

Relationship between alexithymia, loneliness, resilience and non-suicidal self-injury in adolescents with depression: a multi-center study

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Abstract

Objective

Non-suicidal self-injury (NSSI) behaviors are prevalent in adolescents and have adverse effects on physical and mental health. However, little is known about the relationship between NSSI and alexithymia, or the underlying mechanisms that could explain this relationship. This study aimed to elucidate the current status of NSSI in adolescent depression, and analyze the relationship between alexithymia, loneliness, resilience, and adolescent depression with NSSI, so as to provide a theoretical basis for psychotherapeutic interventions.

Method

The study sample involved inpatients and outpatients from 12 hospitals across China and adolescents with depression who met the DSM-5 diagnostic criteria for depression episode. The following scales were used: The Functional Assessment of Self-Mutilation, Toronto Alexithymia Scale, UCLA Loneliness Scale, and Connor Davidson Resilience Scale.

Results

The detection rate of NSSI in adolescents with depression from 2021.01.01-2022.01.01 was 76.06% (1782/2343). Spearman's correlation analysis revealed a significant correlation between alexithymia, loneliness, resilience and NSSI in depressed adolescents, the results of the independent samples t-test showed that the differences between the two groups for each factor were statistically significant. Binary logistic regression results showed that alexithymia ($B = 0.023$, $p = 0.003$, $OR = 1.023$, 95% CI: 1.008–1.038) and depression ($B = 0.045$, $p < 0.001$, $OR = 1.046$, 95% CI: 1.026–1.066) are risk factors for NSSI, resilience ($B = -0.052$, $p < 0.001$, $OR = 0.949$, 95% CI: 0.935 – 0.964) is a protective factor for NSSI. Alexithymia directly predicted NSSI and also indirectly influenced NSSI through the mediated effect of resilience. Loneliness moderates the first half of the path of this mediated model.

Conclusion

The data from this study provide evidence for the mediating effect of resilience between alexithymia and NSSI, as well as evidence that loneliness can moderate the first segment of the pathway in this moderated mediation model. We discuss perspectives for future research and interventions based on the findings of the study.

1 Introduction

Non-suicidal self-injury (NSSI) is the act of an individual deliberately and repeatedly injuring his or her own bodily tissues without clear suicidal intent, commonly in the form of cuts, bruises, burns, scratches, bites, hitting the head against a hard object, etc. These acts are not fatal but are extremely dangerous[1]. NSSI has a high global prevalence, especially occurring in adolescents, for example: the detection rate of NSSI among community adolescents is 13.0–46.5% in the United States, 17.0% in Canada, 6.2% in Australia[2], and 27.4% in China[3]. The recurrence rate of NSSI is high and increasing year by year [4], which has seriously endangered the physical and mental health of adolescents[5]. NSSI has been shown to be strongly associated with suicidal behavior [6, 7], increasing the risk of suicidal behavior sevenfold [8] and being a significant predictor of suicidal behavior in adolescents[2], which has become a global concern for public health concern [9].

Much of the current research has focused on exploring risk factors or positive factors for the occurrence of NSSI in adolescents. Results showed that NSSI was associated with higher levels of alexithymia, depression, anxiety, bullying, impulsivity, substance abuse, history of abuse and sexual problems[10], as well as lower levels of mindfulness, resilience and self-esteem[11]. However, few studies have explored the underlying mechanisms between these factors. With the current study, we found that resilience mediates the relationship between narrative disorder and NSSI, with loneliness playing a moderating role. This finding provides more ideas for future psychotherapy programs, as current psychotherapy programs for adolescents with NSSI are mainly based on avoidance approaches [12], and in the future we can adopt more positive psychology approaches to effectively reduce or control NSSI.

1.1 Alexithymia In Nssi

Alexithymia, a term initially coined by Nemiah and Sifneos[13], is not an independent disorder, but a psychological trait that accompanies the development of personality, mainly in that the individual has difficulties in recognizing emotions, has a thin emotional experience and is not concerned with his or her inner world, much less understanding and recognizing the emotions of others[14]. Multiple studies have shown that narrative impairment is positively associated with increased suicide risk in depressed patients[15]. International literature reports alexithymia as one of the potential risks most closely associated with self-harm [16–18]. The cognitive approach of people with alexithymia is conditioned by external stimuli, resulting in difficulties in recognizing and expressing emotions, impaired extroverted thinking and impaired imagination[19]. Research has shown that alexithymia in adolescents is strongly associated with self-harm[20–22], and the severity of alexithymia is significantly higher in patients with repeated self-injury (> 5 times/year) than in occasional self-injury patients (< 5 times/year)[23]. A study confirmed that alexithymia was a significant predictor of NSSI at 5 months of age, suggesting that depression and alexithymia may be predictors of NSSI[11].

At present, experience-avoidance theory holds that NSSI is an avoidance method chosen by individuals who, when faced with negative stimuli, exhibit an impaired ability to express emotions as a way to release negative emotions[24]. Alexithymia has been shown to be an important construct that, in

combination with problematic emotions, may lead to a tendency for people with depression to use NSSI to escape intense emotional experiences, or as an alternative form of emotional expression[19]. NSSI is often hidden and difficult to detect in time, especially in the case of adolescents with alexithymia. Long-term repeated NSSI will have an adverse effect on adolescent mental health and considerably increase their suicide risk.

1.2 The Mediated Effect Of Resilience In Alexithymia And Nssi

Resilience is a positive inner protective force, and it helps an individual to maintain a sense of continuity with respect to their survival goals. It constitutes a lateral attitude that can be understood as the ability to overcome difficulties experienced in different areas of life, with an attitude of perseverance and a sound awareness of oneself and one's inner coherence through the activation of personal growth projects[25]. Resilience, as a person's mental capacity and internal resource, can be seen as a dynamic process that is constantly self-regulation and developing as the person grows[26]. Resilience can help teenagers to understand what they need to do when faced with difficulties. It can help them to find ways to prevent long-term psychological distress and maintain a normal developmental trajectory, while encouraging the creation of meaning to help them to make sense of their situation and identity[27]. A study on patients with depression found that alexithymia was negatively correlated with resilience[28]. Individuals with high levels of resilience can use more psychological resources to buffer the adverse effects of alexithymia on suicidal ideation and behavior[29]. In a correlation analysis of alexithymia and resilience among nursing undergraduates, an impaired ability to actively communicate with others and perceive the emotional changes of patients was associated with decreased levels of resilience[30]. At the same time, resilience can actively restructure an individual's psychology, encourage a healthy and balanced state of mind, and prevent the formation of suicidal ideation[31].

Resilience as a positive factor has been shown in many studies to mediate between many psychological factors. Several Chinese studies have shown that resilience has the mediated effect between childhood abuse and suicidal ideation in adolescents[32], resilience has the mediated effect between physical fitness and anxiety in children[33], and resilience has the mediated effect between school bullying and anxiety in adolescents[34]. It has also been shown that resilience has the mediated effect between loneliness and depressive symptoms in elderly people in nursing homes[35]. The study found that alexithymia can significantly predict resilience and NSSI, while resilience has the mediated effect between alexithymia and NSSI[12]. This is consistent with the findings in this paper that alexithymia negatively predicts resilience and positively predict NSSI, and that the relationship between alexithymia and NSSI can be influenced through the mediated effect of resilience.

1.3 The Relationship Between Loneliness And Other Psychological Factors

The American psychologist L.S.Hollingworth refers to the period between adolescence and early youth as the "psychological weaning period". This period is a time of great anxiety for adolescents. Although they have a subjective need and desire to be independent, it is difficult for them to adapt to independent living in a short period of time. There are many problems that they cannot solve on their own and they are reluctant to ask their parents or others for help, fearing that this may compromise their independence. In addition, the need for intimacy at this time, but the social relationships associated with it, have not yet been established, so when they fall into a state of isolation, it is often difficult for them to extricate themselves. Loneliness in this period is a chronic pervasive state of mind.[36]. Loneliness, as a negative emotion, has been identified as a predisposing factor for depression and is a common condition with affective, cognitive, and motivational scales[37]. An association was observed between loneliness and NSSI, with higher levels of loneliness associated with a higher likelihood of NSSI[38]. The Interpersonal Functional Model of NSSI proposes that there are important links between interpersonal experiences and NSSI[39]. Loneliness, for example, is a negative interpersonal experience that is often serve as precipitants to NSSI[40].

Chronic loneliness threatens an individual's future mental health and a number of indicators regarding psychosocial functioning[41]. Research on loneliness has shown that it is associated with a range of risk or protective factors strongly associated with NSSI, including lack of alexithymia [42], stress, social deficits[43], low self-esteem[44], resilience, mental health, mental and physical quality of life[45]. Some aspects of alexithymia may lead to mistrust, and this mistrust interacts with the initial alexithymia to produce a range of interpersonal problems that lead to loneliness[41]. Many articles have begun to explore the relationship between loneliness and these risk or protective factors. Some studies have shown that higher levels of loneliness are associated with lower levels of mental health and resilience, and that loneliness, resilience and mental health all affect mental and physical quality of life[46]. We found that resilience can reduce the impact of loneliness on the physical and mental health of people with depression. Some studies have shown that adolescents with poor emotional regulation increase their feelings of loneliness over time, while adolescents with high emotional regulation can successfully overcome loneliness by perceiving and managing the negative emotions associated with it[47]. Loneliness persists in adolescence, but as adolescents grow older, they become more mature in their interpersonal relationships, have more friends and have less relationships with their families. This is when adolescents' feelings of loneliness change, and this change will certainly affect other psychological factors, which this study will explore.

1.4 The Current Study

Although there are known empirical relationships between alexithymia, resilience, loneliness, and NSSI, no empirical investigation has been carried out to examine the exact nature of these relationships. Based on the above discussion, the research assumptions of this paper are as follows:

1. Among adolescents with depression, resilience would mediate the relation between alexithymia and NSSI.
2. Loneliness would moderate the direct and indirect relationships between alexithymia and resilience.

It is hoped that the results of this cross-sectional study can provide a theoretical basis for therapists to strengthen adolescents' psychological elasticity and alleviate symptoms of alexithymia by developing effective psychological interventions that draw on a positive psychology perspective, so as to effectively manage NSSI in this population.

2 Methods

2.1 Participants

This study is a nationwide multi-center combined cohort study of adolescent depression (CSCAD). Includes a cross-sectional study of adolescents with depression who are engaging in NSSI or have engaged in NSSI. A total of 2411 questionnaires were distributed, of which 2343 valid questionnaires were retrieved, with an effective recovery rate of 97.17%. The questionnaire was completed by 1826 girls and 517 boys, with an average age of (14.99 ± 1.65) years; the average number of years in education was (9.18 ± 1.76) years; 2135 participants were of Han ethnicity and 208 were from ethnic minority groups; about 67.4% of the participants lived in urban areas, while the remaining patients lived in rural areas; and the annual household income of the patients surveyed was (6.12 ± 2.44) , expressed in units of 1,0000 yuan. Among the 2342 participants, 379 patients reported never having NSSI, and 182 patients had NSSI behaviors in the past but did not have NSSI in the last year, and 1782 patients had experienced NSSI in the past year.

2.2 Procedure

From January to December 2021, adolescent patients with depression from 12 general hospitals and psychiatric hospitals across China were investigated and assessed using various clinical measurement instruments, and all participants provided their written informed consent. This paper has been approved by the Medical Ethics Committee of Shenzhen Kangning Hospital with the ethics number 2020-K021-02.

Inclusion criteria:

1. Participants met the diagnostic criteria of depressive episodes or depressive episodes corresponding to bipolar disorder as defined in the DSM-5; (outpatient depression status meets the criteria of depressive episode);
- 2) aged 12–18 years;
- 3) Years of education ≥ 6 years; and
- 4) the patients and their families agreed to participate in the research and signed the informed consent form.

Exclusion criteria:

1) Patients with severe somatic diseases, infectious diseases, or immune system diseases; 2) patients with brain trauma, epilepsy, or other known serious neurological diseases or brain organic diseases; and 3) patients with a previous history of severe mental disorders such as schizophrenia or intellectual disability.

2.3 Measures

2.3.1 General demographic data

Demographics information (age, sex assigned at birth, and ethnicity) was collected using a questionnaire created by the research team.

2.3.2 The Functional Assessment Of Self-mutilation (Fasm) Scale

The Functional Assessment of Self-Mutilation (FASM) scale is a structured interview questionnaire compiled by Lloyd in 1997. This study used the Chinese FASM scale[48]. This paper mainly analyzes NSSI (e.g., cutting, burning, deliberately beating oneself) in order to understand whether the participants had intentionally exhibited 13 different behaviors associated with NSSI listed in the evaluation form over the past 12 months. Moreover, frequency, severity, treatment, and duration were assessed. In this study sample, Cronbach's alpha was 0.991.

2.3.3 Toronto Alexithymia Scale

The current study used a Chinese version of this scale[49], which is divided into three dimensions: Difficulty identifying feelings (DIF); (2) Difficulty describing feelings (DDF); Externally-oriented thinking (EOT). With reference to a study on alexithymia in children and adolescents, it was noted that the EOT subscale has low reliability in adolescents. Emotional disturbance is reliably and validly measured in adolescents when only the 12 items of the TAS-20 are used[50]. Therefore, data from the EOT subscale were excluded from the data processing of this study. The scale consists of 20 items in total. In this study sample, Cronbach's alpha was 0.812.

2.3.4 Ucla Loneliness Scale

The first edition of this scale was compiled in 1978 by Russell et al. It was revised twice in 1980 and 1988[51]. The current study used the third version of this scale[52], which is a self-assessment scale. It mainly evaluates feelings of loneliness that are caused by a gap between a desire for social communication and the actual level of communication. In this study sample, Cronbach's alpha was 0.908.

2.3.5 Connor Davidson Resilience Scale (Cd-risc)

The original version was compiled by Connor and consists of 25 entries[53]. This study used the Chinese version of the short-form of this scale compiled by Campbell[54]. In this study sample, Cronbach's alpha was 0.921.

2.3.6 Patient Health Questionnaire-9 (Phq-9)

The Depression Screening Scale (PHQ-9) is one of the internationally used depression screening scales. Its nine entries cover the DSM-5 diagnostic criteria for depressive disorders, making the scale both useful for assessing depression severity and potentially diagnostically valid[55–57]. In this study sample, Cronbach's alpha was 0.904.

2.4 Statistical Analyses

SPSS version 21.0 (IBM Corp, Armonk, NY, USA) was used for statistical analysis. The counting data are expressed in [n (%)]. Firstly, for data validity, we examined the common method bias. Secondly, descriptive analyses were conducted for demographic information. Then, the Shapiro-Wilks test was used to test the normality of each continuous key variable. The total score of PHQ-9, CD-RISC-10, TAS and UCLA did not satisfy the normal distribution in our dataset. Therefore, the median (M) and inter-quartile range (IQR) were used to describe their distribution characteristics, and Spearman correlation analysis was carried out to evaluate the correlation between each variable. Finally, we used independent samples t-tests to test whether the factors were significantly different between the two groups.

Factors associated with NSSI in adolescents with depression were analyzed by binary logistic regression. The dependent variable is a dichotomous variable, 1 (engaging in NSSI), 0 (patients without NSSI and those who have had NSSI in the past but not in the last year). Independent variables included alexithymia, resilience, loneliness and depression. Mplus8 software was used for calculation, which was exploited by Linda Muthén and Bengt Muthén. We used the first stage regulation model of the seven moderated mediation models proposed by Edwards (2007) in the article published by psychological methods. NSSI was used as the dependent variable, alexithymia as the independent variable, resilience as the mediating variable and loneliness as the moderating variable put into the model for calculation. As the NSSI is a nominal variable, the type we have chosen is general, estimator is MLR, the confidence interval was 95%.

3 Results

3.1 Detection rate of NSSI

A list of the types and frequency of NSSI is shown in Table 1. In this survey, 2343 adolescent patients with depression were investigated. A total of 1782 cases of NSSI were reported in the past year, with a

detection rate of 76.06%. Among them, the frequency of deliberate cutting or scratching of skin reached 87%, which was the most common method of self-harm. The second was deliberately punching, hitting, or slapping oneself (55.4%); followed by hitting the fist or head on a hard surface (50.2%), deliberately biting oneself (47.9%), and deliberately scratch one's skin (44.4%).

Table 1
Types and frequency of NSSI

	rate n = 1782(%)	Frequency of occurrence
Deliberately cut or scratch your skin	1551(87.0)	77.75 ± 280.94
Deliberately hit yourself	988(55.4)	74.07 ± 174.36
Pull your hair on purpose	719(40.3)	88.24 ± 305.81
Deliberately use sharp objects to stab and engrave characters or patterns on the body	615(34.5)	41.22 ± 180.44
Deliberately stimulate the wound and hinder healing	684(38.4)	68.81 ± 206.56
Deliberately stabbing objects into the skin or nails	328(18.4)	69.91 ± 259.53
Deliberately bite oneself, such as the mouth or lips	853(47.9)	106.24 ± 377.24
Deliberately scratch yourself and bleed	562(31.5)	50.15 ± 199.02
Strike with your fist or head against a hard object	897(50.2)	66.52 ± 216.67
Deliberately scratch your skin	792(44.4)	83.39 ± 277.92

3.2 Descriptive statistics and correlation

The correlation analysis of alexithymia, resilience, loneliness, and NSSI in adolescent patients with depression is shown in Table 2. Resilience was negatively correlated with depression, alexithymia, and loneliness ($r = -0.497$ – -0.577 , $P < 0.001$). The total score of resilience was negatively correlated with NSSI ($r = -0.281$, $P < 0.001$). Alexithymia and loneliness were positively correlated to NSSI ($r = 0.223$ – 0.276 , $P < 0.001$). Alexithymia was positively correlated with loneliness ($r = 0.599$, $P < 0.001$). Independent samples t-tests, was used to analyses whether the differences in the outcomes of alexithymia, loneliness, depression, and resilience were significant between the groups of 1 (engaging in NSSI) and 0 (patients without NSSI and those who have had NSSI in the past but not in the last year), with differences being statistically significant at $p \leq 0.05$. The results are shown in Table 3. The results show that Alexithymia was significantly higher for 1 (engaging in NSSI) than 0 (patients without NSSI and those who have had NSSI in the past but not in the last year) ($t = -12.32$, $p < 0.001$), loneliness was significantly higher for 1 than 0 ($t = -11.084$, $p < 0.001$), depression was significantly higher for 1 than 0 ($t = -13.90$, $p < 0.001$), and resilience was significantly lower for 1 than 0 ($t = 14.74$, $p < 0.001$). The results are shown in Table 3.

Table 2
The correlation analysis between alexithymia, resilience, loneliness and NSSI

	M ± SD	1	2	3	4
1	0.76 ± 0.43				
2	44.57 ± 8.96	0.247**			
3	13.77 ± 8.48	-0.291**	-0.497**		
4	56.95 ± 11.40	0.223**	0.599**	-0.577**	
5	16.86 ± 7.17	0.276**	0.604**	-0.549**	0.620**

Notes: M, mean; SD, standard deviation. *indicates a difference at the significance level of 0.05, **indicates a difference at the significance level of 0.01.
1.NSSI;2.alexithymia 3.resilience 4.loneliness 5.depression.

Table 3
Differences in psychological factors between groups of adolescents with depression and without NSSI

	NSSI (M ± SD)		t	P
	0 (n = 561)	1(n = 1782)		
alexithymia	40.42 ± 9.58	45.80 ± 8.38	-12.32	< 0.001
resilience	18.17 ± 8.80	12.39 ± 7.88	14.74	< 0.001
loneliness	52.41 ± 12.07	58.37 ± 10.81	-11.084	< 0.001
depression	13.33 ± 7.42	17.97 ± 6.72	-13.90	< 0.001

Notes: M, mean; SD, standard deviation. NSSI is divided into two groups: 1: engaging in NSSI; 0: patients without NSSI and those who have had NSSI in the past but not in the last year.

3.3 NSSI related factors in adolescent depression

The results of the binary logistic regression are shown in Table 4. Alexithymia (B = 0.023, p = 0.003, OR = 1.023, 95% CI: 1.002 – 1.037) and depression (B = 0.045, p < 0.001, OR = 1.046, 95% CI: 1.026 – 1.066) when 1 (engaging in NSSI) and 0 (patients without NSSI and those who have had NSSI in the past but not in the last year) were compared, the implication is that there is a significant positive relationship between alexithymia and depression severity and NSSI, suggesting that depressed adolescents with higher scores on alexithymia and depression are more likely to engage in NSSI. Alexithymia and depression are risk factors for NSSI. Resilience (B = - 0.052, p < 0.001, OR = 0.949, 95% CI: 0.935 – 0.964), implying that higher levels of resilience have a significant negative relationship with NSSI, suggesting that adolescents

with depression with higher resilience scores are less likely to engage in NSSI. Resilience is a protective factor for NSSI.

Table 4
NSSI related factors in adolescent depression

	B	S.E,	Wald χ^2	P	OR	95%CI	
						Low	Up
alexithymia	0.023	0.008	8.927	0.003	1.023	1.008	1.038
resilience	-0.052	0.008	47.274	< 0.001	0.949	0.935	0.964
loneliness	-0.006	0.006	0.770	0.380	0.994	0.982	1.007
depression	0.045	0.010	21.223	< 0.001	1.046	1.026	1.066

Notes: NSSI is divided into two groups: 1: engaging in NSSI; 0: patients without NSSI and those who have had NSSI in the past but not in the last year.

3.4 The Mediated Effect

According to the results of the above correlation analysis, a structural equation model was constructed with alexithymia as the independent variable, resilience as the mediating variable, loneliness as the regulating variable, and NSSI as the dependent variable. The results are shown in Table 5. Alexithymia positively predicted for NSSI ($B = 0.170$, $t = 5.862$, $P < 0.001$, 95%CI: 0.024 – 0.049), but negatively predicted for resilience ($B = -0.546$, $t = -8.338$, $P < 0.001$, 95%CI: -0.632 – -0.393), loneliness had a significant negatively predictive effect on resilience ($B = -0.746$, $t = -11.632$, $P < 0.001$, 95%CI: -0.645 – -0.460). The interaction term between alexithymia and loneliness was significant ($B = 0.556$, $t = 5.104$, $P < 0.001$, 95%CI: 0.003 – 0.008), indicating that the moderating effect holds. The indirect effect of this moderated mediation model was significant ($B = 0.030$, $t = 5.988$, $P < 0.001$, 95%CI: 0.020 – 0.040). To more clearly explain the mediated effect of alexithymia and loneliness on resilience, a simple slope analysis was conducted by dividing loneliness into high and low subgroups by mean plus or minus one standard deviation. The indirect effect was significant for the low loneliness subgroup ($B = 0.031$, $t = 5.969$, $p < 0.001$, 95%CI: 0.020 – 0.041), indicating that the indirect effect holds for the low subgroup, and significant for the high loneliness subgroup ($B = 0.030$, $t = 6.007$, $p < 0.001$, 95%CI: 0.020 – 0.040), indicating that the indirect effect holds for the high subgroup. The results suggest that the indirect effect of alexithymia on NSSI through resilience is significant for loneliness as a moderating variable, regardless of whether low or high values are taken. The result of this moderated mediation model is shown in Fig. 1.

Table 5
Moderated mediation models

		STDYX Standardization		t	p	95%CI	
		B	S.E.			Low	Up
NSSI	alexithymia(c)	0.170	0.029	5.862	< 0.001	0.024	0.049
resilience	alexithymia(a1)	-0.546	0.065	-8.338	< 0.001	-0.632	-0.393
	loneliness(a2)	-0.746	0.064	-11.632	< 0.001	-0.645	-0.460
	alexithymia × loneliness(a3)	0.556	0.109	5.104	< 0.001	0.003	0.008
NSSI (Y)	resilience(b1)	-0.256	0.027	-9.436	< 0.001	-0.072	-0.046

Note: standard scores are used for all variables in this model; c is the direct effect of alexithymia - NSSI, a1 is the path coefficient of alexithymia - resilience, b1 is the path coefficient of alexithymia - NSSI, a2 is the path coefficient of loneliness - resilience, and a3 is path coefficient of loneliness × alexithymia - resilience. indirect effect: a1*b1. 95%CI:confidence intervals of model results.

4 Discussion

This study investigated the prevalence of NSSI among adolescents with depression, explored the relationship between loneliness, resilience, alexithymia, and NSSI through a moderated mediation model. The findings showed that depression, loneliness, resilience, and alexithymia were all significantly associated with NSSI, but the effects of these factors varied. Results supported the role of resilience in mediating alexithymia to NSSI and verified the moderating role of loneliness as a moderating variable in this moderated mediation model.

The relationship between depression and NSSI is gaining traction[58]. Several studies have shown that depression is positively associated with NSSI[59], which is consistent with our findings ($r = 0.276$, $p < 0.001$). People who engage in NSSI are more likely to suffer from depression. Faced with the negative emotions and numbness associated with depression, sufferers usually self-harm[60].

The score of alexithymia in the group reporting have NSSI were significantly higher than those who did not report having NSSI in the past year. This implies that adolescent depressed patients with NSSI have more difficulty in correctly identifying their emotions and show deficits in describing their emotions, as well as symptoms such as rigid thinking and lack of imagination, compared to the average depressed patients. Studies have shown that patients with serious emotional disorders have a higher prevalence of NSSI[61]. An emotion management-based group counseling found that alexithymia reduction in adolescents can decrease the incidence of NSSI to some extent[62]. The results also showed that

alexithymia scores were significantly and negatively correlated with resilience scores ($r = -0.577, p < 0.001$). Therefore, more severe alexithymia was associated with lower levels of resilience. The findings suggest that alexithymia can predict loneliness directly, as well as different dimensions of loneliness through the interaction of different dimensions with interpersonal distrust[41]. Research also suggests that emotional processing deficits in individuals with alexithymia may be associated with increased feelings of loneliness[63]. More severe alexithymia is related to stronger feelings of loneliness. At the same time, when the patient experiences stronger feelings of loneliness, their alexithymia is also more severe.

Resilience can negatively predict NSSI and generate protective mechanisms against it. The available literature also confirms this result [64]. Resilience refers to an individual's ability to proactively adapt to their environment in the face of adversity and includes two key conditions: exposure to significant adversity (e.g., exposure to community violence, parental mental illness and poverty) and positive adaptation (good academic performance, positive relationships with teachers or peers)[65]. As a result, patients have lower levels of resilience, which means that they are unable to properly regulate their psychological and emotional states. Therefore, when a patient has higher levels of resilience, there is an improvement in alexithymia, loneliness and NSSI symptoms.

This study found that resilience mediates the relationship between alexithymia and NSSI. Alexithymia not only directly affects NSSI, but also indirectly through resilience. This is also consistent with previous research. Research findings also show that loneliness negatively predicts resilience. The interaction between loneliness and alexithymia also had a significant effect on resilience. This means that the moderating effect of loneliness as a moderating variable in this moderated mediation model is significant. Adolescents with alexithymia have difficulty integrating into normal social life and are more likely to feel lonely. And lonely individuals, because of the lack of necessary social connections, will lead to the inability to meet the needs of emotion and belonging[66], thus aggravating the degree of their alexithymia. Some research suggests that the evolutionary theory of loneliness suggests that loneliness may work through a mechanism of social distress that motivates people to repair and maintain social connections. Similarly, empirical studies have shown that lonely people are more likely to be motivated to deal with situations involving social inclusion than non-lonely people, and to experience more positive impacts in such situations[67]. Adolescents grow up with a particular psychological state that is accompanied by loneliness. Based on this theory, combined with this moderation mediated model. We infer that loneliness, as a psychological factor that persists in adolescence, also leads adolescents to explore more solutions to social problems, thus ameliorating strong feelings of isolation. At this point, their resilience is strengthened by these explorations. While alexithymia can lead to feelings of loneliness, loneliness can also influence narrative disorders to some extent. The interaction between the two can have unexpected effects.

This mediated model with moderation provides us with a potential intervention strategy. There are considerable difficulties in the clinical treatment of depressed adolescents with NSSI. Commonly used methods include drug therapy (e.g., SSRIs), psychotherapy (e.g., cognitive behavioral therapy (CBT)), and

physical therapy (e.g., repetitive transcranial magnetic stimulation). Adolescents are in a period of rapid growth and development, and the medical treatment is not satisfactory[68]. For example, adolescents do not say that their parents cannot detect their condition in time, parents are reluctant to give adolescent patients worried about drug side effects, and adolescents cannot cooperate with psychological treatment due to academic stress. CBT has been shown to be an effective psychotherapy method[69]. However, due to the length of treatment sessions, high cost, and the need to find highly qualified therapists who specialize in this approach, this is so challenging for both patients and therapists that few patients receive formal CBT treatment with complete received treatment. This is why it is so important to find a simple, effective and targeted psychological intervention.

Exercise therapy has been shown to be a beneficial intervention to alleviate depression[70]. It is low cost, highly operational and ideal for school teachers and parents to help young people get moving. It allows them to integrate into a harmonious social scene, reducing their loneliness and increasing their sense of well-being. In terms of psychological interventions for adolescent patients with depression, the psychological developmental characteristics of independence, loneliness, extremes, and paranoia at that stage can be sought, and their psychological elasticity can be enhanced by interventions that adopt a positive psychology perspective. Not only can clinicians use this strategy, but teachers can also organize group activities to encourage students to talk about their problems and emotions, and learn to listen to other people's worries and troubles. They can also teach them empathy, emotional expression, and other skills to alleviate feelings of loneliness to some extent, try to enhance their sense of belonging and happiness, and make them feel needed. These strategies can help to reduce alexithymia and depressive symptoms, and decrease NSSI.

5 Conclusion

The advantage of this paper is that a large amount of sample data was collected from many areas across the country. There are many factors that affect NSSI; however, this article is the first to link alexithymia, loneliness, and resilience, and explore the underlying mechanisms of this association. By examining this potential mechanism, we hope to provide psychotherapists with a new way of thinking when carrying out treatment interventions with this population. At this stage, the treatment methods for NSSI among Chinese adolescents are very limited, and many children are unwilling and afraid to go to the hospital. If school teachers can understand the relationship between these influencing factors and learn relevant theoretical knowledge, they can also undertake intervention measures.

The main limitation of this study is that cross-sectional data were collected and a correlation analysis rather than a causal analysis was performed. In addition, the sample population was quite narrow in scope, and there are many potential NSSI patients that need our attention. In the future, it is hoped that some scholars can apply positive psychology as a psychological intervention to conduct longitudinal comparisons of patients, and analyze the causal relationship between potential mechanisms. In this way, research can focus on developing an intervention method that is applicable to clinical settings, daily

learning, and daily life in order to help these patients, while encouraging teenagers solve problems and improve their mental health.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki. Participants and their guardians completed informed consent forms at the beginning of the study. All materials, measures, methods and procedures were approved by the ethics committee of the Shenzhen Kangning Hospital (IRB: 2020-K021-02).

Consent for publication

Not applicable.

Conflict of Interest

No conflict of interest exists in the submission of this manuscript, and manuscript is approved by all authors for publication. I would like to declare on behalf of my co-authors that the work described was original research that has not been published previously, and not under consideration for publication elsewhere, in whole or in part. All the authors listed have approved the manuscript that is enclosed.

Availability of data and materials

The data that support the findings of this study are available from Hefei Fourth People' Hospital but restrictions apply to the availability of those data, which were used under license for the current study and so are not publicly available. Data are however available from the authors upon reasonable request.

Author Contributions

Bing Zhang collected the relevant data, designed the study, analyzed the data, and wrote the manuscript. Many thanks to the authors for their contributions to this article. In particular, Yang Chen, Cheng Jiang and Wenxian Fu gave a great deal of support in the collection of data for the study, and Dr Kongliang He, Dr Yongjie Zhou gave very important help in the analysis of the data.

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Figures

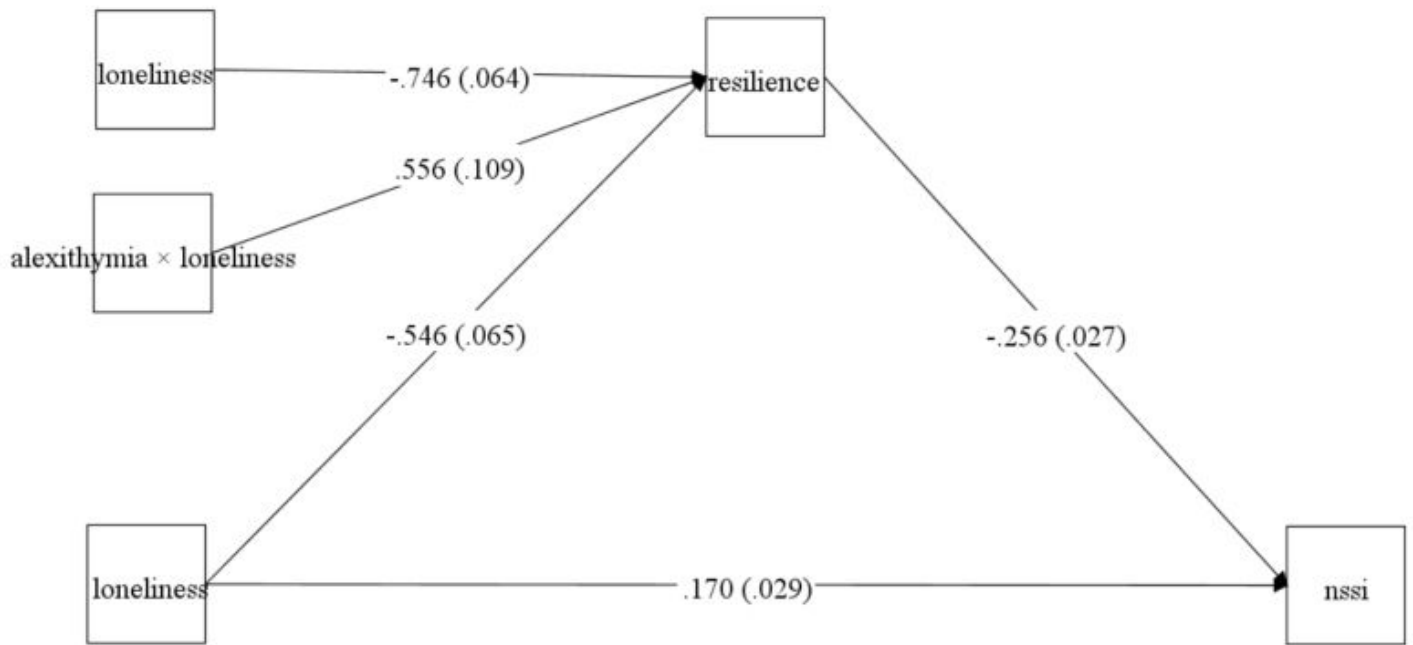


Figure 1

Mediating regulation model

Note: The NSSI is divided into two groups. 1: engaging in NSSI; 0: patients without NSSI and those who have had NSSI in the past but not in the last year.