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A longitudinal study on depression and non-suicidal self-injury in children who have experienced parental migration: moderating effect of parental care



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Abstract

Background Depression and non-suicidal self-injury (NSSI) are theorized to mutually reinforce one another, yet longitudinal evidence for this bidirectional relationship, particularly in high-risk populations like children who have experienced parental migration, remains limited. Parental migration often exacerbated vulnerabilities due to prolonged separation, making this population critical for understanding mechanisms to disrupt the vicious cycle.

Methods A 10-month longitudinal study was conducted to assess 390 left-behind children (158 girls; 7 unreported gender; $M_{age} = 12.50 \pm 0.67$) at two time points. Cross-lagged panel model was constructed to examine the bidirectional relationship between depression and NSSI, while hierarchical regression was used to examine the moderating role of parental care.

Results A significant increase in depression was observed over time, with a significant gender difference that girls reporting higher depression than boys. The prevalence of NSSI remained stable over time, though girls exhibited significantly elevated NSSI at follow-up. Cross-lagged panel modeling confirmed bidirectional relationships that baseline depression significant positively predicted subsequent NSSI, and baseline NSSI significant positively predicted subsequent depression. Notably, parental care emerged as a significant moderator, specifically attenuating the association between depression and subsequent NSSI, but showed no comparable effect on the NSSI to depression pathway.

Conclusions This study confirms a reciprocal relationship between depression and NSSI in Chinese children who experienced parental migration, highlighting the buffering effect of parental care on depression-driven NSSI risk.

Keywords Children who have experienced parental migration, Non-suicidal self-injury, Depression, Cross-lagged analysis

Introduction

With the rapid development of China's economy, rural laborers have been migrating to cities. For economic reasons, many migrant workers leave their minor children in their hometowns. According to a research report on

*Correspondence: Kun Hu hongqian1978@163.com ¹ Changsha Social Work College, Changsha 410081, China left-behind children in rural areas published by the Long Form sample data of the seventh Census show that in 2020, the number of children affected by parental migration in China totals more than 66.93 million [1]. Leftbehind children often cannot live with their parents for years, and even their most basic psychological needs for family affection are not met [2]. Promoting the healthy development of left-behind children is a major topic of concern to the government. How to effectively carry out



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the care, protection and assistance of left-behind children is a major social issue of great concern to the government as well as the public. From the personal point of view, what we can do is to try our best to reduce the negative effects of left-behind phenomenon.

Generally, children who have experienced parental migration are those under the age of 18 who remain in their home community while one or both of their parents migrate for work, resulting in the separation of parents and children [3]. These children, often referred to as 'left-behind children', face the challenge of growing up without the daily presence and care of at least on of their parents. According to their caregivers, these left-behind children can be divided into two categories: double leftbehind children (those cared for by grandparents) and single left-behind children (cared for by either the father or the mother). The long-term absence of one or both parents creates changes in the internal family structure and leads to a loss of basic family functions [4]. These circumstances place left-behind children in an unfavorable growth situation, making them more susceptible to psychological and behavioral problems [5-7].

Non-suicidal self-injury (NSSI) refers to intentional and repeated physical injuries to one's own body without suicidal intention, such as cutting, banging the body into walls, burning, and stabbing. These behaviors are not acceptable in society and culture [8, 9]. Previous studies have indicated that children who have experienced parental migration in China exhibit a higher frequency and severity of NSSI compared to those have not [10-12]. Emotion regulation is the most common function of NSSI [13, 14]. According to the Experiential Avoidance Model (EAM) of NSSI, individuals who repeatedly engage in NSSI can temporarily alleviate negative emotions. Through this process, they experience a temporary relief, which serves as a negative reinforcement. Consequently, a link between negative emotions and NSSI is established, making NSSI an automatic escape response to negative emotions [15].

Depression, a typical negative emotion, including profound sadness, emotional distress and psychological pain [16], is notably more prevalent among dual-left-behind children (those with both parents absent) and historically left-behind children compared to their non-left-behind and migrant counterparts [17, 18]. Previous studies have established a positive correlation between depression and self-injurious behavior in adolescents; as depressive symptoms intensify, so too does the incidence of NSSI [19, 20]. A cross-national study on NSSI among adolescents in the United States, Italy, and the Netherlands revealed that, among various psychological factors, the positive relationship between depression and NSSI consistently emerged across all three countries [21]. This aligns with the EAM of NSSI, which posts that individuals use NSSI to alleviate psychological distress stemming from depression. However, as an ineffective emotional coping strategy, NSSI fails to resolve emotional issues and instead perpetuates a reciprocal relationship with negative emotions [22-24].

Notably, NSSI may also serve as a precursor to depression. Longitudinal studies spanning one to two years have demonstrated that adolescents' prior NSSI significantly predict subsequent depression [25-27]. This bidirectional relationship can be further understood through Stress Generation Theory [28], which posits that maladaptive behaviors may generate interpersonal or environmental stressors, which in turn exacerbate depression. Specifically, NSSI-related shame or social rejection may compound emotional distress, creating a feedback loop that amplifies both depression and recurrent NSSI [29]. While the predictive strength of this relationship may vary with follow-up duration, Burke et al. [30] demonstrated through three sub-studies that although NSSI did not predict depression at one-month follow-up, it emerged as a significant predictor at six months after controlling for baseline depression levels. An internal meta-analysis of these findings concluded that NSSI is a consistent predictor of depression. Once depression and NSSI become intertwined, they form a mutually reinforcing vicious cycle. A critical question thus arises: How can this cycle be disrupted?

Psychological resilience theory suggests that individuals in adverse environments are not inevitably destined for psychological maladjustment [31]. Cultivating and possessing protective factors is therefore critical for mitigating risks and fostering adaptive outcomes [32]. Children with access to robust protective resources develop enhanced capacities to actively manage negative emotions and navigate challenges [33, 34]. According to the buffering effect mechanism, social support as an important resource in the process of individual development, can attenuate the adverse impacts of negative stimuli on individual [35]. Family support, as key components of adolescents' social support systems, has been empirically validated to mitigate the detrimental effects of adverse environments on depression and NSSI [36, 37].

While prior research has predominantly focus on the protective role of family support (including caregiving by extended relatives), parental care may hold unique significance for left-behind children, a population characterized by prolonged parental absence. Parental care-distinct from generalized family support-refers to the psychological and emotional support provided by migrant parents who have left their households for work, yet maintain caregiving responsibilities. It encompasses assistance, guidance, encouragement, affirmation, and communication with children, emphasizes parental attention and acceptance at the psychological and emotional levels, even in contexts of physical separation [38, 39]. While material caregiving (e.g., daily provision of resources) may be limited due to physical separation, these parents typically maintain caregiving responsibilities through mediated communication (e.g., phone calls, messages) to guide their children's growth, express acceptance, and nurture emotional bonds. In a longitudinal study, Fan et al. [40] found that parental care had both immediate and delayed negative predictive effects on depression in left-behind children. Specifically, when left-behind children perceive greater parental care, their depression may decrease, subsequently reducing the predictive effect on future self-injurious behavior and breaking the vicious cycle between depression and NSSI [41]. In other words, parental care moderates the crosslagged effect between depression and NSSI in left-behind children.

The current study

Although previous studies have examined the relationship between between depression and NSSI [21], as well as the delayed predictive impact of depression on NSSI [25, 26, 30], verifying whether depression and NSSI reinforce each other in a vicious cycle remains challenging. Notably, existing studies have not systematically examined their cross-lagged effects within a unified analytical framework, leaving the "vicious cycle" hypothesis between these constructs inadequately tested. Therefore, the present study employs a two-wave design with a 10-month interval between assessments to examine the reciprocal temporal relationships between NSSI and depression among Chinese left-behind children. The primary challenge faced by left-behind children stems from the lack of care resulting from parent-child separation, which exacerbated their psychological vulnerabilities. Based on the Psychological resilience theory and stress-buffering model, we further explore whether parental care moderates the longitudinal interplay between depression and NSSI. Therefore, we propose the hypothesis:

- H1: Depression and NSSI will exhibit reciprocal cross-lagged predictive effects across the 10-month follow-up period.

- H2: Parental care will moderate the bidirectional cross-lagged relationships between depression and NSSI. Specifically, among left-behind children with higher levels of parental care, the predictive effects of depression on subsequent NSSI and of NSSI on subsequent depression will be significantly attenuated.

The theoretical hypothesis model of this study is shown in Fig. 1.

Methods

Participants

This longitudinal study utilized a two-wave design to examine the bidirectional, cross-lagged relationships between depression and NSSI among left-behind children. Data were collected at two time points spaced 10 months apart to capture temporal dynamics. Participants were left-behind children from 27 grade 7 classes in 9 middle schools in 2 regions of Hunan Province, selected via cluster sampling method. The first wave (T1) was conducted in December 2018 with 390 valid questionnaires, and the second wave (T2) occurred in October



Fig. 1 Theoretical hypothesis model

2019, with 374 valid responses. After integrating data across both waves, 353 left-behind children were retained for analysis, comprising 193 boys (54.70%), 160 girls (45.30%). The age range of the first test group was 11-14 years old, and the average age was 12.50 ± 0.67 . Demographic information is presented in Table 1.

Measures

NSSI

The Adolescent Self-Harm Scale, initially developed by Zheng [42], was subsequently revised by Feng [43]. The scale consists of 18 items, with no reverse scoring or additional dimensions, and one short-answer question to assess self-injurious behavior among adolescents. For scoring, items measuring the frequency of NSSI utilize a 4-point scale, ranging from 0 (never) to 3 (five times or more). Items assessing the severity of NSSI employ a 5-point scale, spanning from 0 (none) to 4 (extremely severe). The overall level of NSSI is determined by multiplying the frequency and severity scores. The total score range reflects the combined frequency and severity of NSSI, with higher scores indicating a higher level of NSSI. In this study, the internal consistency of the scale was assessed using Cronbach's α coefficients, which were found to be 0.93 at T1 and 0.92 at T2, indicating strong reliability.

Center for epidemiological studies depression scale

The Center for Epidemiological Studies Depression (CESD) Scale was originally developed by Radloff [44]. The Chinese version of the CESD, which was adapted and validated for use in Chinese populations, was employed in this study to measure depressive symptoms in adolescents [45]. The scale consists of 20 items, including 4 reverse scoring questions. The scale is scored on a 4-point scale, ranging from 1 (occasionally) to 4 (most or all of the time) resulting in a total score range of 0 to 60.

Table 1 Demographics characteristics of the study participants (N = 353)

Variables		Frequency	Percentages
Gender	Girls	160	45.30%
	Boys	193	54.70%
Father-child separation duration	< 1 year	169	47.90%
	1–3 years	49	13.90%
	3–5 years	29	8.20%
	> 5 years	75	21.30%
Mother-child separation dura-	< 1 year	105	29.70%
tion	1–3 years	43	12.20%
	3–5 years	16	4.50%
	> 5 years	38	10.80%

The higher the score, the higher the frequency of depressive symptoms. The CESD has demonstrated excellent reliability and validity in young Chinese adults [46]. In our study, the Cronbach's α coefficient was 0.73 at T1 and 0.85 at T2, indicating that the Chinese version of CESD is a reliable tool for measuring depression in adolescents.

Parental care questionnaire

The Parental Care Questionnaire was originally compiled based on the Affective Relationships Scale (ARS) by Takahashi and Sakamoto [47], and it was later revised by Fan et al. [48]. This questionnaire measures the situation of left-behind children's parental care. It consists of eight items, each rated on a 5-point scale (1 = more, 5 = less), asking participants to report how often their father and mother had provided help, encouragement, and guidance in the previous year, even if on or both parents working away from home for extended periods. Scores ranging from 8 to 40, with higher scores indicating that children perceived more parental care. There are no reverse scoring or other dimensions in this questionnaire. In our study, Cronbach's α at T1 was 0.92, indicating good reliability of the tool.

Procedure

The study was conducted in collaboration with the educational institutions of the selected area. The Institutional Ethics Committee of the primary author approved the ethical conduct of the study. The research was conducted between December 2018 and October 2019, with a total of two data collections. Prior to initiating the research, written consent was obtained from both students and their parents. Assurance was given to the participants regarding the voluntary nature of their involvement, their liberty to withdraw at any time, and the confidentiality of their personal information. In each class, a graduate student used a unified examination paper to conduct a group test. Participants completed the questionnaire during class time. Before administering the questionnaire, the researchers fully informed the participants about the purpose of the study and highlighted the confidentiality of the surveys. A unique ID number for each student was created for data-matching purposes. To preserve anonymity, each questionnaire had a code that enabled the researchers to match the two tests and responses from each student. The final eligible participants comprised adolescents with one or both parents migrating for employment.

Data analytic strategy

First, repeated measurement ANOVA was performed to examine the development of depression and NSSI in left-behind children over time, testing for significant

changes in mean scores and providing an overview of mental health trajectories. Second, bivariate correlations using Pearson coefficients were calculated to explore the relationship between depression, NSSI and parental care. Third, a cross-lagged panel model was constructed in Mplus 8.0, where depression T1 and NSSI T1 were used as exogenous variables and depression T2 and NSSI T2 as endogenous variable sin the model; the maximum likelihood (ML) estimation method was used, and the model was saturated to comprehensively investigate cross-lagged relationships between depression and NSSI. Finally, for the moderation analysis, parental care at T2 was assessed for its role in moderating the cross-lagged depression and NSSI relationship. This timing aligns with the study's focus on how ongoing parental engagement buffers mental health trajectories over time, rather than static baseline effects. To reduce collinearity, gender, age, depression T1, NSSI T1, and parental care were standardized, and interaction terms (depression $T1 \times parental$ care and NSSI T1 × parental care) were created. Hierarchical regression was used to test the moderating role of parental care on the relationships between depression T1 and NSSI T2 and between NSSI T1 and depression T2. A significance level of $\alpha = 0.05$ was applied throughout, with a *p*-value < 0.05 indicating statistical significance to balance the risks of Type I and Type II errors and identify meaningful relationships.

Results

Development of depression and NSSI in left-behind children

To examine the development of depression and NSSI in left-behind children, we conducted a repeated measures ANOVA. Results indicated that the main effect of the measurement time of depression was significant [F (1,346) = 10.13, p = 0.002, $\eta_p^2 = 0.03$], Depression T2 was significantly higher than depression T1. The main effect of gender was significant [F (1,346) = 8.27, p = 0.004, $\eta_p^2 = 0.02$]. The interaction effect of time and gender

was significant [F (1,346) = 4.39, p = 0.037, η_p^2 = 0.01] and additional simple effect analysis revealed depression was significantly higher in girls than in boys. The main effect of measurement time of NSSI was not significant [F(1,346) = 2.20, p = 0.139, η_p^2 = 0.01], and the main effect of gender was significant [F (1,346) = 5.84, p = 0.016, η_p^2 = 0.02]. The NSSI of girls was significantly higher than that of boys, and the interaction between time and gender was not significant [F (1,346) = 3.07, p = 0.081, η_p^2 = 0.01].

Correlation analysis of depression and NSSI in left-behind children

Table 2 showed that depression T1 was significantly related to depression T2 (r = 0.40, p < 0.001). NSSI T1 was significantly related to NSSI T2 (r = 0.34, p < 0.001), indicating that depression and NSSI in left-behind children have a certain stability from grade 7 to grade 8.

There was significant simultaneous correlation between depression and NSSI among left-behind children. At the same time, the successive correlation between depression and NSSI among left-behind children was also significant; the coefficient of association between depression T1 and NSSI T2 was 0.27, p < 0.001, and the correlation coefficient between NSSI T1 and depression T2 was 0.25, p < 0.001. The simultaneous and successive correlations between depression and NSSI in left-behind children were both significant, indicating that there was a certain relationship between them, which conformed to the conditional hypothesis of the cross-lagged design. Besides, the duration of parent-child separation has no significant correlation with primary variables (ps > 0.05), so the additional impact of this variable will not be considered in the subsequent analysis.

Cross-lagged analysis of depression and NSSI in left-behind children

The results indicated that the cross-lagged model is a saturated model (RMSEA = 0, SRMR = 0, CFI = 1, TLI =

 Table 2
 Descriptive statistics of and correlations between measured variables

	М	SD	1	2	3	4	5	6	7
Father-child separation duration	2.04	1.25	1						
Mother-child separation duration	2.04	1.21	0.71***	1					
Depression T1	37.57	10.76	0.03	0.03	1				
Depression T2	39.57	12.14	- 0.05	0.05	0.40****	1			
NSSI T1	4.23	8.57	- 0.06	- 0.08	0.37***	0.25***	1		
NSSI T2	5.03	10.92	- 0.03	0.01	0.27***	0.48***	0.34***	1	
Parental Care	27.33	8.96	- 0.03	- 0.06	- 0.30****	- 0.47***	- 0.12*	- 0.34***	1

M Mean, SD Standard deviation, T1 Time 1, T2 Time 2

* *p* < 0.05; ***p* < 0.001, ****p* < 0.001, the same below

1). This model revealed the key patterns of longitudinal associations between depression and NSSI among leftbehind children across the 10-month follow-up period.

Figure 2 indicates that the auto-regressive paths of depression (β = 0.36, *SE* = 0.05, *p* < 0.001) and self-injury $(\beta = 0.28, SE = 0.05, p < 0.001)$ from T1 to T2 were significant. These paths suggest persistent continuity in internalizing symptoms and self-injury behaviors respectively, across the transition from grade 7 to 8. Critically, the results provided robust support for Hypothesis 1 (H1) by demonstrating reciprocal cross-lagged predictive effects between depression and NSSI. Depression T1 significantly predicted NSSI T2 ($\beta = 0.17$, *SE* = 0.05, *p* < 0.001); the more depression left-behind children experienced in grade 7, the more self-injurious behaviors appeared in grade 8. Conversely, NSSI T1 significantly predicted depression T2 (β = 0.12, *SE* = 0.05, *p* = 0.026); the more self-injurious behaviors reported for left-behind children in grade 7, the more depression evidenced in grade 8.

Moderating effect of parental care on the relationship between depression and NSSI

To evaluate Hypothesis 2 (H2), we first examined the moderating role of parental care in the relationship between depression T1 and NSSI T2 using hierarchical regression (Table 3, Model 1). After controlling for gender and age, depression T1 significantly predicted NSSI T2 (β = 0.19, p < 0.001). Critically, the interaction term for depression T1× parental care emerges as a significant negative moderator ($\beta = -0.17$, p < 0.01), which indicated that parental care significantly negatively regulates the relationship between depression T1 and NSSI T2. Next, we tested the reverse pathway by examining the moderating role of parental care in the relationship between NSSI T1 and depression T2 (Table 3, Model 2). While NSSI T1 significantly predicted depression T2 (β = 0.19, p < 0.001), the interaction term of NSSI T1× parental care was non-significant ($\beta = -0.03$, p = 0.56). This indicated that parental care did not buffer the effect

 Table 3
 Analysis of the moderating effect of parental care on depression and NSSI

	Step	Predictive variable	В	t
Model 1	Step 1	Gender	0.08	1.59
		Age	0.02	0.42
	Step 2	Depression T1	0.19	3.54***
		Parental Care	- 0.27	- 5.06***
		$\Delta F = 15.80$		$\Delta R^2 = 0.16$
	Step 3	Depression T1× Parental Care	- 0.17	- 3.40**
		$\Delta F = 11.54$		$\Delta R^2 = 0.03$
Model 2	Step 1	Gender	0.09	1.91
		Age	0.03	0.71
	Step 2	NSSI T1	0.19	3.97***
		Parental Care	- 0.43	- 9.14***
		$\Delta F = 31.36$		$\Delta R^2 = 0.27$
	Step 3	NSSIT1× Parental Care	- 0.03	- 0.58
		$\Delta F = 0.33$		$\Delta R^2 = 0.001$

of prior NSSI on subsequent depression. These findings partially support H2: parental care weaken the prospective impact of depression on NSSI but did not mitigate the reverse association.

The moderating trend of parental care in the prediction of depression T1 and NSSI T2 in left-behind children was analyzed using a simple slope test, based on parental care scores and dividing the left-behind children into high and low groups that indicated a standard deviation higher and lower than the average, respectively. The study investigated the predictive effect of depression on NSSI in left-behind children with different levels of parental care and created a moderation diagram (see Fig. 3). The results showed that depression T1 had a significant positive predictive effect on NSSI T2 in the lowlevel parent care group (simple slope = 0.35, p < 0.001), while depression T1 had no significant predictive effect on NSSI T2 in the high-level parent care group (simple slope = -0.01, p = 0.914), indicating that the higher the level of parental care of left-behind children, the smaller



Fig. 2 The cross-lagged model between NSSI and depression



Fig. 3 Moderating effect of parental care on depression and NSSI of left-behind children

the predictive effect of depression on NSSI. As presented in Fig. 3, parental care was shown to effectively alleviate the impact of depression on the self-injurious behavior of left-behind children.

Discussion

In the present study, we examined the bidirectional relationship between depression and NSSI in 353 left-behind children over a 10-month follow-up period, as well as the moderating role of parental care in this relationship. Our findings revealed that depression in left-behind children in grade 7 (depression T1) significantly predicted NSSI in grade 8 (NSSI T2); NSSI in grade 7 (NSSI T1) also significantly predicted depression in grade 8 (depression T2). There is a reciprocal relationship between depression and NSSI in left-behind children. This reciprocal relationship between depression and NSSI in left-behind children is consistent with previous research suggesting that emotional difficulties and NSSI are mutually reinforcing risk factors [25]. Furthermore, it was found that depression T1 had a significant predictive effect on NSSI T2 when parental care was absent, but depression T1 had a nonsignificant predictive effect on NSSI T2 when parental care was higher. Parental care played a moderating role in the predictive effect of depression on NSSI for leftbehind children. This finding aligns with prior evidence emphasizing the protective role of positive parent-child relationship in buffering against emotion dysregulation **[49]**.

Through repeated ANOVA measurement, the study also observed a significant increase in depression levels among left-behind children from grade 7 to grade 8, with a notable gender difference emerging. While there was no significant difference in depression levels between boys and girls in grade 7, girls exhibited significantly higher levels of depression than boys in grade 8. This finding is consistent with previous studies indicating that girls are more susceptible to stress-related mental health issues, such as anxiety and depression, which may contribute to higher level of NSSI [45, 47]. Additionally, our study confirmed the presence of significant gender differences in NSSI levels among left-behind children, with girls reporting higher levels than boys. This finding is in line with previous research demonstrating fender disparities in NSSI prevalence and severity [50]. As Chinese adolescents enter grade 7, they face increased academic pressures and challenges, which may disproportionately affect girls and contribute to higher levels of stress and self-injurious behavior [51].

The cross-lagged analysis has shown that depression and NSSI among left-behind children exhibit a mutual reinforcing effect. This finding is consistent with the Experience Avoidance Model proposed by Chapman et al. [15], which posits that NSSI serves as a maladaptive means for individuals to alleviate their negative emotions, temporarily relieving their negative experiences. Adolescents are in a period of physical, mental, and cognitive development. They have not yet mastered sufficient strategies for emotion management [52]. Moreover, compared to non-left-behind children, left-behind children may still face a greater number of risk factors [53]. Consequently, when confronted with challenges and difficulties, they are more likely to choose NSSI, this maladaptive behavior, as a way to temporarily mitigate their distressing experiences. However, since NSSI only provides a temporary respite from individuals' negative experiences rather than fundamentally helping them address the real challenges and difficulties they face, from a long-term perspective, it will actually exacerbate their negative experiences. This, in turn, froms a vicious cycle with depression [54, 55].

The current study delves into the moderating effect of parental care on the relationship between depression and

NSSI among left-behind children. The findings revealed that depression in Grade 7 significantly predicted NSSI in Grade 8, but only under conditions of insufficient parental care. When parental care was robust, this predictive effect was not significant, suggesting that effective parental care significantly mitigates the risk of depression escalating into NSSI.

Notably, despite physical separation, modern communication technologies (e.g., video calls, messaging) enable migrant parents to provide diverse care [56]. For instance, parents who employ problem-solving encouragement and empathetic listening during remote interactions can foster secure attachment bonds, even across distances. Conversely, reliance on maladaptive strategies, such as dismissive response or avoidance of emotional topics, may exacerbate feelings of abandonment, amplifying depression and NSSI. Drawing on attachment theory, children will internalize remote caregiving experiences into internal working models, shaping their coping responses to distress [57]. Effective parental care cultivates a "secure base" that encourages adaptive emotion regulation (e.g., seeking social support, reappraisal), whereas inconsistent or dismissive care reinforces maladaptive patterns (e.g., rumination, emotional suppression) [58, 59]. Therefore, left-behind children who feel sufficiently cared for by their parents can choose adaptive strategies to face and solve difficulties and challenges, and thus will not choose maladaptive strategies such as NSSI and suicide. From another vantage point, the scarcity of parental care perpetuates a vicious cycle of emotional and behavioral difficulties for these children. This may will be the key factor explaining why Chinese leftbehind children often exhibit more severe psychological and behavioral issues compared to their non-left-behind peers [5].

It stands out clearly that parental care is indispensable for the holistic development of left-behind children. This insight offers a potential pathway to disrupt and ameliorate the progression of self-injury among this vulnerable group. Consequently, prevention or intervention programs aimed at addressing self-injury in left-behind children should prioritize enhancing parental care. By doing so, these children can derive emotional and practical support from their parents, enabling them to manage negative emotions in a more resilient manner and consequently diminish the incidence of self-harm [60]. Notably, even though parents may not be physically present to offer direct care, they can still nurture their children through telephone and video communications. While the medium may have shifted, the fundamental essence of care remains steadfast [40]. For instance, intervention programs could prioritize training for migrant parents in communication strategies to fortify children's secure attachment. Schools might complement these efforts by deploying mental health professionals to coach adolescents in adaptive emotion regulation when parental support is intermittently available. Importantly, the moderating effect of parental care on the relationship between NSSI and subsequent depression was not significant, may reflect differing temporal dynamics. Depression as a typical negative emotion, often antecedent to NSSI, is more amenable to parental intervention, whereas entrenched NSSI may require targeted behavioral interventions beyond emotional support alone.

Limitations and future research

This study has some limitations. First, the population of left-behind children is highly diverse and complex group, with variations in guardianship arrangements (e.g., having one or both parents migrate) and the developmental stages at which parent-child separation occurs. However, the study failed to account for these distinctions, which could introduce biases into the results and limit the generalizability of our findings to the broader population of left-behind children. Future research should aim to more meticulously categorize this population, taking into account these differentiating factors to mitigate the influence of extraneous variables.

Second, while the left-behind children are known to have a higher school dropout rate compared to the general student population [61], our study's sample was restricted solely to left-behind children who remained in school. This limitation restricts the generalizability of our findings to the entire population of left-behind children, as it excludes those who have discontinued their education. To enhance the representativeness of the sample and the generalizability of the findings, future research should comprehensively consider the proportion of leftbehind children who drop out school during the sampling phase.

Third, the absence of a comparison group comprising non-left-behind children hindered our ability to ascertain whether the study findings were unique to left-behind children or applicable to a broaden population. This limitation prevents us from making definitive conclusions about the specific impact of being left-behind children. Incorporating a comparison group of non-left-behind children in future analyses would allow for more nuanced understanding of the similarities and differences in relationship patterns among variables between these two populations. Such a comparison would provide valuable insights into the unique challenges and experiences faced by left-behind children and help identify potential interventions tailored to their specific needs.

Additionally, the study was limited by the use of only two timepoints, which may not fully capture the dynamic nature of the experiences and outcome of left-behind children. Future research should consider employing longitudinal designs with multiple timepoints to better understand the trajectories and changes over time in this population. Furthermore, our study did not account for potentially important covariates that could influence the outcomes, such as the socioeconomic status. This omission could introduce confounding effects and limit the accuracy of our findings. Future research should strive to include a comprehensive set of covariates in their analyses to more accurately isolate the effects of being a left-behind child.

Conclusion

This study presents several key conclusions. Firstly, depression among left-behind children showed an increasing trend from Grade 7 to Grade 8, with notable gender differences observed. Secondly, while the increasing trend of NSSI among left-behind children is not significant, a significant gender difference emerges in Grade 8. Furthermore, depression and NSSI among left-behind children are predictive of each other. Specifically, pre-test depression (i.e., depression levels recorded prior to the initial questionnaire administration) has a significant positive predictive effect on posttest NSSI, and conversely, pre-test NSSI significantly predicts post-test depression. Notably, parental care acts as an effective moderating factor in the predictive relationship between pre-test depression and post-test NSSI among left-behind children. In scenarios with low levels of parental care, pre-test depression can significantly predict post-test NSSI, whereas this predictive effect is not significant with high levels of parental care. These findings contribute to deeper understanding of the developmental mechanisms underlying psychological and behavioral issues in Chinese left-behind children and offer valuable insights for the formulation of targeted psychological intervention strategies.

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Authors' contributions

KH and HL designed the study and devised the project. KU wrote the main manuscript text, collected the data, analyzed and interpreted the data. All authors reviewed the manuscript.

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Data availability

The datasets generated and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The manuscript is not under review elsewhere, and the results have not been published previously or accepted for publication. All methods were carried out in accordance with relevant guidelines and regulations. All participants provided written informed consent for their participation, and their legal guardians gave approval. This study received ethical approval from ethical approval from the Ethics Committee of Changsha Social Work College. In accordance with the Declaration of Helsinki, all participants guardians gave written informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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