




Rumination as a Mediator Between Peer Rejection and Depressive Symptoms in Teens

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Article Info

Article type:

Original Research

How to cite this article:

Karna, W., Wright, A., & Mata, G. (2025). Rumination as a Mediator Between Peer Rejection and Depressive Symptoms in Teens. *Journal of Assessment and Research in Applied Counseling*, 7(3), 1-9.

<http://dx.doi.org/10.61838/kman.jarac.7.3.16>



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ABSTRACT

Objective: This study aimed to examine whether rumination mediates the relationship between peer rejection and depressive symptoms in adolescents.

Methods and Materials: A descriptive correlational design was employed with a sample of 380 adolescents aged 13 to 18 from secondary schools in London. The sample size was determined based on the Morgan and Krejcie sample size table to ensure statistical power. Standardized self-report instruments were used to assess peer rejection, rumination, and depressive symptoms. Data were analyzed using Pearson correlation coefficients in SPSS-27 and Structural Equation Modeling (SEM) in AMOS-21 to test the hypothesized mediation model. Model fit was assessed using χ^2/df , CFI, GFI, AGFI, TLI, and RMSEA.

Findings: Descriptive statistics indicated moderate levels of depressive symptoms ($M = 22.84$, $SD = 6.73$), rumination ($M = 30.42$, $SD = 5.26$), and peer rejection ($M = 18.67$, $SD = 4.89$). Pearson correlation results revealed significant positive correlations between depressive symptoms and both rumination ($r = .54$, $p < .001$) and peer rejection ($r = .46$, $p < .001$). Rumination was also positively correlated with peer rejection ($r = .39$, $p < .001$). SEM showed good model fit ($\chi^2 = 104.23$, $df = 48$, $\chi^2/df = 2.17$, CFI = .97, RMSEA = .056), and confirmed that rumination significantly mediated the relationship between peer rejection and depressive symptoms (indirect effect: $b = 0.23$, $\beta = .17$, $p < .001$). The total effect of peer rejection on depressive symptoms was $b = 0.54$, $\beta = .45$, $p < .001$.

Conclusion: The findings suggest that rumination plays a significant mediating role in the association between peer rejection and depressive symptoms in adolescents. Interventions aimed at reducing ruminative thought patterns may mitigate the impact of peer-related stressors on adolescent mental health.

Keywords: Peer rejection, rumination, depressive symptoms, adolescence.

1. Introduction

Depression is one of the most prevalent mental health issues among adolescents, with significant consequences for psychosocial functioning, academic achievement, and long-term wellbeing. Research indicates that cognitive vulnerabilities such as rumination and distorted self-referential thinking can heighten the likelihood of developing depressive symptoms in the face of environmental stressors (Alba & Calvete, 2019; Caouette & Guyer, 2016). Rumination, defined as the repetitive and passive focus on negative emotions and their causes and consequences, has been extensively linked to the onset and maintenance of depression (Harmon et al., 2017; Stone et al., 2017). Adolescents who engage in high levels of rumination tend to amplify their emotional responses to rejection and failure, making them more susceptible to prolonged depressive episodes (Monti et al., 2017; Stone & Gibb, 2017).

Peer rejection, which encompasses experiences of social exclusion, neglect, or active victimization, has been identified as a potent predictor of emotional disorders during adolescence. The developmental significance of peer relationships during this period cannot be overstated. As adolescents transition away from parental dependence, their sense of belonging and self-worth becomes increasingly tied to peer acceptance (Copeland, 2021; Fussner et al., 2016). Disruptions in these social bonds, such as rejection or exclusion, can threaten adolescents' psychological security and initiate a cascade of negative emotional and cognitive responses (Criss et al., 2016). Several longitudinal studies have demonstrated that experiences of peer rejection predict elevated levels of internalizing symptoms, including sadness, hopelessness, and suicidal ideation (Fan et al., 2016; Perron-Gélinas et al., 2017).

Despite the robust association between peer rejection and depression, not all adolescents who experience rejection develop depressive symptoms, suggesting the presence of intervening variables. Cognitive processes such as rumination have been proposed as key mediators in this relationship. Theoretical models posit that when adolescents experience rejection, those with a tendency to ruminate are more likely to engage in self-critical and perseverative thought patterns, which reinforce feelings of inadequacy and sadness (Rose et al., 2016; Spyropoulou & Giovazolias, 2022). These thoughts may, in turn, solidify negative self-schemas and prevent effective problem-solving or emotional

regulation, thereby increasing vulnerability to depression (Masuya et al., 2025; Stone et al., 2017).

Empirical research supports the mediating role of rumination in the link between peer rejection and depression. For instance, Monti et al. (2017) found that rumination about socially stressful events mediated the relationship between peer victimization and depressive symptoms in middle childhood (Monti et al., 2017). Similarly, Dorio et al. (2018) reported that adolescents who were victimized by peers and engaged in rumination showed lower levels of school engagement and higher levels of depressive symptoms (Dorio et al., 2018). These findings underscore the importance of cognitive styles in shaping adolescents' emotional responses to negative social experiences.

Another body of literature has focused on the construct of rejection sensitivity, which refers to the disposition to anxiously expect and overreact to social rejection. Rejection sensitivity has been shown to interact with rumination in predicting depressive outcomes (Giovazolias, 2023; Noda et al., 2022). Adolescents high in rejection sensitivity are more likely to perceive ambiguous social cues as rejection and dwell on these experiences in maladaptive ways. Noda et al. (2022) demonstrated that rumination mediated the relationship between rejection sensitivity and depressive symptoms among Japanese outpatients, indicating that the cognitive interpretation of rejection plays a crucial role in emotional outcomes (Noda et al., 2022). These findings are consistent with the broader framework of cognitive vulnerability-stress interaction models, which emphasize the interplay between environmental stressors and individual cognitive styles in the development of psychopathology.

In addition to personal traits, contextual and developmental factors can influence the impact of peer rejection and rumination on adolescent depression. For example, McGuire et al. (2019) found that pubertal maturation was associated with greater emotional reactivity and an increased tendency toward depressive symptoms, particularly in girls (McGuire et al., 2019). This may be due to hormonal shifts, heightened self-consciousness, or increased importance of peer relationships during puberty. Moreover, emotion dysregulation has been found to mediate the association between peer rejection and depressive symptoms over time, suggesting that difficulties in managing emotional responses may reinforce ruminative thinking and internalizing problems (Fussner et al., 2016). Similarly, Evans and Fite (2018) proposed a dual-pathway model in which reactive aggression and social withdrawal

each contribute to depressive outcomes through different cognitive and emotional mechanisms (Evans & Fite, 2018).

Recent neurobiological research has also begun to uncover the physiological correlates of rumination and peer rejection. For instance, Stone et al. (2017) reported that depressed adolescents exhibited atypical pupillary responses to peer acceptance and rejection cues, with rumination moderating these physiological responses (Stone & Gibb, 2017). These findings suggest that rumination not only affects self-reported emotional states but also modulates neurobiological reactivity to social stimuli. Such evidence reinforces the conceptualization of rumination as a maladaptive cognitive-emotional regulation strategy that sustains depressive affect in the face of social adversity.

The role of co-rumination—defined as excessive discussion of problems and negative emotions with peers—has also garnered attention in recent literature. While co-rumination can initially foster social bonds, it may ultimately reinforce negative thinking patterns and increase vulnerability to depression (Rose et al., 2016; Stone et al., 2017). Rose et al. (2016) found that co-rumination predicted stress generation and depressive symptoms among adolescents, particularly those who already exhibited internalizing tendencies. Similarly, Stone and Gibb (2017) concluded that co-rumination contributes to the maintenance of depressive risk by fostering further rumination, thus creating a feedback loop of negative affect (Stone et al., 2017). These findings emphasize the complex social and cognitive dynamics that underlie adolescent emotional development.

In cross-cultural contexts, the interplay of peer rejection, rumination, and depressive symptoms may manifest differently based on societal norms and relational values. For instance, Masuya et al. (2025) examined Japanese adults and found that depressive rumination mediated the impact of peer victimization and parental attitudes on anxiety, highlighting the enduring effects of social experiences across developmental stages (Masuya et al., 2025). Similarly, Fan et al. (2016) demonstrated that both rumination and co-rumination mediated the association between interpersonal stressors and depressive symptoms among Chinese adolescents (Fan et al., 2016). These findings highlight the universality of these mechanisms while also suggesting the potential influence of cultural values on emotional coping strategies.

Although the literature supports the link between peer rejection and adolescent depression, as well as the mediating role of rumination, more research is needed to clarify the

directionality and strength of these relationships across diverse adolescent populations. Moreover, while existing studies have often focused on clinical or high-risk samples, there is a growing need to examine these mechanisms within general adolescent populations to inform school-based and community interventions. Adolescents in urban centers like London may face unique social pressures and relational dynamics, making it crucial to assess how these psychosocial variables operate in real-world settings.

The current study seeks to fill this gap by investigating the mediating role of rumination in the relationship between peer rejection and depressive symptoms in a non-clinical adolescent sample.

2. Methodology

2.1. Study Design and Participants

This study utilized a descriptive correlational design to investigate the mediating role of rumination in the relationship between peer rejection and depressive symptoms in adolescents. The sample consisted of 380 teenagers (aged 13 to 18) recruited from secondary schools across London. The sample size was determined based on the Morgan and Krejcie (1970) sample size table to ensure adequate statistical power. A multistage cluster sampling method was employed to ensure representativeness from different school districts. Participation was voluntary, and informed consent was obtained from all participants and their legal guardians. Ethical approval was secured from the institutional review board prior to data collection.

2.2. Measures

2.2.1. Depressive Symptoms

To assess depressive symptoms in adolescents, the Children's Depression Inventory 2 (CDI-2) developed by Maria Kovacs (2011) was used. The CDI-2 is a widely utilized self-report instrument designed to measure the severity of depressive symptoms in children and adolescents aged 7 to 17. It consists of 28 items divided into two main scales: Emotional Problems and Functional Problems. These are further broken down into four subscales: Negative Mood/Physical Symptoms, Negative Self-Esteem, Ineffectiveness, and Interpersonal Problems. Each item is rated on a 3-point Likert scale (0 to 2), with higher scores indicating greater depressive symptomatology. The CDI-2 provides a total score reflecting the overall level of depressive symptoms. Numerous studies have confirmed the

strong internal consistency and test-retest reliability of the CDI-2, and its validity has been supported through correlations with clinical diagnoses and other established measures of depression (Faro et al., 2025; Wang et al., 2024; Zheng et al., 2024).

2.2.2. Rumination

Rumination was measured using the Ruminative Responses Scale – Short Form (RRS-SF), a standardized tool developed by Treynor, Gonzalez, and Nolen-Hoeksema (2003). This 10-item self-report scale is derived from the original 22-item Ruminative Responses Scale and specifically measures the tendency to engage in repetitive, passive focus on symptoms of distress and their possible causes and consequences. The RRS-SF includes two subscales: Brooding and Reflection. Each item is rated on a 4-point Likert scale ranging from 1 (almost never) to 4 (almost always), with higher scores indicating a greater tendency toward ruminative thinking. The short form was created to improve construct validity by eliminating items overlapping with depressive content. The RRS-SF has demonstrated good internal consistency and factorial validity in adolescent samples, and its reliability and convergent validity have been confirmed in both clinical and non-clinical populations (Polat, 2025; Wang, 2025; Zhao, 2025).

2.2.3. Peer Rejection

Peer rejection was assessed using the Peer Experiences Questionnaire (PEQ) developed by Prinstein, Boergers, and Vernberg (2001). The PEQ is a self-report measure designed to assess adolescents' experiences with peer victimization and social exclusion. It includes 18 items that cover three subscales: overt victimization, relational victimization, and reputational victimization. Responses are recorded on a 5-point Likert scale ranging from 1 (never) to 5 (a few times a week), with higher scores indicating more frequent

experiences of peer rejection. The PEQ has been used widely in adolescent research and has demonstrated strong internal consistency and construct validity. Prior studies have also supported its predictive validity in relation to emotional and behavioral outcomes, including depressive symptoms, thus affirming its utility in studies involving peer-related stressors and psychological adjustment (Perron-Gélinas et al., 2017; Tajabadi et al., 2020; Wright & Wachs, 2019).

2.3. Data Analysis

Data were analyzed using SPSS version 27 and AMOS version 21. Descriptive statistics were calculated to summarize the demographic characteristics of the sample. Pearson correlation coefficients were computed to examine the bivariate relationships between peer rejection, rumination, and depressive symptoms. Subsequently, Structural Equation Modeling (SEM) was used to assess the hypothesized mediating effect of rumination between peer rejection and depressive symptoms. Model fit was evaluated using multiple indices, including the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Chi-square to degrees of freedom ratio (χ^2/df).

3. Findings and Results

Of the 380 adolescents who participated in the study, 207 (54.47%) identified as female and 173 (45.53%) as male. Regarding age distribution, 84 participants (22.10%) were aged 13–14, 144 participants (37.89%) were aged 15–16, and 152 participants (40.00%) were aged 17–18. In terms of ethnicity, 186 participants (48.95%) identified as White British, 92 (24.21%) as Black British, 61 (16.05%) as South Asian, and 41 (10.79%) as belonging to other ethnic backgrounds. Most participants ($n = 312$; 82.11%) reported living in two-parent households, while the remaining 68 participants (17.89%) lived in single-parent or alternative caregiving arrangements.

Table 1

Descriptive Statistics for Study Variables (N = 380)

Variable	Mean (M)	Standard Deviation (SD)
Depressive Symptoms	22.84	6.73
Rumination	30.42	5.26
Peer Rejection	18.67	4.89

Table 1 presents the descriptive statistics for the study variables. The mean score for depressive symptoms was

22.84 (SD = 6.73), while the mean score for rumination was 30.42 (SD = 5.26). Peer rejection had a mean of 18.67 (SD

= 4.89). These scores reflect moderate levels of depressive symptoms and cognitive-affective risk, as measured by the standard tools described previously.

Before conducting the main analyses, assumptions for Pearson correlation and SEM were examined. Normality was assessed by inspecting skewness and kurtosis values, all of which fell within acceptable ranges (skewness between -0.71 and 0.64; kurtosis between -0.88 and 0.93). Linearity and homoscedasticity were visually confirmed through

scatterplots. No multivariate outliers were detected based on Mahalanobis distance (maximum value = 13.45, below the critical χ^2 value of 16.27 for 3 variables at $p < .001$). Additionally, the Variance Inflation Factor (VIF) values ranged from 1.11 to 1.37, indicating no multicollinearity. These findings confirmed that the data met the statistical assumptions required for both Pearson correlation and SEM analysis.

Table 2

Pearson Correlation Coefficients Between Variables (N = 380)

Variable	1	2	3
1. Depressive Symptoms	—		
2. Rumination	.54***	—	
3. Peer Rejection	.46***	.39***	—

The correlation matrix in Table 2 displays the Pearson correlation coefficients between all study variables. Depressive symptoms were significantly positively correlated with rumination ($r = .54$, $p < .001$) and peer rejection ($r = .46$, $p < .001$). Rumination was also

significantly correlated with peer rejection ($r = .39$, $p < .001$). These results suggest strong, positive associations between peer-related stressors, cognitive processes, and depressive outcomes.

Table 3

Fit Indices for the Structural Equation Model

Fit Index	Value
Chi-Square (χ^2)	104.23
Degrees of Freedom (df)	48
χ^2/df	2.17
GFI	.96
AGFI	.93
CFI	.97
TLI	.95
RMSEA	.056

Table 3 shows the fit indices for the structural equation model used to test the hypothesized mediation model. The model demonstrated an acceptable fit to the data: $\chi^2 = 104.23$, $df = 48$, $\chi^2/df = 2.17$, $GFI = .96$, $AGFI = .93$, $CFI =$

.97, $TLI = .95$, and $RMSEA = .056$. These indices fall within commonly accepted thresholds, supporting the adequacy of the proposed model structure.

Table 4

Path Coefficients in the Structural Model

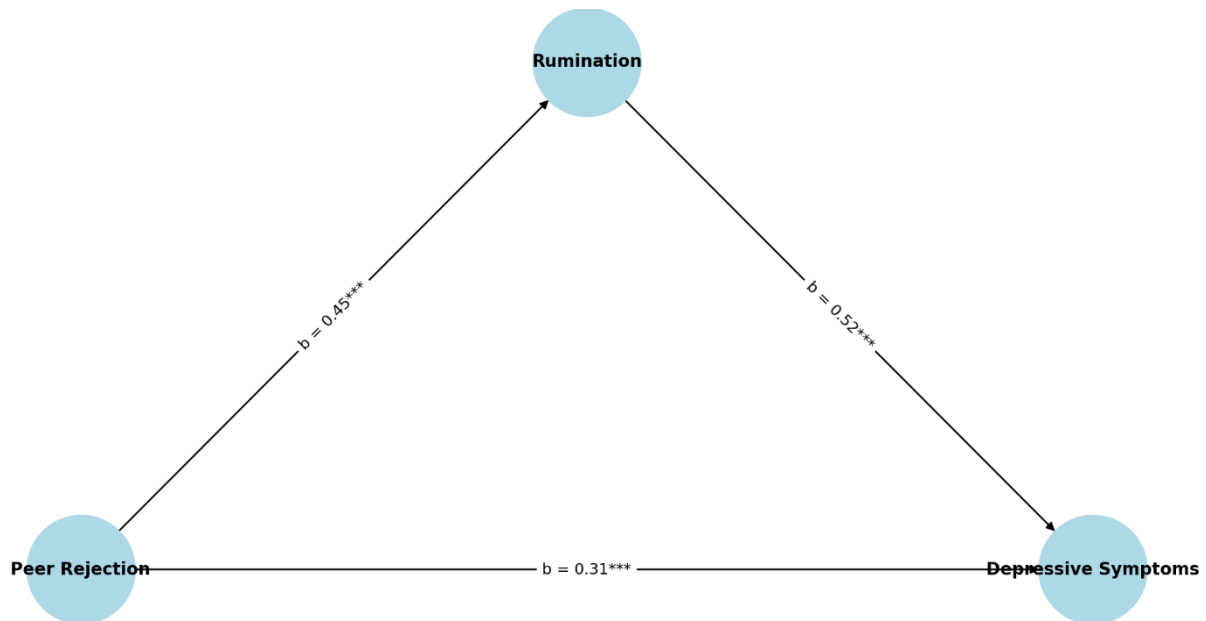
Path	b	SE	β	p
Peer Rejection → Depressive Symptoms	0.31	0.07	.28	< .001
Peer Rejection → Rumination	0.45	0.08	.39	< .001
Rumination → Depressive Symptoms	0.52	0.06	.44	< .001
Peer Rejection → Rumination → Depressive Symptoms (Indirect)	0.23	0.05	.17	< .001
Total Effect (Direct + Indirect)	0.54	0.09	.45	< .001

Table 4 summarizes the path coefficients for the structural model. The direct path from peer rejection to depressive symptoms was significant ($b = 0.31$, $SE = 0.07$, $\beta = .28$, $p < .001$), as was the path from peer rejection to rumination ($b = 0.45$, $SE = 0.08$, $\beta = .39$, $p < .001$), and from rumination to depressive symptoms ($b = 0.52$, $SE = 0.06$, β

$= .44$, $p < .001$). The indirect path from peer rejection to depressive symptoms via rumination was also significant ($b = 0.23$, $SE = 0.05$, $\beta = .17$, $p < .001$). The total effect of peer rejection on depressive symptoms (including both direct and indirect paths) was $b = 0.54$, $SE = 0.09$, $\beta = .45$, $p < .001$, confirming the hypothesized mediation.

Figure 1

Model with Beta Coefficients



4. Discussion and Conclusion

The present study aimed to examine the mediating role of rumination in the relationship between peer rejection and depressive symptoms in adolescents. Using data from 380 participants in London, Pearson correlations and Structural Equation Modeling (SEM) revealed significant positive associations among all three variables. Specifically, peer rejection was positively correlated with both rumination and depressive symptoms, and rumination itself was positively correlated with depressive symptoms. The SEM analysis confirmed that rumination significantly mediated the relationship between peer rejection and depressive symptoms, suggesting that adolescents who experience higher levels of peer rejection are more likely to engage in ruminative thinking, which in turn increases their risk of experiencing depressive symptoms.

These findings align with a growing body of research indicating that peer rejection is a potent predictor of internalizing problems in adolescence, particularly

depressive symptoms. Peer rejection can disrupt adolescents' sense of belonging and self-worth, which are critical during this developmental stage (Copeland, 2021; Criss et al., 2016). Adolescents who are rejected by their peers are more vulnerable to emotional maladjustment, not only because of the immediate stress rejection causes but also due to the enduring cognitive patterns it activates (Fussner et al., 2016; Perron-Gélinas et al., 2017). Consistent with previous studies, the current findings support the view that negative peer experiences, such as victimization or exclusion, act as environmental triggers for depressive processes (Evans & Fite, 2018; Fan et al., 2016).

The mediating effect of rumination reinforces existing models that conceptualize it as a maladaptive cognitive process amplifying emotional distress in adolescents. Rumination involves repetitive and passive focus on one's distress and the potential causes and consequences of that distress, often leading to a deepening of negative mood and a prolonged duration of depressive episodes (Harmon et al., 2017; Stone et al., 2017). The present findings echo those of

Monti et al. (2017), who found that rumination about social stress significantly mediated the link between peer victimization and depressive symptoms in middle childhood (Monti et al., 2017). Likewise, Dorio et al. (2018) demonstrated that rumination explained the negative impact of peer victimization on both depressive symptoms and school disengagement in adolescents (Dorio et al., 2018). These patterns highlight the centrality of internal cognitive processes in how adolescents interpret and respond to peer-related adversity.

Furthermore, the results resonate with research on rejection sensitivity, a construct closely related to peer rejection. Studies have shown that adolescents high in rejection sensitivity tend to interpret ambiguous social cues as negative and ruminate over perceived slights, thereby elevating depressive symptoms (Giovazolias, 2023; Noda et al., 2022). In this regard, the current study builds on the work of Noda et al. (2022), who identified rumination as a mediator between rejection sensitivity and depressive outcomes in a Japanese outpatient sample. The convergence of findings across cultural contexts suggests that rumination may serve as a universal mechanism through which social rejection contributes to internalizing problems.

The relationship among these constructs may also be partly explained by emotion dysregulation. Adolescents who are rejected by peers may lack effective emotional regulation strategies and thus rely on rumination, which exacerbates their distress and fosters depressive thinking (Fussner et al., 2016). Additionally, neurocognitive evidence supports the link between rumination and altered emotional reactivity. Stone et al. (2017) observed that depressed adolescents exhibited abnormal pupillary responses to peer rejection and acceptance cues, moderated by rumination levels (Stone & Gibb, 2017). Such findings offer a biological basis for the cognitive-emotional pathways implicated in this study, suggesting that rumination may be both a psychological and physiological response to social stress.

Another factor to consider is the social context in which rumination occurs. Co-rumination, or the tendency to dwell on problems excessively in conversations with peers, has been identified as a contributing factor to adolescent depression (Rose et al., 2016). Although it may initially serve to enhance peer closeness, co-rumination can reinforce negative cognitive patterns and increase depressive symptoms, especially in adolescents with a predisposition toward internalizing behaviors (Stone & Gibb, 2017; Stone et al., 2017). The interplay between co-rumination and peer rejection deserves further investigation, as adolescents who

are rejected may either withdraw socially or seek validation through co-ruminative interactions, both of which can maintain depressive symptoms.

Developmental and cultural influences also shape these relationships. McGuire et al. (2019) noted that pubertal maturation can increase emotional vulnerability and magnify the effects of interpersonal stress, including peer rejection, on mental health outcomes (McGuire et al., 2019). In collectivist cultures, interpersonal harmony and social approval may hold even greater importance, leading to heightened emotional responses to rejection and a greater tendency to ruminate (Fan et al., 2016; Masuya et al., 2025). These cultural variations underline the importance of context-sensitive interventions that address both social and cognitive vulnerabilities.

Interestingly, the role of sports and extracurricular engagement has been examined as a potential buffer against the negative effects of rejection and rumination. For example, Perron-Gélinas et al. (2017) found that sports participation moderated the effects of depression and aggression on peer rejection, suggesting that structured group activities may help adolescents build social competence and reduce vulnerability to depressive symptoms (Perron-Gélinas et al., 2017). Although this study did not investigate such moderators, the findings imply that targeting ruminative thinking and enhancing social engagement may reduce the psychological burden of peer rejection.

Taken together, the results support an integrated model of adolescent depression that incorporates environmental stressors (peer rejection), cognitive vulnerabilities (rumination), and affective outcomes (depressive symptoms). This model is aligned with previous research emphasizing the transactional nature of adolescent development, where experiences with peers influence cognition, which in turn shapes emotional health (Caouette & Guyer, 2016; Criss et al., 2016). Adolescents' responses to social adversity are not solely dependent on the presence of external stressors but are mediated through internal processing mechanisms that can be targeted through therapeutic and preventive strategies.

5. Limitations & Suggestions

Despite the strengths of this study, several limitations should be acknowledged. First, the cross-sectional design precludes any causal inference about the directionality of relationships among peer rejection, rumination, and

depressive symptoms. Longitudinal studies are needed to examine how these constructs interact over time and whether rumination precedes depressive symptoms following peer rejection or vice versa. Second, data were collected exclusively through self-report measures, which may introduce biases related to social desirability or inaccurate recall. Although the instruments used are well-validated, the inclusion of teacher or peer ratings and behavioral observations would provide a more comprehensive assessment. Third, the study sample was limited to adolescents from London, which may restrict the generalizability of the findings. Cultural norms and peer dynamics may differ significantly across geographical regions and social contexts. Lastly, while the model focused on rumination as a mediator, other potential mediators such as self-esteem, emotion regulation, and social support were not included and may provide further insights into the mechanisms linking peer rejection to depression.

Future research should employ longitudinal designs to examine how the relationships among peer rejection, rumination, and depressive symptoms evolve across time and developmental stages. It would be valuable to investigate whether early experiences of peer rejection during middle childhood set the stage for chronic rumination and depressive patterns in later adolescence. Additionally, experimental and intervention studies are needed to assess the effectiveness of cognitive-behavioral strategies aimed at reducing rumination and improving social coping skills in adolescents at risk for peer rejection. Future studies could also examine moderators of these relationships, such as gender, pubertal timing, or cultural values related to social connectedness. Moreover, the inclusion of neurobiological or physiological markers—such as cortisol levels, heart rate variability, or brain imaging—would deepen our understanding of how cognitive and emotional responses to peer rejection manifest at the biological level. Finally, future research should explore the role of online peer interactions and cyber-rejection, which are increasingly relevant in today's digital adolescent landscape.

The findings of this study have important implications for practitioners working with adolescents in educational and clinical settings. School counselors, psychologists, and educators should be vigilant about identifying students who experience peer rejection, as they may be at elevated risk for developing depressive symptoms through rumination. Interventions that teach adolescents how to challenge negative thought patterns, reduce ruminative thinking, and build effective coping strategies may be particularly

beneficial. Social skills training and peer mentoring programs could help rejected adolescents form positive relationships and reduce social isolation. Moreover, fostering inclusive school climates that discourage bullying and exclusion may prevent the initial emergence of peer rejection. Group-based cognitive-behavioral therapy programs may be well-suited for addressing both the cognitive and social aspects of depression. Lastly, parent education programs can equip caregivers with tools to support their children's emotional health and help them navigate complex peer dynamics.

Acknowledgments

We would like to express our appreciation and gratitude to all those who cooperated in carrying out this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

Funding

This research was carried out independently with personal funding and without the financial support of any governmental or private institution or organization.

Authors' Contributions

All authors equally contributed in this article.

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