



Original article

Perceived parental depression, intrusive rumination, and internalizing problems: A three-wave longitudinal study in adolescents

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ABSTRACT

Background/objective: Research suggests that perceiving parental depression elicits internalizing problems in adolescents, but certain studies have indicated that adolescents' internalizing problems also increase their perception of parental emotion. To further investigate the inconsistent findings about the nature of this relationship, the current study used longitudinal data to examine the causal association between adolescents' internalizing problems and the parental depression they perceived, as well as the role of intrusive rumination in the relationship. **Method:** In this longitudinal study, 392 adolescents who experienced the catastrophic Jiuzhaigou earthquake in 2017 were surveyed at three time points after the earthquake: 12 months (T1), 21 months (T2) and 27 months (T3). A cross-lagged panel model was used to carry out the data analysis. **Results:** Mutual cause-and-effect relationships were found between intrusive rumination and both perceived parental depression and internalizing problems, respectively; a unilateral causal relationship in which internalizing problems positively predicted perceived parental depression was also found. In addition, internalizing problems predicted perceived parental depression via the mediating role of intrusive rumination; similarly, intrusive rumination predicted perceived parental depression via internalizing problems. **Conclusions:** Internalizing problems were a risk factor for perceived parental depression, and intrusive rumination played an important role in the relationship between internalizing problems and perceived parental depression.

Introduction

Internalizing problems usually refer to negative emotional experiences of an individual (Reijntjes et al., 2010). Recent studies have found that individuals who experience major traumatic events tend to exhibit internalizing problems, such as post-traumatic stress disorder (PTSD) and depression (Mendez et al., 2022; Morris et al., 2012; Vivrette et al., 2018). For example, the incidence of PTSD in the victims of the catastrophic disaster ranged from 21.5% to 40.1% (Goenjian et al., 2005) and the incidence of depression among adolescents after the earthquake was between 13.6% and 76% (Şalcıoğlu & Başoğlu, 2008). More generally, almost 37% of adolescents who have experienced traumatic events developed internalizing problems (Deković et al., 2008). In addition, traumatic natural disasters can also induce adverse psychological reactions in parents (Chen et al., 2020; Lai et al., 2015; Self-Brown et al., 2014). As important nurturers of adolescents, in the course of usual parent-child interactions parents' adverse trauma-induced reactions will inevitably be noted by their children, which may then cause the children to have internalizing problems such as anxiety and depression (Chen et al., 2020; Lai et al., 2015). Therefore, in order to provide adolescents with targeted psychological services after they have experienced a

catastrophic event, many researchers have focused on the effect of parental trauma on adolescents' internalizing problems, suggesting that parental distress is an important risk factor of children's internalizing problems (Humphreys et al., 2012; Leen-Feldner et al., 2011; Roubinov et al., 2022).

However, these studies have several limitations. First, these studies emphasized that children were passive recipients of their parents' distress and overlooked the children's active role in this process. In fact, the prerequisite of parental distress influencing their children's post-traumatic reactions may be whether children perceive the distress or not (Gaylord et al., 2003). On the one hand, there are differences between parents' self-reported behavioral responses and their children's perceptions of these responses; on the other hand, children's perceptions of their parents' reactions are more likely to significantly affect children's mental health than parents' adverse reactions themselves (Gaylord et al., 2003; Spitz et al., 2021). Given these findings, examining the effect of the parental distress children perceive on children's mental health is both meaningful and necessary.

Second, studies have found that adolescents with internalizing problems may also misunderstand the feelings of others (Kan et al., 2004; Kupferberg et al., 2016), which in turn may aggravate their existing

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problems (Brawer-Sherb et al., 2020). However, these previous studies were cross-sectional in design and did not assess the role of internalizing problems in the adolescents' perceptions of their parents' distress. Thus, these studies precluded a comprehensive understanding of the causal relationship between the two concepts. Third, it is unclear whether there is another factor underlying the relationship between perceived parental distress and children's internalizing problems, which further hinders understanding. To address these issues, this study first examined the causal relationship between the parental distress (e.g., depression) perceived by children and children's internalizing problems using a longitudinal design. Next, this study further assessed the potential mechanisms underlying this relationship.

Perceived parental depression predicting internalizing problems via the mediating role of intrusive rumination

Depression is a common post-traumatic psychological problem (Morris et al., 2012; Vivrette et al., 2018), and its incidence is generally much higher than other post-traumatic reactions, such as PTSD. For instance, a study found that the lifetime prevalence rate of depression in adults after natural disasters was 19%, while that of PTSD was 11.3% (Arnberg et al., 2013). Another study found that although PTSD in adults who experienced Typhoon Morakot decreased from 29.2% to 15.9% in the year following the disaster, the prevalence of depression increased from 43.3% to 46.6% during the same year (Chen et al., 2015). Some studies have even suggested that the depressive symptoms victims experience after natural disasters persist for many years (Lai et al., 2015; Sastry & Van-Landingham, 2009). Moreover, many cross-lagged studies found that depression not only appeared earlier than PTSD, but that it also predicted the occurrence of PTSD (Schindel-Allon et al., 2010; Schumm et al., 2015; Ying et al., 2012). Therefore, it was suggested that researchers should pay more attention to depression as a post-traumatic symptom.

Several recent empirical studies have confirmed the important role of parental depression in children's psychological problems (Goodman, 2020; Grabow et al., 2017; Siegel & Han, 2018; Spitz et al., 2021). However, most of these studies relied on self-assessments completed by parents and were less concerned with the perceptions of the children themselves. As they are distinct from depression levels self-reported by parents, adolescents' perceptions of parental emotions are crucial in understanding how parental emotions affect adolescents (Gaylord et al., 2003; Spitz et al., 2021). For example, as adolescents' cognitive abilities are not yet mature, when they perceive their parents' depressive symptoms, they are more inclined to adopt negative rather than positive cognitive views of the situation (Kaimal & Beardslee, 2010). Specifically, adolescents may think that their parents' depressive symptoms will be persistent, never-ending, or unpredictable, which may lead the adolescents themselves to experience negative emotions such as isolation, tension, stress, and unpleasantness (Champlin, 2009; Kaimal & Beardslee, 2010). Moreover, adolescents may feel self-blame for not being able to help their parents recover from perceived depression, and thus develop negative emotional experiences such as shame, anxiety, and depression (Brawer-Sherb et al., 2020). They may also believe that their parent is physically present but psychologically absent (Mechling, 2016), which can affect physical, cognitive, emotional, and behavioral responses adversely. Such adverse responses can cause psychological maladjustment and ultimately exacerbate the severity of internalizing problems in adolescents (Boss, 2010). Therefore, we hypothesized that the parental depression perceived by adolescents would positively predict adolescents' internalizing problems.

Furthermore, Hoffman's theory of emotional contagion asserted that when individuals perceive the emotions of others, emotional expression cues will cause the individuals to perceive similar experiences or inspire the individuals to recall comparable past experiences in order to generate similar emotional states (Hoffman, 2002; Wang et al., 2010). In the context of our study, this suggests that when adolescents perceive their parents' depressive emotions, they may not only directly generate the

same negative mood but may also indirectly produce the same depressive symptoms by being prompted to recollect adverse experiences similar to those of their parents. Specifically, adolescents may think that the negative emotions and behaviors shown by their parents are the consequences of catastrophic experiences and thus pay more attention to the severity of their parents' depression. This process may lead to adolescents being repeatedly reminded of events and related cues that reinforce negative understandings of trauma. In other words, this could promote the occurrence of intrusive rumination and ultimately worsen adolescents' internalizing problems (e.g., depression, PTSD; Egan et al., 2014; Thompson et al., 2010). We therefore hypothesized that perceived parental depression might elicit more internalizing problems in adolescents by increasing their likelihood of intrusive rumination.

Internalizing problems predicting perceived parental depression via the mediating role of intrusive rumination

Information processing theory suggests that individuals with internalizing problems experience various types of cognitive distortions (Beck & Clark, 1988). Therefore, when adolescents develop internalizing problems, they usually show cognitive biases about the external world. For example, they are more likely to notice negative signs when processing external information (Connolly et al., 2017), show higher vigilance to threatening information (Taghavi et al., 1999), and give negative interpretations of ambiguous situations in society and life (i.e., situations that they perceive as dire and threatening; Barrett et al., 1996; Platt et al., 2017; Reid et al., 2006). After experiencing unexpected traumatic events, adolescents who gradually develop internalizing problems may exhibit cognitive biases toward their parents' responses. Thus, they may become especially sensitive to their parents' reactions and interpret their parents' states and actions in an excessively negative way. This may lead them to misinterpret their parents' depressive symptoms and exaggerate perceived levels of parental depression (Johnco et al., 2021). In terms of the parent-child relationship, internalizing problems may also cause adolescents to negatively perceive their parents' statements and behaviors (Platt et al., 2017), which could in turn increase their concerns about parental mental health (Rote et al., 2021) and exaggerate perceived parental depression. That is, adolescents' internalizing problems could also lead to an increase in the parental depression they perceive.

Moreover, the schema theory argues that an individual's cognitive processing is manipulated by schemas, which largely determine what information an individual attends to, interprets, and memorizes (Beck & Clark, 1997). The schemas of adolescents with internalizing problems are often biased toward remembering threatening negative information (Bar-Haim et al., 2007). This means when adolescents demonstrate severe internalizing problems, their cognitive processing is more focused on catastrophic events. They will automatically show pessimistic attitudes toward their environment and others (Agar et al., 2006), be flooded with catastrophic thoughts, and become more likely to misestimate the severity of traumatic events (Mazur et al., 1999). Additionally, adolescents with internalizing problems are prone to focus solely on crisis experiences and stimuli (Gotlib et al., 2004; Reid et al., 2006), which can in turn lead to uncontrollable and repetitive recall of catastrophic events, related cues, and negative consequences of the trauma (Nolen-Hoeksema et al., 2008). This can increase the occurrence of intrusive rumination and thereby exacerbate a destructive understanding and evaluation of negative events (Wisco et al., 2014; Wisco & Nolen-Hoeksema, 2010). This is consistent with the attention scope model (Whitmer & Gotlib, 2013), which states that repetitive passive rumination will constrict the scope of adolescents' attention to negative stimuli like parental depression. Therefore, in daily interactions with parents, such adolescents can be overly sensitive to the adverse emotions of their parents (Ray et al., 2005), as well as negatively and automatically associate these behaviors with past crisis experiences (Nolen-Hoeksema et al., 2008). In turn, they may then exaggerate parental mental health

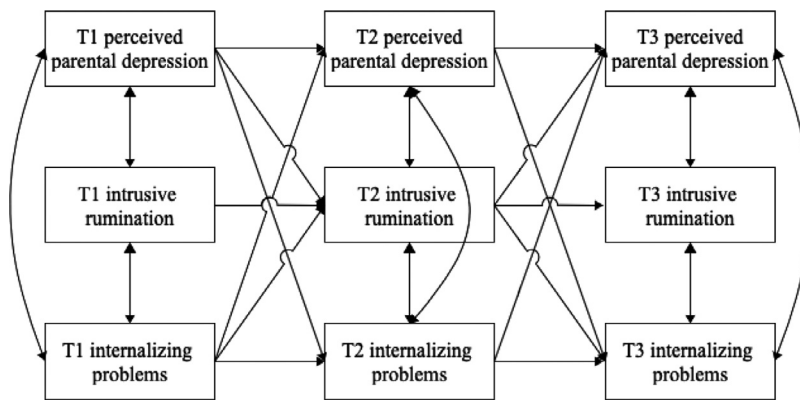


Fig. 1. The conceptual model. Notes: T1 = 12 months after the earthquake occurred; T2 = 21 months after the earthquake occurred; T3 = 27 months after the earthquake occurred.

problems and report higher levels of parental depression. We therefore hypothesized that internalizing problems may increase the parental depression adolescents perceive by causing them to engage in intrusive rumination.

In light of the research discussed above, we suggest that there may be a bidirectional causal relationship between the parental depression perceived by adolescents and internalizing problems, and that intrusive rumination may play a mediating role in this relationship. Hoffman's (2002) emotional contagion theory and Beck and Clark's (1988, 1997) information processing and schema theory found conflicting and opposite causal relationships among perceived parental depression, intrusive rumination, and internalizing problems in adolescents. While these theories were supported by empirical studies, because of their cross-sectional designs these studies were unable to resolve these inconsistencies and elucidate the specific causal relations among the three variables. To fill these gaps, in the current study we aimed to examine the potential causal relationship between perceived parental depression and internalizing problems using a longitudinal design, and to elucidate the possible mediating effect of intrusive rumination in this relationship. By combining Hoffman's (2002) emotional contagion theory and Beck and Clark's (1988, 1997) information processing and schema theory, we proposed a hypothetical conceptual model (Fig. 1) wherein adolescents' perceived parental depression and internalizing problems exhibit positive predictive effects on each other, and where intrusive rumination plays a mediating role in the reciprocal relationship between them.

Methods

Participants and procedures

Participants were adolescents selected from two schools in Jiuzhaigou County of Sichuan Province, China, which was hit by a catastrophic 7.0-magnitude earthquake in 2017 that caused both significant loss of life and severe damage to property. One middle school (grades 7–9) and one high school (grades 10–12) were selected with the help of the local bureau of education. Inclusion criteria required that participants be between 10 and 19 years old, and that they had experienced the Jiuzhaigou earthquake with their parents. Furthermore, considering that the study involved follow-up measurements, only students in grades 7, 8, 10, and 11 were selected for the initial study. We conducted the first set of measurements 12 months after the earthquake occurred (time 1 [T1]); the second and third sets took place at 21 months (T2) and 27 months (T3) after the earthquake, respectively. A total of 620 participants completed the self-report questionnaires at T1. Although 616 and 511 participants took part at T2 and T3, respectively, only 392 participated in all 3 sets of measurements. Therefore, these 392 participants comprised the final sample, which included 134 male students. The mean age of the participants at T3 was 16.54 years, and ranged from 13 to 19 years. Among the students in the final sample, 30.9% were in middle school and 69.1% were in high school. In addition, 5.1% of the

participants had parents who had divorced or remarried, 44.1% were ethnic minorities, and 16.2% had fathers or mothers who worked outside their hometown.

All students who attended school on the assessment dates agreed to participate in the study. There were no further exclusion criteria and no compensation provided to participants, and participants were free to withdraw at any time. Both the purpose of the study and the method of research were explained to school administrators, teachers, and students prior to data collection, and written informed consent forms were obtained from students' guardians. The assessments were conducted during regular school hours. After completing the assessments, participants were informed that they could receive help from the school psychologist or teachers if needed. This study was approved by the Research Ethics Committee of the Department of Psychological and Behavioral Sciences, Zhejiang University.

Measures

Trauma exposure. The trauma exposure questionnaire developed by Zhou et al. (2022) was used to evaluate the adolescents' trauma exposure during the Jiuzhaigou earthquake. The scale contains 7 items; each item is scored 0 (i.e., "No") or 1 (i.e., "Yes"). The higher the total score, the higher the level of trauma exposure. The Cronbach's alpha coefficient of this scale at T1 was 0.636.

Perceived parental depression. The parental depression level perceived by adolescents was assessed using the Perceived Parental Depression Scale developed by Zhou et al. (2021). The questionnaire consists of 7 items rated on a 4-point Likert scale, with 0 representing "not at all" and 3 representing "always". The higher the score, the more severe the parent's perceived depression level. The Cronbach's alpha coefficients of this scale at T1, T2, and T3 were 0.894, 0.897, and 0.910, respectively.

Intrusive rumination. Adolescents' intrusive rumination was assessed using the intrusive rumination subscale from the Rumination Scale developed by Cann et al. (2011) and revised by Zhou et al. (2017). The subscale includes 10 items scored on a 4-point Likert scale, with 0 indicating "not at all" and 3 indicating "always". The Cronbach's alpha coefficients of this subscale at T1, T2 and T3 were 0.919, 0.935, and 0.934, respectively.

Depression. We used the Center for Epidemiological Studies Depression Scale (CES-DS) to measure adolescents' degree of depression (Fendrich et al., 1990). The scale contains 20 items scored from 0 to 3; 0 indicates that the individual has not experienced a similar situation recently, while 3 indicates that a similar situation has recently occurred frequently. The higher the total score, the more severe an individual's state of depression. The Cronbach's alpha coefficients of this scale at T1, T2, and T3 were 0.812, 0.804, and 0.876, respectively.

PTSD. Zhou et al. (2017) revised the PTSD checklist (referred to as PCL-5) developed by Weathers et al. (2013). This was used to assess adolescents' PTSD symptoms and includes four subscales to measure various types of symptoms: intrusion, avoidance, negative cognitive-

Table 1
Fit indices for measurement invariance.

Variables	Model	χ^2/df	CFI	TLI	RMSEA	ΔCFI
PTSD	M1: Configural invariance (varying λ_s , τ_s , ϵ_s)	1.663	0.915	0.904	0.041	–
	M2: Weak invariance (equal λ_s , varying τ_s , ϵ_s)	1.672	0.912	0.903	0.041	–0.003
	M3: Strong invariance (equal λ_s , τ_s , varying ϵ_s)	1.707	0.906	0.898	0.042	–0.006
Depression	M1: Configural invariance (varying λ_s , τ_s , ϵ_s)	1.559	0.915	0.906	0.038	–
	M2: Weak invariance (equal λ_s , varying τ_s , ϵ_s)	1.548	0.915	0.907	0.037	–0.000
	M3: Strong invariance (equal λ_s , τ_s , varying ϵ_s)	1.571	0.910	0.903	0.038	–0.005
Perceived parental depression	M1: Configural invariance (varying λ_s , τ_s , ϵ_s)	2.391	0.950	0.939	0.060	–
	M2: Weak invariance (equal λ_s , varying τ_s , ϵ_s)	2.408	0.946	0.938	0.060	–0.004
	M3: Strong invariance (equal λ_s , τ_s , varying ϵ_s)	2.524	0.937	0.933	0.062	–0.009
Intrusive rumination	M1: Configural invariance (varying λ_s , τ_s , ϵ_s)	2.905	0.905	0.891	0.070	–
	M2: Weak invariance (equal λ_s , varying τ_s , ϵ_s)	2.842	0.903	0.895	0.069	–0.002
	M3: Strong invariance (equal λ_s , τ_s , varying ϵ_s)	2.920	0.895	0.891	0.070	–0.008

Notes: PTSD = post-traumatic stress disorder; λ_s = factor loading; τ_s = item intercepts; ϵ_s = residual variances; CFI = comparative fit index; TLI = Tucker–Lewis index; RMSEA = root mean square error of approximation; ΔCFI = changes in CFI.

emotional change, and hyperarousal. The checklist has 20 items, each rated on a 5-point Likert scale, where 0 represents "never" and 4 represents "always". The Cronbach's alpha coefficients of this scale at T1, T2, and T3 were 0.899, 0.919, and 0.955, respectively.

Data analysis

We built a cross-lagged panel model to examine our hypotheses and used both SPSS 25.0 and Mplus 8.0 for data analysis. Both PTSD and depression were continuous variables and scored in the same way, and both were considered internalizing problems. Therefore, we summed the raw scores of the depression and PTSD scales at each time point, and used the resulting composite scores as an index of internalizing problems, in keeping with previous studies (Daughters et al., 2009; Murray et al., 2021; Wang et al., 2021).

Next, we used latent constructs to examine the longitudinal measurement invariance of internalizing problems (e.g., PTSD and depression), perceived parental depression, and intrusive rumination to determine whether they had the same meanings across different time points. Given the invariance of longitudinal measurement, we tested configural invariance models, weak invariance models, and strong invariance models, respectively. Configural invariance was the least restrictive level of measurement invariance, so we regarded it as the baseline model with which to compare the more restrictive models. The corresponding factor loadings (λ_s), intercepts (τ_s), and residual variances (ϵ_s) across the three time points were freely estimated in the configural invariance model. The weak invariance models were nested within the configural invariance model, and the corresponding factor loadings (λ_s) were set to be

equal across time points; intercepts (τ_s) and residual variances (ϵ_s) were set to vary freely. The strong invariance models restricted equal intercepts (τ_s) in addition to those parameters set already set in the weak invariance models, but allowed the residual variances (ϵ_s) to vary freely over time (Jorgensen, 2017).

We used the chi-square statistic, comparative fit index (CFI), Tucker–Lewis index (TLI) and root mean square error of approximation (RMSEA) to evaluate model fit. Changes in the CFI (ΔCFI) can indicate invariance of measurements. If $\Delta CFI \leq 0.01$, it indicates that the null hypothesis of invariance should be accepted (Cheung & Rensvold, 2002), which means that there is equivalence of relationships between items and their respective latent constructs over time. Table 1 shows that our models all have a good fit, and that the changes in model fits for PTSD, depression, perceived parental depression, and intrusive rumination all demonstrated invariance.

We then used descriptive and correlation analyses to assess the means and correlations among internalizing problems, intrusive rumination, and perceived parental depression across the three time points. Next, we constructed a cross-lagged model to examine the causal relationship between perceived parental depression and adolescents' internalizing problems at the three time points (see Fig. 2). Intrusive rumination was then inserted in this cross-lagged model to form a final cross-lagged mediating model (see Fig. 3). Next, to evaluate the significance levels of the indirect effects observed in the model, 1000 bootstrap resamples were extracted to estimate the 95% bias-corrected bootstrap confidence intervals (CIs) of the indirect effects.

To evaluate model fit, we used χ^2 values, CFI, TLI, RMSEA, and the standardized root mean square residual (SRMR). The general cutoffs for

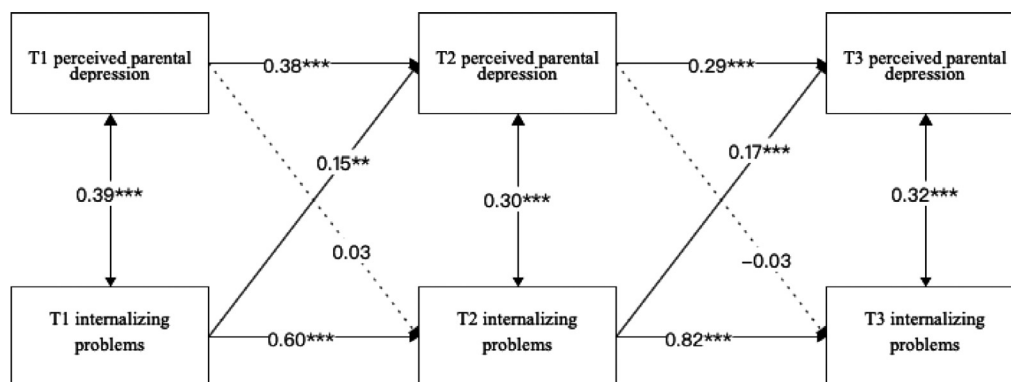


Fig. 2. Cross-lagged model of perceived parental depression and adolescents' internalizing problems. Notes: *** $p < .001$, ** $p < .01$. T1 = 12 months after the earthquake occurred; T2 = 21 months after the earthquake occurred; T3 = 27 months after the earthquake occurred. The model controlled for trauma exposure; for the sake of simplicity, paths related to trauma exposure are not marked in the figure. Solid lines denote significant pathways and dotted lines non-significant pathways; single arrows indicate predicted relationships and double arrows correlation relationships. The path coefficients are standardized.

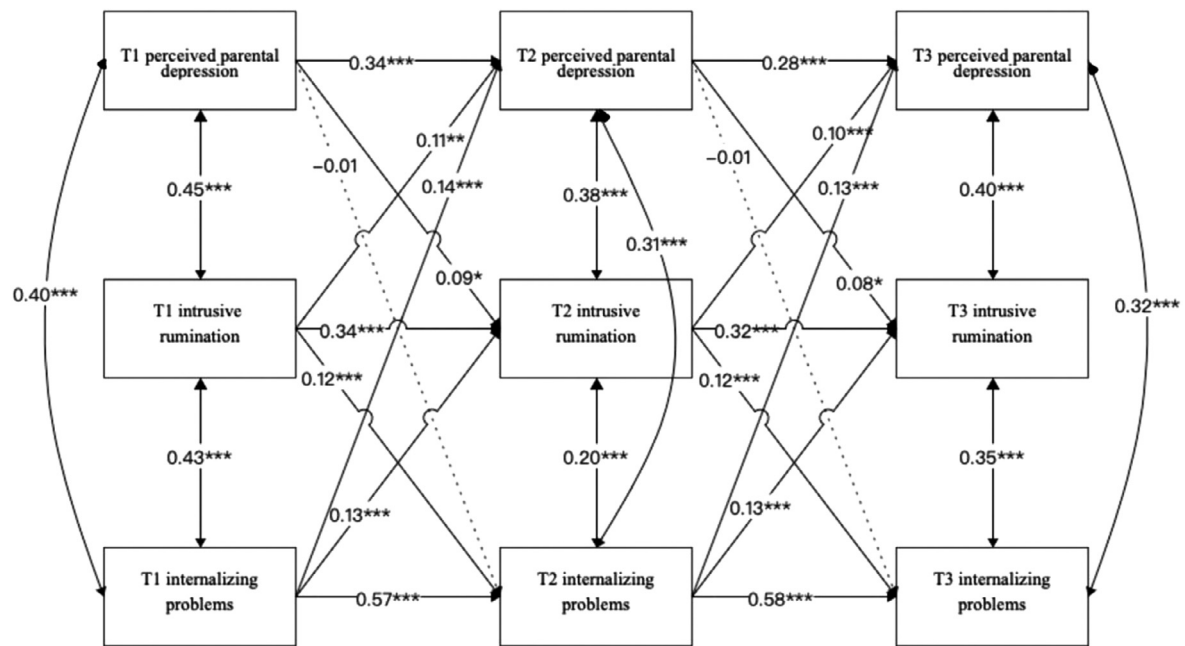


Fig. 3. Cross-lagged model of perceived parental depression, intrusive rumination, and adolescents' internalizing problems. Notes: *** $p < .001$, ** $p < .01$, * $p < .05$. T1 = 12 months after the earthquake occurred; T2 = 21 months after the earthquake occurred; T3 = 27 months after the earthquake occurred. The model controlled for trauma exposure; for the sake of simplicity, paths related to trauma exposure are not marked in the figure. Solid lines denote significant pathways and dotted lines non-significant pathways; single arrows indicate predicted relationships and double arrows correlation relationships. The path coefficients are standardized.

model acceptance were ≥ 0.90 for the CFI and TLI and < 0.08 for the SRMR and RMSEA (Wen et al., 2004). The large time span of longitudinal studies means that there will inevitably be missing values within the data. A Little's Missing Completely at Random (MCAR) test, $\chi^2(1024) = 1.09$, $p = .019$, indicated that the missing values in our data occurred in a non-random way. However, the missing values represented only 0.7% of the data in this study. This indicated that they could be handled by the robust maximum likelihood estimator (MLR), as shown in previous research (Chen & Liu, 2015; Gold & Bentler, 2000; Muthén et al., 2011, 1987; Schafer, 2003; Shin et al., 2009).

Results

Descriptive statistics and correlations among main measures

Table 2 shows the results of the descriptive analyses and correlations among the main measures across time points. We found that except for the non-significant correlations between internalizing problems at T1 and both perceived parental depression and intrusive rumination at T3, respectively, all correlations between perceived parental depression,

intrusive rumination, and internalizing problems at the three time points were significant. We also found that trauma exposure at T1 was significantly correlated with all three variables at both T1 and T2, so we controlled for T1 trauma exposure as a covariate in subsequent cross-lagged model analyses.

Longitudinal association between perceived parental depression, intrusive rumination, and internalizing problems

We first used a cross-lagged model to assess the longitudinal association between perceived parental depression and internalizing problems (Fig. 2). This model had good fit indices: $\chi^2(2) = 3.16$, CFI = 1.00, TLI = 0.98, RMSEA = 0.04 (90% CI: 0.00–0.12), SRMR = 0.01. We found that after controlling for T1 trauma exposure, internalizing problems had a significant and positive cross-lagged effect on perceived parental depression, but that perceived parental depression had a non-significant cross-lagged effect on internalizing problems.

Next, we inserted intrusive rumination at T1, T2, and T3 into our first model (Fig. 2) to build the model in Fig. 3. This model also had good fit indices: $\chi^2(17) = 34.63$, CFI = 0.99, TLI = 0.96, RMSEA = 0.05 (90%

Table 2
Correlations among main measures.

Variables	M(SD)	1	2	3	4	5	6	7	8	9
1.T1trauma exposure	2.50±1.41	1								
2.T1perceived parental depression	6.00±4.34	0.27**	1							
3.T2perceived parental depression	5.21±3.88	0.16*	0.33**	1						
4.T3perceived parental depression	6.32±3.75	0.12	0.34**	0.31**	1					
5.T1intrusive rumination	9.64±6.32	0.19**	0.45**	0.28**	0.19**	1				
6.T2intrusive rumination	8.46±6.11	0.18**	0.23**	0.45**	0.19**	0.40**	1			
7.T3intrusive rumination	9.77±5.46	0.13	0.24**	0.23**	0.40**	0.25**	0.28**	1		
8.T1internalizing problems	50.97±23.33	0.17*	0.36**	0.28**	0.06	0.42**	0.28**	0.12	1	
9.T2internalizing problems	45.78±23.04	0.15*	0.23**	0.40**	0.15**	0.29**	0.33**	0.19**	0.62**	1
10.T3internalizing problems	47.67±23.10	0.09	0.23**	0.27**	0.28**	0.32**	0.35**	0.37**	0.47**	0.62**

Notes: * $p < .05$, ** $p < .01$. M = mean scores; SD = standard deviation; T1 = 12 months after the earthquake occurred; T2 = 21 months after the earthquake occurred; T3 = 27 months after the earthquake occurred.

Table 3
Bias-corrected bootstrap tests of indirect paths.

Indirect paths	95%CI
T1 perceived parental depression - T2 intrusive rumination - T3 internalizing problems	[0.000 ^a , 0.025]
T1 internalizing problems - T2 perceived parental depression - T3 intrusive rumination	[0.000 ^b , 0.028]
T1 internalizing problems - T2 intrusive rumination - T3 perceived parental depression	[0.002, 0.028]
T1 intrusive rumination - T2 internalizing problems - T3 perceived parental depression	[0.005, 0.033]

Notes. ^a indicates that the lower limit of 95%CI is 0.000184, ^b indicates that the lower limit of 95%CI is 0.000086. T1 = 12 months after the earthquake occurred; T2 = 21 months after the earthquake occurred; T3 = 27 months after the earthquake occurred.

CI: 0.03–0.08), SRMR = 0.04. After controlling for trauma exposure at T1, we found the following: that perceived parental depression had a positive cross-lagged effect on intrusive rumination, but not internalizing problems, between T1 and T3; that intrusive rumination had positive cross-lagged effects on perceived parental depression and internalizing problems across the three time points; and that internalizing problems had positive cross-lagged effects on perceived parental depression and intrusive rumination between T1 and T3. Furthermore, the model also indicated the following four mediating paths: from internalizing problems at T1 to perceived parental depression at T3 via intrusive rumination at T2; from intrusive rumination at T1 to perceived parental depression at T3 via internalizing problems at T2; from internalizing problems at T1 to intrusive rumination at T3 via perceived parental depression at T2; and from perceived parental depression at T1 to internalizing problems at T3 via intrusive rumination at T2.

Next, we conducted bias-corrected bootstrap tests with a 95% CI to examine whether these four mediating paths were significant. As the lower limit in 95%CI of path from T1 perceived parental depression to T3 internalizing problems via T2 intrusive rumination and that of path from T1 internalizing problems to T3 intrusive rumination via T2 perceived parental depression were both very close to 0, we considered the two mediating paths as non-significant. Moreover, two mediating paths were significant: that from internalizing problems at T1 to perceived parental depression at T3 via intrusive rumination at T2; and that from intrusive rumination at T1 to perceived parental depression at T3 through internalizing problems at T2 (Table 3).

Discussion

Based on existing theoretical assumptions and empirical studies, the current study assessed the causal relationship between perceived parental depression, intrusive rumination, and internalizing problems among adolescents at three time points following the Jiuzhaigou earthquake. We found that although most of the variables were significantly correlated, there were non-significant correlations between internalizing problems at T1 and perceived parental depression and intrusive rumination at T3, respectively. One possible explanation for this is that the effect of internalizing problems on adolescents' cognition may not be permanent (Bierman et al., 2008). Because both intrusive rumination and perception of parental depression are individual cognitive factors, thus the direct relation between internalizing problems and these two cognitive variables may not persist over time. The results also indicated that adolescents with internalizing problems were likely to perceive more parental depression, but that adolescents who perceived parental depression did not report significant internalizing problems. In addition, the model indicated mutual cause-and-effect relationships between intrusive rumination and both perceived parental depression and internalizing problems, respectively.

The results suggested that not only do internalizing problems directly predict the parental depression adolescents perceive, but that

internalizing problems also have an indirect positive effect on perceived parental depression via intrusive rumination. In contrast, perceived parental depression did not significantly predict internalizing problems in adolescents. These findings suggested that the parental depression adolescents perceived following the Jiuzhaigou earthquake had no effect on their own post-traumatic reactions, which was inconsistent with the assumptions of existing family therapy theories (Hoffman, 2002; Mechling, 2015). Instead, this finding indicated that internalizing problems are a risk factor for perceiving parental depression, and emphasized that intrusive rumination is one potential mechanism through which internalizing problems can elicit mistaken perceptions of parental depression.

Specifically, adolescents' internalizing problems had a significant positive effect on the parental depression they perceived, which was consistent with previous findings (Platt et al., 2017; Rote et al., 2021). One possible reason for this is that adolescents with internalizing problems have biases toward negative stimuli, which may make them more sensitive to symptoms of depression in their parents (Klein et al., 2018). It is also possible that after experiencing a catastrophic event such as an earthquake, adolescents' internalizing problems increase parental attention and care toward them (Radovic et al., 2015). In these parent-child interactions, adolescents may discover evidence of parental depression, and thereby increase their further perception of it.

Counter to our hypothesis, we found that perceived parental depression did not significantly predict subsequent internalizing problems, which was inconsistent with previous findings (Brawer-Sherb et al., 2020; Mechling, 2015). One possible reason for this is that these previous studies were cross-sectional in design, and thus only reported the effect of perceived parental depression on adolescents' internalizing problems in the short term. Under a long-term post-trauma framework, adolescents who perceived their parents to be continually suffering from depression may have subconsciously chosen to distance themselves from their parents to protect themselves from being similarly affected by mental illness (Mordoch & Hall, 2008). This may explain why perceived parental depression did not have a significant effect on adolescents' mental health.

We found that inserting intrusive rumination in the relationship between perceived parental depression and adolescents' internalizing problems made no substantial changes to that relationship. However, we did find two significant indirect paths. First, adolescents' internalizing problems had an indirect positive effect on perceived parental depression through intrusive rumination. This finding supported both Beck's schema theory (Beck & Clark, 1997) and Bower's emotional memory processing theory (Bower, 1981). That is, when adolescents experienced the Jiuzhaigou earthquake, their internalizing problems made it easier for them to recollect past traumatic events. When adolescents observed their parents' negative emotions and behaviors in subsequent daily interactions with their parents, they may have spontaneously associated these negative behaviors with the catastrophic earthquake and begun to believe that it was this traumatic experience that caused their parents' negative reactions (Scheeringa & Zeanah, 2001; Tutus & Goldbeck, 2016). This may have increased the occurrence of intrusive rumination in adolescents and led them to overestimate their parents' mental health problems, thereby also exaggerating perceived parental depression.

Second, we found that intrusive rumination enhanced the parental depression adolescents perceived by facilitating internalizing problems, which supported the response-style model of rumination (Nolen-Hoeksema et al., 2008). This model posits that rumination, as a maladaptive response, makes individuals focus only on a negative event itself without solving any associated problems, and may also cause negative mood, thoughts, and perceptions (Chen & Feng, 2015). As a result of this, adolescents with intrusive rumination may dwell on crises, which can deepen their negative perceptions of major disaster episodes (Wisco et al., 2014; Wisco & Nolen-Hoeksema, 2010), thereby worsening the severity of trauma and exacerbating its adverse effects. This inevitably

induces negative emotions and increases the incidence of internalizing problems (Aldao et al., 2010; Yu et al., 2021). In turn, these internalizing problems both engender negative bias in adolescents' cognitive processing and cause them to habitually interpret external stimuli pessimistically (Connolly et al., 2017). As such stimuli include their parents' emotional state, this could increase their perception of parental depression.

Our model suggested that intrusive rumination could also have a direct effect on perceived parental depression. This finding supports the attention scope model (Whitmer & Gotlib, 2013). After adolescents experienced the Jiuzhaigou earthquake, it is possible that intrusive rumination made them keep reviewing disturbing earthquake-related scenes and conditions (Nolen-Hoeksema et al., 2008). This could have led them to overstate the traumatic results of the catastrophe, especially the negative impact of the natural disaster on significant relatives—their parents. In this way, intrusive rumination may have enhanced the parental depression they perceived.

We should note several limitations of this study. First, we used only self-report questionnaires to assess the relationship of perceived parental depression, intrusive rumination, and internalizing problems, which may have caused self-report bias. Second, the adolescents who participated in the survey attended only two schools, so whether the above results are representative of the mental state of all adolescents across the region is uncertain. Third, because of the extended time span of this longitudinal study, we did not assess whether adolescents experienced other traumatic events during the follow-up measurement period. Fourth, although we conducted this longitudinal study to elucidate the relationship between perceived parental depression, intrusive rumination, and internalizing problems in adolescents after trauma, we were unable to account for depression and PTSD in the adolescents or their parents prior to the earthquake, which may affect our understanding of these variables. Moreover, although this study measured adolescents' perception of parental depression, we did not collect parents' self-reported depression. Furthermore, when examining the causal mechanism between perceived parental depression and internalizing problems, we investigated only the role of intrusive rumination; future research should consider other possible variables.

Despite these limitations, to our knowledge this is the first study to examine the causal relationships between perceived parental depression, intrusive rumination, and internalizing problems. As such, it contributes new knowledge to theories of family therapy by suggesting that mutual cause-and-effect relationships exist between intrusive rumination and both perceived parental depression and internalizing problems, respectively. Specifically, it highlights that internalizing problems are an important risk factor for perceived parental depression, and emphasizes that intrusive rumination is its underlying mechanism. Intrusive rumination is a similarly important risk factor for perceived parental depression, with internalizing problems as its potential mechanism. This study clearly shows that perceived parental depression does not affect the internalizing problems of adolescents in either direct or indirect ways. In terms of practical application, our findings suggest that for adolescents, psychological interventions following trauma should focus on both addressing internalizing problems and relieving intrusive rumination.

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Declaration of Competing Interest

None.

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