguity. Therefore, the scale had good content validity. Secondly, the applicability of the questions was investigated through item analysis and related methods, and after the inappropriate problems were eliminated, there came to the next round analysis. Again, through exploratory factor analysis to get the final items, including the two sub-scale self-compensation and others-compensation.

Then, in the part of confirmatory factor analysis, on the basis of the investigation results of each fitting index,  $\chi^2 / df$ , RMSEA, CFI and IFI were all within the standard value range (Kwon et al., 2013; Žvelc et al., 2020), indicating that the scale has good model fitting. At the same time, the combined reliability value was greater than 0.6, which indicated that the reliability results of the items were within the acceptable range of indicators, and denoted that the items of the two sub-scales explained the dimensions well. Furthermore, convergence validity test results were all greater than 0.4, demonstrating that the facets of the two dimensions also had good explanatory power (Fung et al., 2020). Finally, the correlations between the total scores of the sub-scales and the general questionnaire and the dimension scores were tested. As a result, the values were within the standard range, which further proved that the structural validity of the total scale was good. Finally, the Cronbach’s coefficient test showed that the reliability of the sub-scale and the general scale was good.

In summary, the theoretical structure of Inferiority Compensation Scale for high school students is reasonable and has good reliability and validity. It can be used as a reliable measurement tool for the follow-up studies of high school students' inferiority compensation.

## **Insights and Limitations**

It is a common phenomenon that inferiority complex is prevailing among high school students, and in view of the general social phenomenon of only emphasizing test scores, people tend to pay little attention to the students' mental health. Some data showed that about 1 / 5 high school students have different degrees of psychological disorders, such as repeated moodiness, lack of self-confidence, study difficulty, test anxiety, lack of concentration, large fluctuations in grades, and difficulty in coping with setbacks, which are one of the factors leading to students' inferiority. Studies have shown that there is no significant difference between high school students' sense of inferiority and senior high school students' sense of inferiority (Greenaway et al., 2015; Hirao, 2014). In particular, it is difficult for high school students to avoid the comparison of academic performance, family background and others in schools. If they find that others have what they want but do not possess, they will easily have mixed complex emotional experiences, such as inferiority, hostility and resentment. But Maria and Cristiano also pointed out that part of the reason why a person can succeed is to compare with others to find their own shortcomings, which can encourage them to change themselves (Ritchie & Long, 2021). Hence, for example, in the performance ranking, students are inevitably compared with their classmates around them at school. How do they view this matter? If the comparison has already happened, and how would they deal with it, so it is necessary to pay attention to the psychological process of students, guide them to reasonably compare everything around them, and correctly view the results.

## **Education recommendations**

(1) Pay attention to students' inferiority complex, develop students' consciousness of inferiority compensation, improve students' ability to adjust emotions when facing setbacks or failures. Teachers need to do their utmost to guide students to control their current negative emotions, and embrace life with positive optimism and smiles, so that students can have a good self-regulation ability in the middle school stage, and can face and confront setbacks or failures with a positive and optimistic attitude. For example, educators should understand the pain which the students are experiencing at the moment, at the bottom of the heart, and express understanding and sympathy for students. Such kind of empathy experience and accompany usually can give students great comfort and strength and it is a critical step for cheering students up to overcome their self-abasement, to guide students to well control the expression of emotions.

(2) Strengthen the publicity of the positive role of inferiority. In the eyes of students, inferiority is generally a word that tends to be negative. Inferiority can make people feel faceless and unpopular, which also explains the phenomenon that mentioned at the beginning that students are very evasive about the topic of inferiority. Yet, Adler said, in life we more or less have different degrees of self-abasement, whether males or females, from the city or rural and so on. Thus, to guide students to face up to their inferiority

and strive to surpass themselves, teachers need to correct students' inferiority bias in their learning and life. If self-abased students can often actively suggest themselves, unaffectedly make friends with their self-abasement, then when students have the reasonable beliefs, they can also face and solve problems at ease when encountering similar setbacks.

(3) Attach importance to the environment around students to compensate for students' inferiority. The effects of others-compensation and self-compensation are equally important. Whether it comes from the success of schoolmates, relatives and friends or others, teachers need to strengthen the guidance of students' jealousy, and convert it into the driving force of students to complete self-improvement. If the success of others is regarded as an excellent example power rather than regarded as a threat by students, it will have a multiplier effect on encouraging a student to improve self-confidence to confront others who seems like or is really better than them. However, without proper guidance of students' psychological control in the face of others' success, it is likely to lead to students' serious jealousy, from month to month, and even lead to more serious inferiority. Certainly, in learning life, educators also should guide students not too much to show off their success in order to avoid making other students jealous

In summary, the practical significance of compensation theory lies in: First of all, teachers should actively guide students to establish correct and appropriate compensation goals, on this basis, to carry out frustration education and life education for students, cultivating students' awareness of compensation, and teaching them to face up to their own shortcomings with appropriate methods; secondly, on the hand of students, they should correctly treat their own shortcomings and the advantages of others, on this basis, to establish the correct life values to exceed the present themselves ; finally, society should also give students more care, encouragement, support and help so that they can get compensation in society, so as to improve their self-confidence.

## Conclusions

(1) The compensative model of inferiority was confirmed, and the inferiority-compensation scale duly included two subscales: self-inferiority-compensation and other-inferiority-compensation. (2) As a reliable and valid measure, this scale can be used to measure the way of inferiority-compensation among high school students.

## Declarations

Ethics approval and consent to participate

Ethics was obtained from the Declaration of Helsinki and was approved by the local research ethics committee of Chongqing Normal University. All procedures were performed in accordance with ethical guidelines and regulations. All participants gave written informed consent.

Consent for publication

Not applicable.

#### Availability of data and materials

Data associated with this article be contacted (or if someone wants to request the data from this study) can be found in the online version at [https://pan.baidu.com/s/1nMAIZ1ZZf-QPYT\\_DFjn\\_7g](https://pan.baidu.com/s/1nMAIZ1ZZf-QPYT_DFjn_7g) code 27x9 and authors Dr Yang can be contacted.

#### Competing interests

The authors declare that they have no competing interests.

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**Youkui Xia and Lingxiao Li:** Data curation, Writing- Original draft preparation.

**Longli Luo and Yanting Li:** Supervision.

**Xiaocui Liu:** Resources.

**Jing Meng:** Conceptualization, Methodology, Funding acquisition and Editing.

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